

Piping questionnaire API 570



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PIPING QUESTIONNAIRE

Questions related to Codes & standard: -

1. What is the ASME code followed for design of piping systems in Process piping (Refineries & Chemical Industries)?

- (i) B 31.1
- (ii) B 31.3
- (iii) B 31.5
- (iv) B 31.9

Answer (II)

2. Which American institute standard does piping engineer refer?

Answer: -

- A. The American Petroleum institute (API).
- B. The American Iron & Steel institute (AISI).
- C. The American Society for Testing and materials (ASTM).
- D. The American National standard institute (ANSI).
- E. The American welding society (AWS).
- F. The American Water Works Association (AWWA).
- G. The American Society for Mechanical Engineers (ASME).

3. What is the different ASME 31 code for pressure piping?

Answer: -

- A. ASME B31.1 - Power piping.
- B. ASME B31.2 - Fuel Gas Piping.
- C. ASME B31.3 - Process piping.
- D. ASME B31.4 - Pipeline Transportation system for liquid hydrocarbon & other liquid.
- E. ASME B31.5 - Refrigeration Piping.
- F. ASME B31.8 - Gas transmission & distribution piping system.
- G. ASME B31.9 - Building services piping.
- H. ASME B31.11 - Slurry transportation piping system.

4. What are the different sections of ASME code? Where these sections are referred?

Answer: -

- A. ASME section I : - Rules for construction of power boiler.
- B. ASME Section II : - Materials.
 - Part A – Ferrous materials.
 - Part B – Non-Ferrous materials.
 - Part C – Specification for electrodes & filler wire.
 - Part D – Properties.
- C. ASME Section IV : - Rules for construction of Heating Boiler.
- D. ASME Section V : - Non- destructive Examination.
- E. ASME Section VI : - Recommended rules for care & operation of heating boiler.
- F. ASME Section VII : - Recommended guidelines for care of power boiler.
- H. ASME Section VIII : - Rules for construction of pressure vessels. (Division I & II)
- I. ASME Section IX : - Welding & Brazing qualification.

5. Which American standard is referred for selection of following piping element?
A. Flanges B. Butt Welded fittings C. Gasket D. Socket & Threaded fittings
E. Valves F. Pipes.

Answer: -

A. Flanges :-

- I. ASME B16.1 :- Cast iron pipes flanges & flanged fittings.
- II. ASME B16.5 :- Carbon steel pipes flanges & flanged fittings. (Up to 24")
- III. ASME B16.47 :- Large Diameter steel flanges. (Above 24")

B. Butt welded fittings :-

- I. ASME B16.9 :- Steel butt welding fittings.
- II. ASME B16.28 :- Butt-welded short radius elbows & returns bends.

C. Gasket :-

- I. ASME B16.20 / API -601: - Metallic gaskets for pipe flanges- Spiral wound, Octagonal ring Joint & Jacketed flanges.
- II. ASME B16.21 :- Non metallic gasket.

D. Socket & Threaded fittings :

- I. ASME B16.11 :- Forged steel socket welding & threaded fittings.

E. Valves :-

- I. ASME B16.10 :- Face to face & end to end dimension of valves.
- II. ASME B16.34 :- Flanged & butt-welded ends steel valves (Pressure & Temperature ratings) except Ball, Plug & Butter fly Valves.

F. Pipes :-

- I. ASME B36.10 :- Welded & Seamless wrought iron pipes.
- II. ASME B36.19 :- Stainless steel pipes.

Questions related to Materials: -

1. What is the ASTM code for the following?

A. Pipes :-

- I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

B. Tubes: -

- I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

C. Wrought Iron Fittings: -

- I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

D. Forged Fittings: -

- I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

E. Cast Fittings: -

- I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

F. Plates: -

- I. Carbon Steel II. Alloy Steel III. Stainless Steel IV. Nickel Steel.

Answer: -

A. Pipes:-

- I. Carbon Steel :- ASTM A53 Gr. A/B, ASTM A106 Gr. A/B/C, ASTM A333 Gr.1/Gr.6
- II. Alloy Steel :- ASTM A335 Gr.P1/P2/P5/P7/P9/P11/P12/P22.
- III. Stainless Steel :- ASTM A312TP304/TP304L/TP304H/TP308/TP310/TP316/TP316L/TP316H/TP317/TP321/TP321H/TP347/TP347H/TP348/TP348H.
- IV. Nickel Steel :- ASTM A333Gr.3/ Gr.8.

B. Tubes:-

- I. Carbon Steel** :- ASTM A178/179/192, ASTM A334 Gr.1/6.
- II. Alloy Steel** :- ASTM A161T1, ASTM A213T1/T2/T5/T7/T9/T11/T12/T22.
- III. Stainless Steel** :- ASTM A213 TP304/TP304L/TP304H/TP310/TP316/TP316L/TP316H/TP317/TP321/TP321H/TP347/TP347H/TP348/TP348H, ASTM A608 HK40.
- IV. Nickel Steel** :- ASTM A334Gr.3/Gr.8

C. Wrought Iron fittings :-

- I. Carbon Steel** :- ASTM A234Gr.WPA/B, ASTM A420 Gr.WPL6.
- II. Alloy Steel** :- ASTM A234 WP1/WP5/WP7/WP9/WP11/WP12/WP22.
- III. Stainless Steel** :- ASTM A403 WP304/WP304L/WP304H/WP309/WP310/WP316/WP316L/WP316H/ WP317/WP321/WP321H/WP347/WP347H/ WP348.
- IV. Nickel Steel** :- ASTM A420WPL6/WPL8.

D. Forged Fittings :-

- I. Carbon Steel** :- ASTM A181. ASTM A105, ASTM A350 LF1/2.
- II. Alloy Steel** :- ASTM A182F1/F2/F5/F7/F9/F11/F12/F22.
- III. Stainless Steel** :- ASTM A182F6/F304/F304L/F304H/F310/F316/F316L/F316H/F321/F321H/F347/F347H/F348.
- IV. Nickel Steel** :- ASTM A350 LF3, ASTM A522.

E. Cast Fittings: -

- I. Carbon Steel** :- ASTM A216, ASTM A352 LCB/C.
- II. Alloy Steel** :- ASTM A217 WC1/WC6/WC9/C5/C12.
- III. Stainless Steel** :- ASTM A217 CA15, ASTM A296 CA15, ASTM A351 CF8/CF3/CH20/CK20/CF 8M/CF 3M/CF 8C/HK40.
- IV. Nickel Steel** :- ASTM A352LC3.

E. Plates: -

- I. Carbon Steel** :- ASTM A285, ASTM A515, ASTM A516.
- II. Alloy Steel** :- ASTM A387 Gr.2/Gr.5/Gr.7/Gr.9/Gr.11/Gr.12/Gr.22.
- III. Stainless Steel** :- ASTM A240 TP410/TP405/TP430/TP304/TP304L/TP309/TP310S/TP316/TP316L/TP317/TP321/TP347/TP348
- IV. Nickel Steel** :- ASTM A203 Gr.D/Gr.E, ASTM A353.

2. What is the basic difference between Pipe specification A106 Gr.A / Gr.B/ Gr.C.?

Answer: -

Difference is due to the Carbon content.

% of carbon content in :-

- I.** ASTM A106 Gr. A – 0.25 %
- II.** ASTM A106 Gr. B – 0.30 %
- II** ASTM A106 Gr. C – 0.35 %.

3. What is the difference between pipe specification ASTM A312 TP 304 & ASTM A312 TP304L, ASTM A312 TP 316 & ASTM A312 TP 316L?

Answer: -

Difference is due to the Carbon content. The Letter "L" denotes lower percentage of carbon.

% of carbon content in :-

- I.** ASTM A312 TP 304 - 0.08 %
- II.** ASTM A312 TP 304L- 0.035%
- III.** ASTM A312 TP 316 - 0.08 %
- IV.** ASTM A312 TP 316L- 0.035%

Questions related to Pipe Fittings: -

1. How can flanges be classified based on Pipe Attachment?

Answer: -

Flanges can be classified based on pipe attachment as: -

- | | |
|---------------|--|
| Slip – on. | : - The Slip-on type flanges are attached by welding inside as well as outside. These flanges are of forged construction. |
| Socket Weld. | : - The Socket Weld flanges are welded on one side only. These are used for small bore lines only. |
| Screwed. | : - The Screwed-on flanges are used on pipe lines where welding cannot be carried out. |
| Lap Joint. | : - The Lap Joint flanges are used with stub ends. The stub ends are welded with pipes & flanges are kept loose over the same. |
| Welding Neck. | : - The Welding neck flanges are attached by butt welding to the pipe. These are used mainly for critical services where the weld joints need radiographic inspection. |
| Blind. | : - The Blind flanges are used to close the ends which need to be reopened. |
| Reducing. | : - The reducing flanges are used to connect between larger and smaller sizes without using a reducer. In case of reducing flanges, the thickness of flange should be that of the higher diameter. |
| Integral. | : - Integral flanges are those, which are cast along with the piping component or equipment. |

2. How can flanges be classified based on Pressure- temperature ratings?

Answer: -

Flanges are classified based on pressure temperature ratings as: -

- A. 150 #
- B. 300 #
- C. 400 #
- D. 600 #
- E. 900 #
- F. 1500 #
- G. 2500#

Pressure temperature rating charts in the standard ASME16.5 specify the non-shock working gauge pressure to which the flange can be subjected to at a particular temperature.

3. How can flanges be classified based on facing?

Answer: -

Flanges are classified based on facing as: -

- A. Flat face. (FF)
- B. Raised face. (R/F)
- C. Tongue and groove. (T/G)
- D. Male and female. (M/F)
- E. Ring type joint. (RTJ)

4. How can flanges be classified based on face finish?

Answer: -

Flanges are classified based on face finish as: -

- A. Smooth finish.
- B. Serrated finish.

5. Where the smooth finish flange & serrated finish flange finds its use?

Answer: -

The smooth finish flange is provided when metallic gasket is provided and serrated finish flange is provided when non-metallic gasket is provided.

6. What are the types of serrated finish provided on flange face?

Answer: -

- A. Concentric or
- B. Spiral (Phonographic)

7. How the serration on flanges is specified?

Answer:

The serration on flanges is specified by the number, which is the **Arithmetic Average Rough Height (AARH)**.

8. Where the concentric serration is insisted for face finish?

Answer: -

Concentric serration are insisted for face finish where the fluid being carried has very low density and can find leakage path through cavity.

9. How the Gaskets are classified based on the type of construction?

Answer: -

Based on the type of construction, gaskets are classified as: -

- A. Full face.
- B. Spiral wound metallic.
- C. Ring type.
- D. Metal jacketed.
- E. Inside bolt circle.

10. What is the most commonly used material for Gasket?

Answer: -

Compressed Asbestos Fibre.

11. Which type of gasket is recommended for high temperature & high-pressure application?

Answer: -

Spiral Wound Metallic Gasket.

11. What are the criteria for selection of MOC of Spiral Wound metallic Gasket winding material?

Answer: -

The selection of material of construction for Gasket winding depends upon: -

- A. The corrosive nature and concentration of fluid being carried.
- B. The operating temperature of the fluid.
- C. The relative cost of alternate winding material.

12. What are the most common materials used for spiral wound metallic gasket winding?

Answer: -

The most commonly used material for spiral wound metallic gasket winding is: -

- A. Austenitic stainless steel 304 with asbestos filler.
- B. Austenitic stainless steel 316 with asbestos filler.
- C. Austenitic stainless steel 321 with asbestos filler.

13. Which material is used as filler material for spiral wound gasket in case of high temperature services?

Answer: -

For very high temperature services, graphite filler is used.

14. What is centering ring in connection to spiral wound gasket?

Answer: -

Spiral wound gaskets are provided with carbon steel external ring called centering ring.

15. What will be the AARH finish on flange face for using spiral wound gasket?

Answer: -

125-250 AARH finish.

16. On which type of flanges the use of spiral wound gasket are restricted?

Answer: -

ASME B16.5 does not recommend the use of 150 # rating spiral wound gasket on flanges other than welding neck and lapped joint type.

17. Up to what temperature limits the low strength carbon steel bolts should not be used for flanged joints?

Answer: -

Flanged joints using low strength carbon steel shall not be used above 200°C or below - 28°C.

17. How the pipe fittings are classified based on end connections?

Answer: -

Pipe fittings are classified based on end connection as: -

- A. Socket weld fittings.
- B. Screwed end fittings.
- C. Beveled end or Butt weld fittings.
- D. Spigot socket fittings.
- E. Buttress end fittings.

18. Up to what temperature the carbon steel materials shall be used?

Answer: -

Carbon steel materials shall be used for temperature up to 425°C.

19. Which material is used for temperature above 426°C?

Answer: -

Alloy steel materials shall be used for temperature above 426°C.

20. Which type of material is used for corrosive fluid?

Answer: -

Stainless steel materials shall be used for corrosive fluid.

21. Which type of piping materials are used for drinking water, instrument air etc?

Answer: -

Galvanized steel materials shall be used for drinking water, instrument air and NI lines (LP).

22. What is the difference between Pipe and Tube?

Answer: -

Pipe is identified by NB and thickness is defined by Schedule whereas Tube is identified by OD & its thickness as BWG (Birmingham wire gauge or 1/100 inch).

23. From which size onwards NB of pipe is equal to OD of Pipe?

Answer: -

From the size 14" and onwards NB = OD of pipe.

24. What should be the radius of long radius elbow?

Answer:

1.5D (Where "D" is the diameter of the pipe.)

25. What should be the radius of short radius elbow?

Answer: -

1D(Where "D" is the diameter of the pipe.)

26. What is the basis of using of short radius & long radius elbow?

Answer: -

Long radius elbow are used for small pressure drop whereas short radius elbow are used for high pressure drops. For catalyst flows vary long radius elbows are used.

27. Normally where do we use the following?

- A. Eccentric reducers.**
- B. Concentric reducers.**

Answer:

- A. Eccentric reducers = Pump suction to avoid Cavitation, To maintain elevation (BOP) in rack.**
- B. Concentric reducers = Pump discharge, vertical pipeline etc.**

28. Concentric reducer is used in pump suction. (Yes / No). Explain.

Answer:

No. Air pockets may form if concentric reducer is used at pump suction, which results in cavitation and cause damage to Pump. To avoid this problem, Eccentric Reducer with flat side up (FSU) is used in Pump Suction.

29. Where the ERW spiral & longitudinal pipes are used?

Answer: -

Use depends upon the availability of pipes. Nothing functional difference.

30. Where the ERW & Seamless pipes are used?

Answer: -

Above 18" ERW pipes are used. Below 18" seamless pipes are used. Seamless pipes can sustain higher temperature & pressure.

31. What is the main use of ASTM A53 & A106 Gr.B pipes?

Answer: -

ASTM A53 pipes are mainly used for utility services whereas A106 Gr. B pipes are used for high Pressure & high temperature services.

32. From which side of pipe will you take a branch connection?

Answer: -

When fluid is Gas, Air or Steam and Cryogenic Service – Topside.
When Fluid is Liquid – Bottom Side.

33. Why don't we take a branch for Cryogenic Service from bottom side though the fluid is in liquid state?

Answer: -

There is the chance of ice formation during normal operation and since ice flows from the bottom of the pipe it will block the branch pipe connection.

33. Why do we provide High Point Vent (HPV) and Low Point Drain (LPD) in piping?

Answer:

HPV – For removing Air during Hydro-test.

LPD – For draining water after conducting Hydro-test.

34. What do you mean by Jacketed Piping?

Answer: -

Piping which is recognized as providing the most uniform application of heat to the process, as well as maintaining the most uniform processing temperatures where steam tracing is not capable of maintaining the temperature of fluid constant. Usually used for molten sulphur, Polymers service.

35. What is the minimum distance to be maintained between two welds in a pipe?

Answer: -

The thumb rule is that the minimum distance between adjacent butt welds is 1D. If not, it is never closer than 1-1/2". This is supposedly to prevent the overlap of HAZs. Minimum spacing of circumferential welds between centerlines shall not be less than 4 times the pipe wall thickness or 25 mm whichever is greater.

36. What do you mean by IBR and which lines comes under IBR purview?

Answer: -

IBR: Indian Boiler Regulation Act.

Steam lines with conditions listed below comes under IBR purview : –

- Lines for which design pressure is 3.5 kg/sq. cm and above.
- Line size above 10" having design pressure 1.0 kg/sq. cm and above.
- Boiler feed water lines to steam generator, condensate lines to steam generator and flash drum.

37. What are Weldolet and Sockolet? And where they are used?

Answer: -

Weldolet and Sockolet are basically self-reinforced fittings.

Weldolet is used for Butt weld branch connection where standard tee is not available due to size restrictions and the piping is of critical / high-pressure service. Sockolet is used for socket welding branch connection, which require reinforcing pad.

38. What is the MOC for Superheated high pressure Steam Lines?

Answer: -

A 335 Gr. P 11 / P 11, Composition: Cr. – ½ Mo (P1) / 1¼ Cr. – ½ Mo (P11)

39. What is the normal upstream and downstream straight length of orifice flow meter?

Answer: -

Upstream - 15D

Downstream - 5D

Questions related to valves: -

1. What is the function of valves?

Answer: -

- A. Isolation.
- B. Regulation.
- C. Non-Return.
- D. Special purpose.

2. How the valves are classified based on their function?

Answer: -

A. Isolation.

1. Gate valve.
2. Ball valve
3. Plug valve.
4. Piston valve.
5. Diaphragm Valve.
6. Butterfly valve.
7. Pinch valve.

B. Regulation

1. Globe valve.
2. Needle valve.
3. Butterfly valve.
4. Diaphragm valve.
5. Piston valve.
6. Pinch valve.

C. Non- Return

1. Check valve.

D. Special purpose

1. Multi- Port valve.
2. Flush Bottom valve.
3. Float valve.
4. Foot valve.
5. Line blind valve.
6. Knife Gate valve.

3. How the valves are classified based on its method of operation?

Answer: -

Valves are classified based on its method of operation as: -

- A. Self- operated valves.
- B. Operated valves.

4. Name the Self – operated & operated valves?

Answer: -

Mainly the check valves are self-operated and all other valve types comes under operated valves.

5. How the valves are classified based on end connection?

Answer: -

Valves are classified based on end connection as: -

- A. Screwed ends.
- B. Socket ends.
- C. Flanged ends.
- D. Butt weld ends.
- E. Wafer type ends.
- F. Buttress ends.

End connection means arrangement of attachment of the valve with the equipment or the piping.

6. What are the types of check valves?

Answer: -

Check valves are divided into two types based on check mechanism as: -

- A. Lift check valve.
- B. Swing check valve.

7. What do you mean by special purpose valves?

Answer: -

Valves that perform duties other than the two-way isolation, control and check are called special purpose valves.

8. What are Glandless piston valves? Where these are used?

Answer: -

Glandless piston valves are regulating valves used in steam services.

Questions related to Welding/ Weld defects/Post heating/Post weld heat treatment/ Electrode/Filler wire.

1. What do you mean by following type of welding?

A. SMAW B. TIG

Answer: -

A. SMAW :- Shielded Metal Arc Welding.

B. TIG :- Tungsten Inert Gas Welding.

2. Mention the contents of TIG welding set?

Answer: -

A. Torch : Consist of hose for argon gas / welding lead / ceramic nozzle/ collet / tungsten rod as cathode to create arc.

B. Regulator with Pressure Gauge (HP & LP) & flow meter.

C. Argon cylinder – Gr.2 / Gr.1 depending upon requirements of the job.

D. Transformer / Rectifier.

E. Filler wire

3. While welding of pipe trunion to pipe/reinforcement pad you have to put a hole or leave some portion of welding why?

Answer:

For venting of hot gas which may get generated due to welding.

4. What is the thumb rule to calculate Current required for Welding?

Answer:

Current (Amp) = [Diameter of Electrode (mm) X 40] ± 20

5. What is the minimum thickness of cs pipe that requires stress relieving to be done as per B31.3?

Answer: - 19.05 mm thk.

6. Which is the Electrode & filler wire used for welding of following materials?

A. Alloy steel

I. ASTM A335P1

II. ASTM A335P2

III. ASTM A335P11

IV. ASTM A335P5

V. ASTM A335P9

B. Stainless steel

I. ASTM A312TP304

II. ASTM A312TP304L

III. ASTM A312TP304H

IV. ASTM A312TP308

- V. ASTM A312TP310
- VI. ASTM A312TP316
- VII. ASTM A312TP316L
- VIII. ASTM A312TP316H
- IX. ASTM A312TP321
- X. ASTM A312TP321H

Answer: -

	Covered Electrode	Bare electrode
<u>Alloy Steel</u>		
I. ASTM A335P1	E7018	E70 S-1B
II. ASTM A335P2	E8018-B1	---
III. ASTM A335P11	E8018-B2	ER515
IV. ASTM A335P5	E502	ER502
V. ASTM A335P9	E505	ER505
<u>Stainless Steel</u>		
I. ASTM A312TP304	E308	ER308
II. ASTM A312TP304L	E308L	ER308L
III. ASTM A312TP304H	E16-6-2	ER16-8-2
IV. ASTM A312TP308	E309	ER309
V. ASTM A312TP310	E310	ER310
VI. ASTM A312TP316	E316	ER316
VII. ASTM A312TP316L	E316L	ER316L
VIII. ASTM A312TP316H	E16-8-2	ER16-18-2
IX. ASTM A312TP321	E347	ER347
X. ASTM A312TP321H	E16-6-2	ER16-8-2

7. What are the common welding defects?

Answer: -

- A. Lack of penetration.
- B. Lack of fusion.
- C. Undercut.
- D. Slag inclusion.
- E. Porosity.
- F. Crack.
- G. Faulty weld size & profile.
- H. Distortion.

A. Lack of penetration.

This defect occurs at the root of the joint when the weld metal fails to reach it or weld metal fails to fuse completely the root faces of the joint. As a result, a void remains at the root zone, which may contain slag inclusions.

Cause: -

- A. Use of incorrect size of electrode in relation to the form of joint.
- B. Low welding current.
- C. Faulty fit-up and inaccurate joint preparation.

B. Lack of fusion.

Lack of fusion is defined as a condition where boundaries of unfused metal exist between the Weld metal & base metal or between the adjacent layers of weld –metals.

Cause: -

- A. Presence of scale, dirt, oxide, slag and other non-metallic substance which prevents the weld metal to reach melting temperature.
- B. Improper deslagging between the weld pass.

Precaution: -

- A. Keep the weld joint free from scale, dirt, oxide, slag and other non- metallic substance.
- B. Use adequate welding current.
- C. Deslag each weld pass thoroughly.
- D. Place weld passes correctly next to each other.

C. Undercut

This defect appears as a continuous or discontinuous groove at the toes of a weld pass and is located on the base metal or in the fusion face of a multipass weld. It occurs prominently on the edge of a fillet weld deposited in the horizontal position.

Cause: -

- A. Excessive welding current.
- B. Too high speed of arc travel.
- C. Wrong electrode angle.

Rectification: -

The defect is rectified by filling the undercut groove with a weld pass. If undercut is deep & contains slag, it should be chipped away before rewelding.

D. Slag Inclusion

Non-metallic particles of comparatively large size entrapped in the weld metal are termed as slag inclusion.

Cause: -

- A. Improper cleaning of slag between the deposition of successive passes.
- B. Presence of heavy mill scale, loose rust, dirt, grit & other substances present on the surface of base metal.

Precaution: -

- A. Clean the slag thoroughly between the weld pass.
- B. Keep the joint surface (especially gas cut surface) and bare filler wire perfectly clean.
- C. Avoid undercut & gaps between weld pass.
- D. Use proper welding consumables.

E. Porosity

The presence of gas pores in a weld caused by entrapment of gas during solidification is termed as porosity. The pores are in the form of small spherical cavities either clustered locally or scattered throughout the weld deposit. Sometimes entrapped gas give rise to a single large cavity called Blowholes.

Cause: -

- A. Chemically imperfect welding consumables, for example, deficient in deoxidiser.
- B. Faulty composition of base material or electrode, for example, high sulphur content.
- C. Presence of oil, grease, moisture and mill scale on the weld surface.
- D. Excessive moisture in the electrode coating or submerged-arc flux.
- E. Inadequate gas shielding or impure gas in a gas –shielded process.
- F. Low welding current or too long an arc.
- G. Quick-freezing of weld deposit.

F. Crack

Fracture of the metal is called crack. Two types of cracks: - Cold crack & Hot crack. Cold crack usually occur in HAZ of the base metal when this zone becomes hard and brittle due to rapid cooling after the weld metal has been deposited & sufficient hydrogen has been absorbed by the weld metal from the arc atmosphere.

Precaution: -

- A. Use of low carbon equivalent materials.
- B. Higher heat input during welding.
- C. Preheating.
- D. Use of low hydrogen electrode.

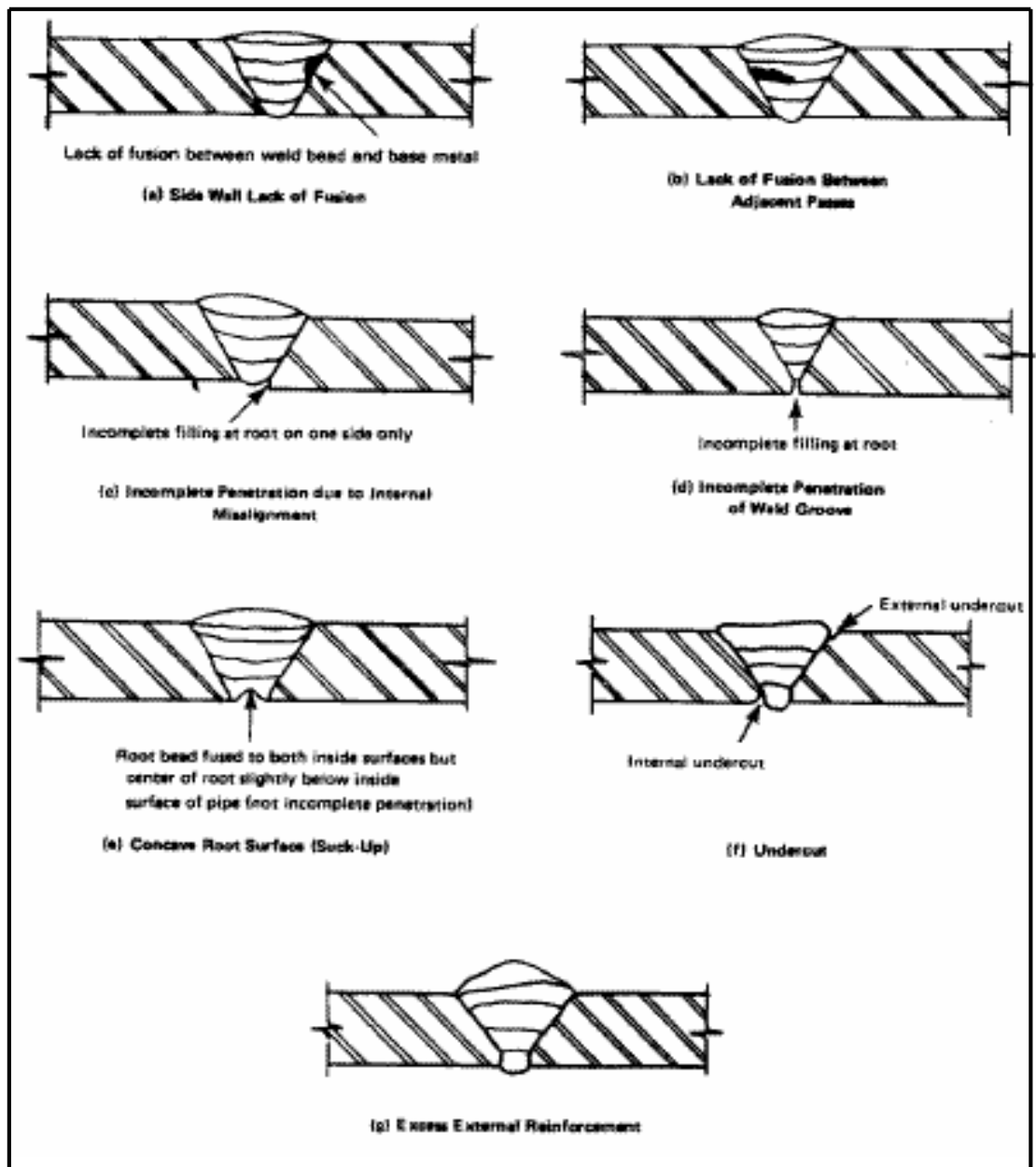
G. Faulty weld size and profile

A weld is considered faulty if it has lack of reinforcement, excessive reinforcement or irregular Profile.

H. Distortion

Because a weldment is locally heated (by most welding processes), the temperature distribution in the weldment is not uniform and changes take place as welding processes. Typically, the weld metal and the base metal heat-affected zone immediately adjacent to it are at a temperature substantially above that of the unaffected base metal. As the molten pool solidifies and shrinks, it begins to exert shrinkage stresses on the surrounding weld metal and heat-affected zone area. When it first solidifies, this weld metal is hot, relatively weak, and can exert little stress. As it cools to ambient temperature, however, the shrinkage of the weld metal exerts increasing stress on the weld area and eventually reaches the yield point of the base metal and the heat-affected zone. Residual stresses in weldments have two major effects. First, they produce distortion, and second, they may be the cause of premature failure in weldments. Distortion is caused when the heated weld region contracts nonuniformly, causing shrinkage in one part of the weld to exert eccentric forces on the weld cross section. The distortion may appear in butt joints as both longitudinal and transverse shrinkage or contraction, and as angular change (rotation) when the face of the weld shrinks more than the root.

Distortion in fillet welds is similar to that in butt welds: transverse and longitudinal shrinkage as well as angular distortion results from the unbalanced nature of the stresses in these welds.



8. What is mean by 'PWHT'? Why it is required?

Answer: -

"POST WELD HEAT TREATMENT" This is done to remove residual stress left in the joint which may cause brittle fracture.

9. Why pre-heating is done on some pipe before starting welding?

Answer: -

To slow down the cooling rate.

10. Why post-heating is done on some pipe after the welding is over?

Answer: -

To maintain uniform homogeneous structure.

11. What is the pre-heat temperature for carbon steel above 19.05MM thk.

Answer: -

Pre -heat temperature for carbon steel above 19.05 mm is 80°C.

12. Is post heating required for carbon steel material above 19.05MM thk.

Answer: -

No. Post heating is not required for carbon steel material of any thickness.

13. What is the soaking temperature during stress relieving for carbon steel material?

Answer: -

Soaking temperature for carbon steel material during stress relieving is 620°C. ($\pm 20^\circ\text{C}$)

14. What is the soaking period during stress relieving for carbon steel material?

Answer: -

Soaking period for carbon steel material during stress relieving is 1hr.

15. What is the rate of heating & cooling during stress relieving for carbon steel material?

Answer: -

The rate of heating & cooling for carbon steel material during stress relieving is 150°C/hr.

16. What is the pre-heat temperature during stress relieving for alloy steel materials?

Answer: -

Pre-heat temperature for AS materials is 180°C.

17. What is the soaking temperature during stress relieving for alloy steel material?

Answer: -

Soaking temperature for alloy steel material is 720°C($\pm 20^\circ\text{C}$).

18. What is the soaking period during stress relieving for alloy steel material?

Answer: -

Soaking period for alloy steel material is 2hrs.

19. What is the rate of heating & cooling during stress relieving for alloy steel material?

Answer: -

The rate of heating & cooling for alloy steel material is 100°C/hr.

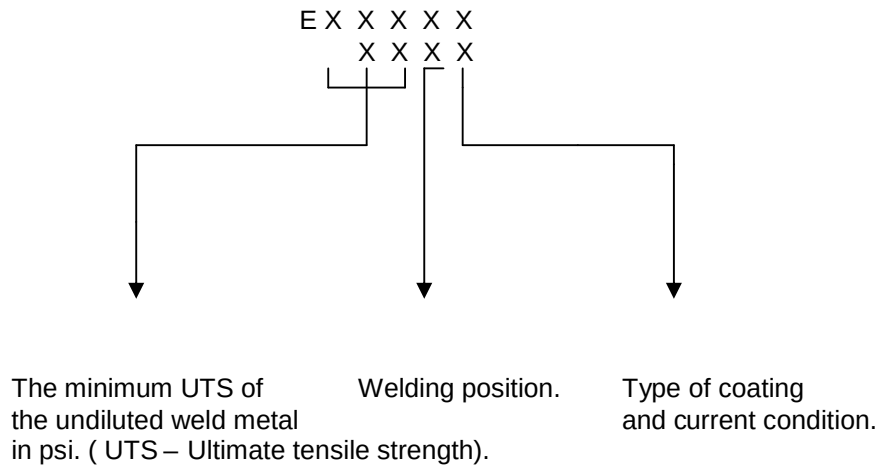
20. What is the post heat temperature for alloy steel material?

Answer: -

Post heat temperature for alloy steel material is 300°C.

21. What is a four or five digit coding for electrode as per AWS classification SFA 5.1?

Answer: -



22. Where the use of electrode E7018 is recommended?

Answer: -

The use of electrode E7018 is recommended for welding the following: -

- A. For high strength steel.
- B. For high thickness carbon steel plates.
- C. Higher carbon equivalent material.

23. Why the electrode E7018 is called low hydrogen electrode?

Answer: -

The low hydrogen electrodes have in their coating ingredient, which produces carbon di-oxide during melting. This CO₂ gives a gaseous shielding for the metal and prevents atmospheric hydrogen from entering in arc atmosphere. By this way the weld metal has low level of hydrogen.

24. What should be the content of chlorine in water while conducting hydrotest for CS & SS pipes?

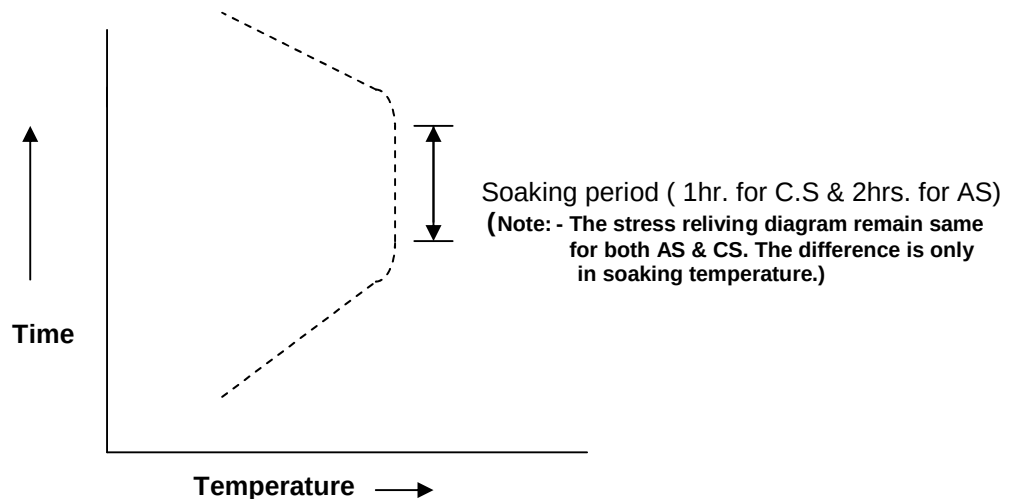
Answer: -

For CS – 250 PPM.

For SS – 30 PPM.

25. Draw the stress-relieving diagram for carbon steel & Alloy steel material?

Answer: -



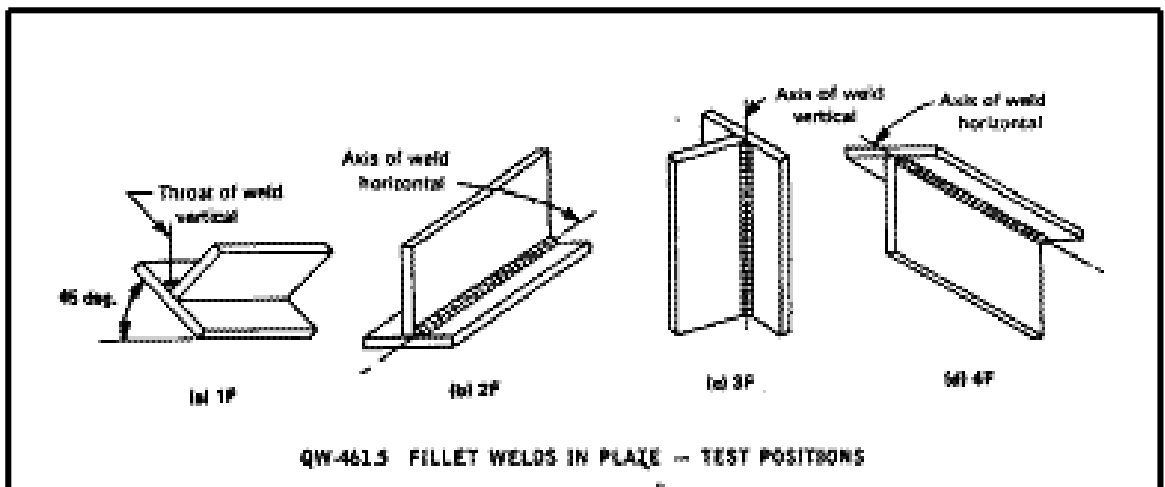
26. What is the test positions for fillet & groove welding in case of plate & pipes?

Answer: -

Test positions for Fillet welds: -

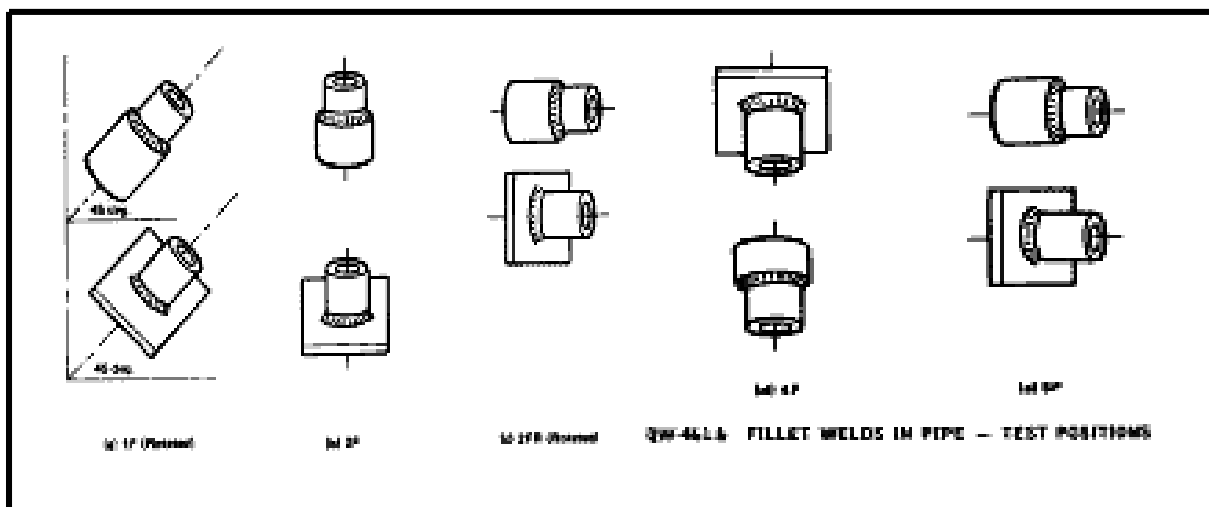
Plate positions: -

- A. Flat Position 1F : - Plates so placed that the weld is deposited with its axis horizontal & its throat vertical. Refer sketch (a).
- B. Horizontal Position 2F : - Plates so placed that the weld is deposited with its axis horizontal on the upper side of the horizontal surface and against the vertical surface. Refer sketch (b).
- C. Vertical Position 3F : - Plates so placed that the weld is deposited with its axis vertical. Refer sketch (c).
- D. Overhead Position 4F : - Plates so placed that the weld is deposited with its axis horizontal on the underside of the horizontal surface and against the vertical surface. Refer sketch (d).



Pipe positions: -

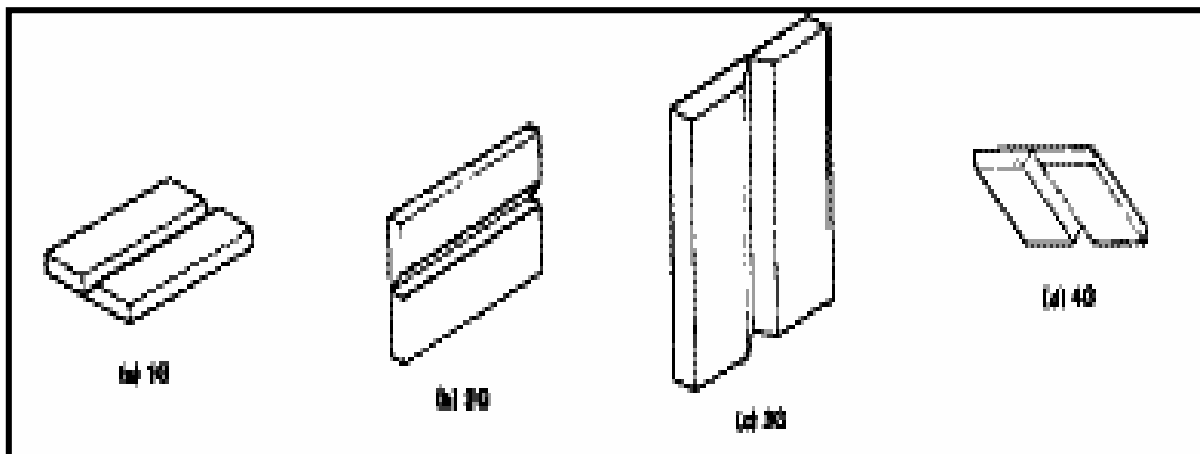
- A. Flat Position 1F : - Pipe with its axis inclined at 45° to horizontal and rotated during welding so that the weld metal is deposited from above and at the point of deposition the axis of weld is horizontal and the throat vertical. Refer sketch (a).
- B. Horizontal Position 2F : - Pipe with its axis vertical so that the weld is deposited on the upper side of the horizontal surface and against the vertical surface. The axis of the weld will be horizontal and the pipe is not to be rotated during welding. Refer sketch (b).
- C. Horizontal Position 2FR: - Pipe with its axis horizontal and the axis of the deposited weld in the vertical plane. The pipe is rotated during welding. Refer sketch (c).
- D. Overhead Position 4F : - Pipe with its axis vertical so that the weld is deposited on the underside of the horizontal surface and against the vertical surface. The axis of the weld will be horizontal and the pipe is not rotated during welding. Refer sketch (d).
- E. Multiple Position 5F : - Pipe with axis horizontal and the axis of the deposited weld in the vertical Plane. The pipe is not to be rotated during welding. Refer sketch (e).



Test positions for Groove welds: -

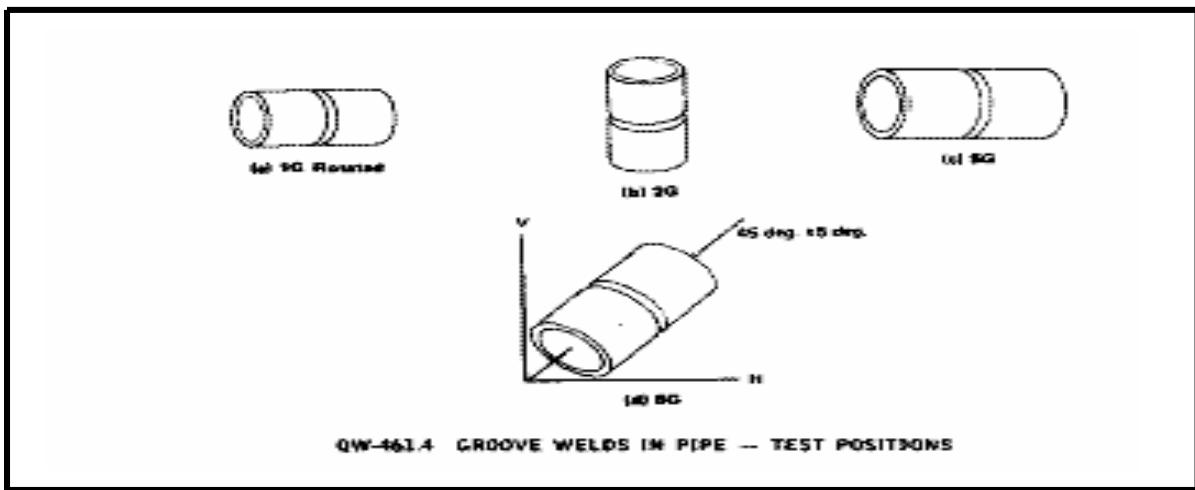
Plate positions: -

- A. Flat Position 1G : - Plate in a horizontal plan with the weld metal deposited from above. Refer sketch (a).
- B. Horizontal position 2G : - Plate in a vertical plane with the axis of the weld in horizontal. Refer sketch (b).
- C. Vertical position 3G : - Plate in vertical plane with the axis of the weld vertical. Refer sketch (c).
- D. Overhead Position 4G : - Plate in a horizontal plane with the weld metal deposited from underneath. Refer sketch (d).

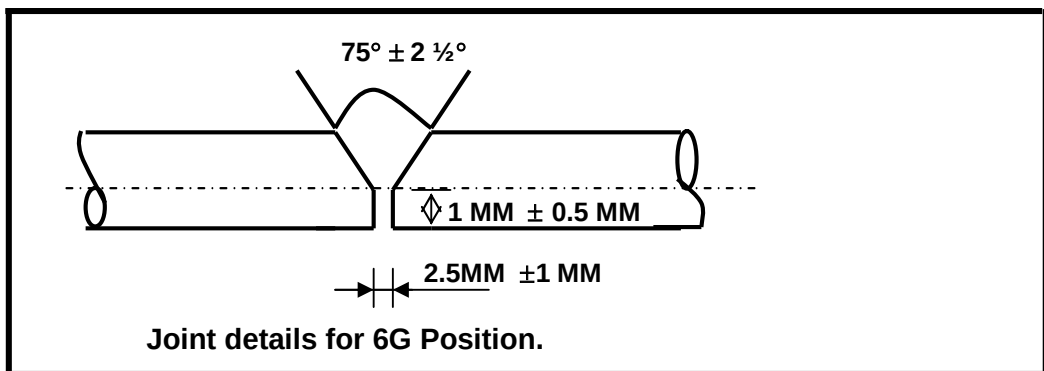


Pipe Positions: -

- A. Flat Position 1G : - Pipe with its axis horizontal and rolled during welding so that the weld metal is deposited from above. Refer sketch (a).
- B. Horizontal Position 2G : - Pipe with its axis vertical and the axis of weld in a horizontal plane. Pipe shall not be rotated during welding. Refer sketch (b).
- C. Multiple Position 5G : - Pipe with its axis horizontal and the welding groove in vertical plane. Welding shall be done without rotating the pipe. Refer sketch (c).
- D. Multiple Position 6G : - Pipe with its axis inclined at 45° to horizontal. Welding shall be done without rotating the pipe. Refer sketch (d).

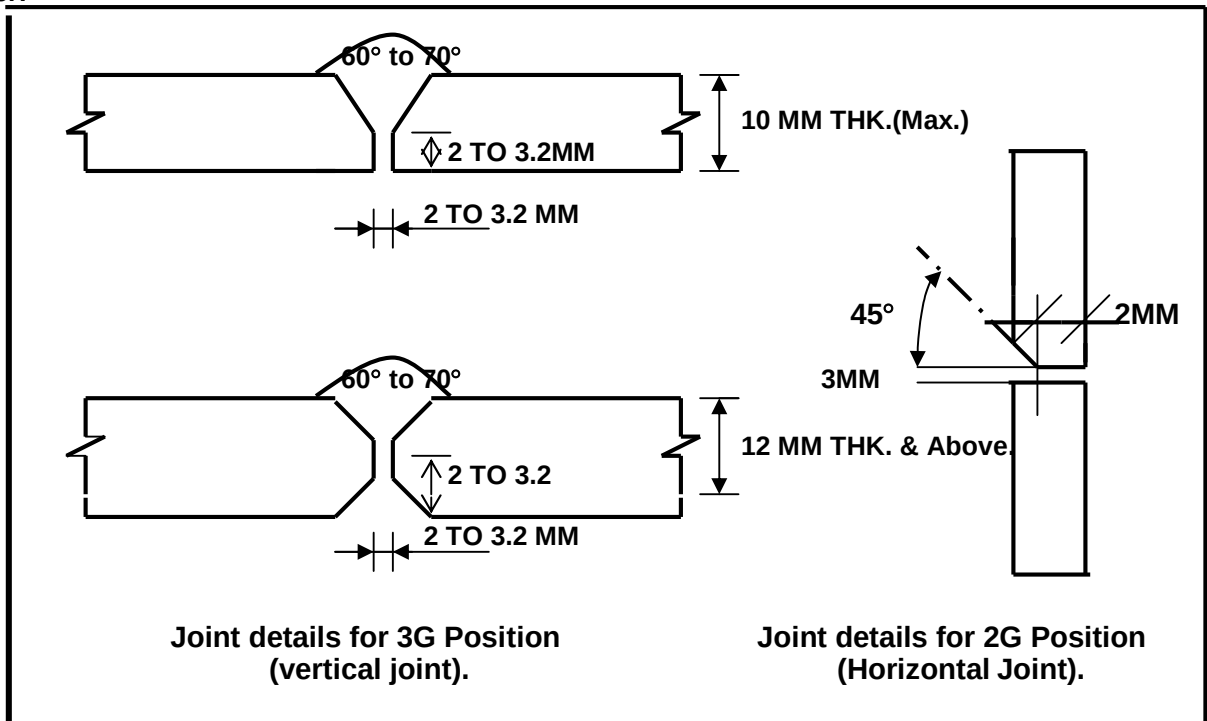


27. Draw the Groove details for 6G position in pipe?



28. Draw the Groove details for 2G & 3G position in case of plates?

Answer: -



29. What is the affect if the quantity of hydrogen induced in weld metal is more?

Answer: -

When hydrogen is more in weld metal, it tends to make the material brittle & subsequently leads to cracking. These cracks are called hydrogen induced cracking or delayed crack. To avoid this the electrode before using is backed at 250°C to 300°C for one hour in mother oven & then cooled down to 100°C in the same oven & finally transferred to portable oven for use where temperature is maintained at 60° to 70°.

Questions related to pipes supports: -

1. What are the Criteria for Pipe Supporting?

Answer: -

Following are the points, which should be taken into account for proper supporting: -

- A. Load of bare pipe + fluid + insulation (if any).
- B. Load of bare pipe + water fill.
- C. Load of valves and online equipment and instrument.
- D. Thermal loads during operation.
- E. Steam out condition, if applicable.
- F. Wind loads for piping at higher elevation, if required.
- G. Forced vibration due to pulsating flow.
- H. Bare pipe with size above 12" shall be supported with Pad or Shoe.

2. What is the basic span of supports for 2"/6"/10"/24" pipe?

Answer: -

Basic Span is 5.5m / 9m / 11.5m / 15m respectively.

3. What is the function of providing the anchor, cross guide and guide for piping?

Answer: -

Anchor is provided to restrict all the axial and rotational movements of pipe, whereas cross guide is provided to restrict displacements of pipe along with the axis perpendicular to its centerline and Guide is provided to restrict the longitudinal movements of pipes along with its axis.

4. How is piping to Tank inlet nozzle is supported and why?

Answer: -

Piping to Tank Nozzle is supported with spring type support (first support from Nozzle) in order to make the nozzle safe from the loads which occurs due to the displacement of pipe (Displacement may be due to thermal expansion of pipe, tank material, tank settlement etc).

5. What are the types of flexible spring hangers?

Answer: -

- 1. Constant Spring Hanger
- 2. Variable Spring Hanger.

6. What is the purpose of providing Graphite Pads in supports below shoes?

Answer: -

To reduce the friction factor. The co-efficient of friction for Graphite Pads is 0.1

7. Where do you provide Anchor and Slotted Support of Heat Exchanger?

Answer: -

Anchor support of Heat exchanger is provided on the side from which Tube bundle will be pulled out for the purpose of maintenance work also it is based on the growth of the connecting piping as exchanger should grow with the piping.

8. What should be the material of shoes for supporting AS pipes & why?

Answer: -

If CS shoes are used then pad in contact with the pipe shall be of Alloy steel to avoid dissimilar welding at pipe. To avoid alloy steel welding and dissimilar welding, fabricated clamps either of CS or SS can be used.

9. What are sway braces?

Answer: -

Sway braces are essentially a double acting spring housed in a canister. Their purpose is to limit the undesirable movement. Undesirable movement means movement caused by wind loading, rapid valve closure, relief valve opening, two phase flow or earthquake.

10. What is the difference between variable spring hanger and constant spring hanger?

Answer: -

Variable spring Hanger: -

As the name itself indicates the resistance of the coil to a load changes during compression.

Constant spring Hanger: -

Constant spring hanger provides constant support force for pipes and equipment subjected to vertical movement due to thermal expansion.

Questions related to Radiography technology: -

1. What are the types of radiation emitted by isotopes?

Answer: -

There are three types of radiation as: -

- A. Alpha particle (α - particle).
- B. Beta particles (β - particle).
- C. Gamma ray (γ - ray).

2. What is the charges on α - particle, β - particle and γ - ray & compare their relative penetration?

Answer: -

Charges on radiation are: -

- | | |
|--|--|
| A. Alpha particle (α - particle) : - | Positive charge & less penetrating in comparison to β - particle & γ - Ray. They can be stopped by a thin sheet of paper. |
| B. Beta particles (β - particle) : - | Negative charge & have definite range of penetration. Easily absorbed in the matter. |
| C. Gamma ray (γ - ray) : - | No charge & highly penetrating. |

3. Name the isotopes, which emits gamma ray?

Answer: -

Gamma ray source are: -

- A. Iridium – 192
- B. Cobalt – 60
- C. Cesium – 137
- D. Thulium – 170

4. Name the gamma ray source used for industrial radiography work?

Answer: -

- A. Iridium – 192
- B. Cobalt – 60

5. What is the depth of penetration in steel by cobalt – 60, cesium – 137, Iridium – 192 & Thulium – 170.

Answer: -

Penetration in steel by: -

- A. Cobalt – 60 : - 9 inch.
- B. Cesium – 137 : - 3 ½ inch.
- C. Iridium – 192 : - 3 inch.
- D. Thulium – 170 : - ½ inch.

6. What do you mean by photographic Density?

Answer: -

It is the quantitative measurement of film blackness. It is expressed as: -

$$D = \log I_0/I_t \quad \dots \dots \text{where, } D \text{ is density.}$$

I_0 - Light intensity incident on the film.
 I_t - Light intensity transmitted through the film.

7. Name the instrument used for measuring density of photographic or radiographic film?

Answer: -

Densitometre is an instrument for measuring the density of photographic and radiographic film.

8. What are the factors on which the density of radiographic film depends?

Answer: -

The density of radiographic films depends upon the following: -

- A. Total amount of radiation emitted by X-ray or gamma ray.
- B. Amount of radiation reaching the specimen.
- C. The amount of radiation passing through the specimen.
- D. Intensifying action of the screen if used.

9. How the intensity of source is related with film distance?

Answer: -

Intensity of X-ray or gamma ray varies inversely with the square of the distance from focal spot or source of light. This relation is known as the Inverse square law.

Mathematically, it is expressed as: -

$$\frac{I_1}{I_2} = \frac{D_2^2}{D_1^2}$$

... Where I_1 and I_2 are intensities at the distance D_1 and D_2 respectively.

10. What are the governing factors for exposure from particular radioisotopes?

Answer: -

There are three factors for governing the exposure with a given kilovoltage for X- ray or with the gamma ray from particular radioisotopes.

- A. Milliamperage (X-ray) or source strength (for Gamma ray).
- B. Focal spot to film distance or source to film distance.
- C. Time of exposure.

11. What is the relation between Milliamperage (source strength) and film distance?

Answer: -

The Milliamperage (M) is directly proportional to the square of the focus to film distance (D). The equation is expressed as: -

$$\frac{M_1}{M_2} = \frac{D_1^2}{D_2^2}$$

... Where, M₁ and M₂ are the Milliamperage.

D₁ and D₂ are the distance from focus to film.

12. What is the relation between exposure time & film distance?

Answer: -

The exposure time (T) is directly proportional to the square of the focus to film distances (D). The equation is expressed as :

$$\frac{T_1}{T_2} = \frac{D_1^2}{D_2^2}$$

13. What is the relation between Source strength & exposure time?

Answer: -

The Milliamperage (M) is inversely proportional to the time of exposure (T). The equation is expressed as: -

$$\frac{M_1}{M_2} = \frac{T_2}{T_1} \quad \text{or} \quad M_1 T_1 = M_2 T_2$$

... Where, M₁ and M₂ are the Milliamperage.

T₁ and T₂ are the time of exposure.

Note: The above relation is also called Reciprocity law and is true for direct X-ray or gamma ray with lead screen exposure. The above relation is not quite accurate for exposure to light.

14. How the source strength of radiographic isotopes expressed?

Answer: -

The source strength of radiographic isotopes expressed in terms of Curie.

15. What do you mean by exposure?

Answer: -

It is defined as the quantity of X or gamma radiation that produces in air, ions carrying 1 coulomb (C) of charge (of either sign) per Kg of air. The unit of exposure is C/Kg.

16. What do you mean by Roentgen?

Answer: -

Roentgen is the old unit for exposure. It is defined as the amount of X or gamma radiation which liberates 1e s u of charge of either sign in 1 C. C of air at S T P.

$$1R = 1e \text{ s u} / \text{C C of air at STP.}$$

$$= 2.58 \times 10^4 \text{ C/ Kg air.}$$

17. What is Dose equivalent?

Answer: -

Dose Equivalent = Quality factor X absorbed dose.

Quality factor generally considered as:

- A. 1 for X, γ or β .
- B. 3 for Thermal neutrons.
- C. 20 for α - particles.

The unit of dose equivalent is Sievert (SV).

Formerly, the unit of dose equivalent was 1 rem.

1 Sievert = 100rem (Roentgen).

18. What is the function of radiographic screens?

Answer: -

It intensifies the radiographic images on the film.

19. What are the types of radiographic screens generally used?

Answer: -

Types of radiographic screens generally used are: -

- A. Lead screen.
- B. Fluorescent screen or salt screens.

20. What are the types of Lead screens?

Answer: -

Types of Lead screens are: -

- A. Lead foil screen.
- B. Lead oxide screen.

21. What do you mean by intensification factor (IF)?

Answer: -

$$\text{Intensification factor} = \frac{\text{Exposure time required to produce required film density without screen.}}{\text{Exposure time for same density using screen.}}$$

In the above definition it is assumed that same film and radiation source used for the both the exposure.

22. What are the factors upon which the intensification factor depends?

Answer: -

Intensification factor due to metallic screens depends on the following: -

- A. Metal of foil.
- B. Thickness of foil.
- C. Energy of radiation.
- D. Specimen thickness.

23. How the intensification factor depends on metal of foil?

Answer: -

For a given radiation source, the number of electrons produced depends on the nature of the metal foil. Intensification factor increases with atomic number of the metal. For gamma ray radiography generally Lead screen are used.

24. How the intensification factor depends on thickness of foil?

Answer: -

The intensification factor increases with the increase in the thickness of the foil. Intensification increases maximum corresponding to the range of photoelectron in that metal. After further increase it remains practically constant. If the thickness further increased, greater number of gamma photons will be attenuated and this will reduce the produce of photoelectrons.

25. How the intensification factor depends on energy of radiation?

Answer: -

More is the energy of radiation, more is the intensifying action.

26. How the intensification factor depends on thickness of the specimen?

Answer: -

A specimen placed in between the source and film performs following two functions: -

- A. It filters the primary radiation.
- B. Gives low energy scattered radiation.

The radiographic screen can have different sensitivities for primary radiation and the radiation given by the above two effects. Hence the change in intensification factor with object thickness is expected. The intensification of low energy scattered radiation is more than the intensification of high energy filtered radiation.

27. Where the fluorescent screen finds its use?

Answer: -

The fluorescent screens are widely used for medical purpose to reduce the exposure time.

28. What are the main constituents of a radiographic film?

Answer: -

The radiographic films consist of the following: -

- A. Base material.
- B. Subbing layer.
- C. Emulsion and
- D. Protective layer/ Super coat.

29. What is the different base material tried so far for radiographic film?

Answer: -

The materials so far tried for base is: -

- A. Glass.
- B. Cellulose Nitrate.
- C. Cellulose Acetate.
- D. Cellulose Triacetate.
- E. Polyester (Most suitable material to be used as base material).

30. What is the function of Subbing material, Emulsion & protective layer in radiographic film?

Answer: -

- | | |
|-------------------------|---|
| Subbing material | : - It provides the sticky action to the emulsion, as the emulsion does not adhere directly on the base material. |
| Emulsion | : - It contains silver bromide gelatin (Generally animal bone marrow) |
| Protective Layer | : - It is coated on emulsion in order to protect the same from physical damage, abrasion and stress mark. |

31. How the Radiographic films are classified?

Answer: -

The Radiographic films are classified as: -

- A. Class – I : - Highest contrast, Lowest speed.
- B. Class – II : - High contrast, Low speed.
- C. Class – III : - Medium contrast, Medium speed.
- D. Class – IV : - Low contrast, High speed.

32. What is the basis of classification of radiographic film?

Answer: -

Classification of Radiographic film is done on the basis of grain size of Silver Bromide (Silver Bromide Crystals). Finer the grain size of Silver Bromide in emulsion, slower will be the speed. Generally used crystal size is 0.22, 0.52, 0.68, 0.80 and 1 micron.

33. What is speed with reference to Radiography film?

Answer: -

It can be defined as the density records on the film resulting from a given exposure. It is inverse of exposure required to produce on radiograph of particular density under the specified conditions. A film requires less exposure to achieve particular density is called fast film and more exposure called slow film.

34. What type of film is generally used for Radiography?

Answer: -

Class – III type (D5,D7 – Agfa make) film is generally used for radiography.

35. What type of film is not used for industrial purpose (Used for Medical purpose)?

Answer: -

Class – IV type (D10 – Agfa make) film is not used for industrial purpose.

36. What do you mean by film processing?

Answer: -

When the film is exposed to the radiation, creates latent image or invisible image by converting the silver bromide present in the emulsion into metallic silver. The exposed film when processed converts latent image into visible image.

37. What are the main steps in film processing?

Answer: -

Main steps in film processing are: -

- A. Developing
- B. Stop bath.
- C. Fixure.
- D. Washing
- E. Drying.

38. What are the ingredients of Developer?

Answer: -

- A. Developing Agent : - Metol, Hydroquinone and Pencilone.
- B. Accelerator : - Sodium carbonate.
- C. Restrainer : - Potassium Bromate.
- D. Preservative : - Sodium Sulphate.

39. What is the function of Accelerator present in Developer?

Answer: -

It encourages the developer to supply more electrons.

40. What is the function of Restrainer present in Developer?

Answer: -

It opposes to reduce the unexposed silver bromide. It acts as antifogging agent.

41. What is the function of Preservative present in Developer?

Answer: -

It prevents oxidation.

42. What is the affect of temperature on Developer?

Answer: -

The Developer supplies more electrons at high temperature and reduces the developing time. Opposite is the case when the temperature is lower.

43. What is the ideal developing temperature?

Answer: -

Below 18°C and above 24°C, developing is not recommended.

44. What is the developing time generally recommended?

Answer: -

5 to 8 minutes. Larger developing time increases the fog density. The developing time below 3 minutes is not recommended as the required density shall not be achieved and may miss minor discontinuities.

45. What is the ingredient of Stop Bath?

Answer: -

2% Acetic Acid.

46. What is the function of Stop Bath?

Answer: -

Stops the Developing action by neutralising the alkaline developer.

47. What are the ingredients of Fixer?

Answer: -

Fixing Agent A. Sodium thiosulphate commonly known as Hypo. Commonly used fixing agent.
 B. Ammonium thiosulphate. Used as rapid fixing agent.

48. What is the function of Fixer?

Answer: -

It removes all unexposed silver grains and clouded film starts to become clear.

49. What is the recommended time for Fixer?

Answer: -

General recommendation is 5 to 15 minutes.

50. What is Radiographic sensitivity?

Answer: -

It is the combination of Radiographic contrast and Radiographic definition. The Radiographic sensitivity is judged by Image quality Indicator (IQI), also known as penetrametre. Judging the qualitative & quantitative quality of radiograph, a penetrametre is required. The image of IQI on the radiograph is the evidence that the radiographic inspection was conducted under proper condition and achieved the required sensitivity.

$$\% \text{ Sensitivity} = \frac{\text{Minimum visible wire diameter.}}{\text{Thickness of the job.}} \times 100$$

51. What is the general requirement of Radiographic Sensitivity?

Answer: -

General requirement of Radiographic sensitivity are: -

> 2% (Less than two percent) – Good.

< 2% (More than two percent) – Not acceptable.

52. What are the commonly used IQI?

Answer: -

Commonly used IQI are: -

A. Wire type Penetrametre.

B. Plate type Penetrametre.

C. Step type Penetrametre.

D. Step- Hole type Penetrametre.

53. What are the criteria for selection of IQI or Penetrametre?

Answer: -

Penetrametre should be made of same material as that of the specimen.

The selection of IQI should be made as: -

A. For carbon Steel & Low Alloy Steel : - Carbon Steel IQI.

B. For High Alloy Steel & Stainless Steel : - Stainless Steel IQI.

C. For Aluminum & Aluminum Alloy : - Aluminum IQI.

D. Copper & copper Alloy : - Copper IQI.

54. Name some IQI?

Answer: -

Wire types IQI : - 1-ISO-7, 6-ISO-12,10-ISO-16

55. What do you mean by Radiographic contrast?

Answer: -

Density difference between the two adjacent areas of the radiograph is known as contrast.

Radiographic contrast is the combined effect of the following.

A. Subject contrast.

B. Film contrast.

56. What is subject contrast?

Answer: -

The factor of the specimen, which affects the contrast, is known as subject contrast.

57. What is film contrast?

Answer: -

The factor of the film, which affects the contrast, is known as Film contrast.

58. What are the factors, which affects subject contrast?

Answer: -

Subject contrast affected by: -

A. Thickness difference in the specimen.

Uniform thickness of the specimen shows no contrast but thickness difference in the specimen shows good contrast.

B. Radiation Quality.

Best contrast is achieved by ray of suitable low kilovoltage (Soft Radiation). By increasing the kilovoltage (Harder Radiation) penetration will increase but decrease the subject contrast.

C. Scattered Radiation.

By reducing the scattered radiation (internal, side and back scatters) using diaphragm, masks, Filters, and lead screens increase the subject contrast.

59. What are the factors, which affects the film contrast?

Answer: -

Film contrast affected by: -

A. Type of film.

Grain size of the film controls the film contrast. Finer the grains (lower speed) of the film higher the film contrast.

B. Film processing.

Increasing the developing time increases the density as well as fog density and decreases the film contrast. Processing of film in fresh developer gives higher contrast then the exhausted developer.

C. Film Density.

At higher film density, the film contrasts is more and at low density the film contrast is less.

60. Where the IQI (Penetrametre) is placed?

Answer: -

The IQI or penetrametre should be placed as possible on the source side of the radiation. When it is not possible as in case of double wall single image radiography, it can be placed on the film side with a lead letter ' F ' near the IQI. The IQI should be placed in most unfavourable location with respect to the radiation beam.

61. What are the different types of Radiography or Exposure technique?

Answer: -

Different types of Radiography techniques are: -

A. Single wall single image (Panoramic Exposure).

B. Double wall single image.

C. Double wall double image.

Question related to Equipment and piping Layout: -

1. What are the steps involve in Plant design?

Answer: -

The mechanical design and development of the plant has three major steps as: -

A. Conceptual layout design.

B. Equipment layout design.

C. Piping layout design.

2. What is conceptual layout design?

Answer: -

It is the part of basic engineering package. It consists of following information: -

A. Essential process design requirement such as horizontal & vertical relationship of equipment.

B. Space allocation for basic plant requirement (space required for laboratories, office, storage etc.)

C. Planning for control room, motor control center room etc.

3. What is Equipment layout design?

Answer: -

It is the detailing of conceptual layout. It is the basic document of mechanical engineering design or in other words this document is the basis for development of construction drawing by all disciplines. It is sometimes also referred as plot plan for large outdoor plant.

It consists of following information: -

A. Floor space needed for the equipment and other facilities are shown.

B. Access, removal space, cleaning area, storage space and handling facilities are outlined.

4. What are the essential data/ documents required for preparation of equipment layout?

Answer: -

The essential data or documents required for preparation of equipment layout is as: -

A. Process flow diagrams (PFD) and Piping & instrument Diagrams (P& ID).

PFD/ P& ID indicates the interconnectivity of each equipment, information regarding solid handling, gravity feed, line slopes, loop sizes, venting requirement, special piping materials etc. which in turns governs the equipment location to a great extent.

B. Project design data.

This consists of following information as: -

- ❖ Geographic location, proximity to roads and railway, topography and local codes and regulations, weather conditions such as rainfall records, seasonal temperature differences, wind direction, outlet points for drains etc.
- ❖ The above information such as wind direction influences the location of cooling towers, furnaces, stacks etc. Similarly, the information regarding outlet drain points affects the design of storm water drains and requirements of enclosures.

C. Equipment sizes and Building.

This includes fabricated equipment such as vessels, Heat Exchangers, Reactors, Tanks and proprietary equipment like pumps, Compressors, Furnaces etc. For locating the above, the equipment is grouped to have optimum location for minimum pipe run as well as follow the process flow sequence.

5. What are the two basic configurations for the equipment layout (unit plot plan)?

Answer: -

The equipment layout can basically be divided into two configurations:

- A.** The Grade Mounted Horizontal arrangement as seen in the refineries and petrochemical plants.
- B.** The vertical Arrangement as seen in many chemical process industries.

6. What is Grade mounted Horizontal Arrangement of equipment layout?

Answer: -

In the Grade mounted Horizontal Arrangement, the equipment is placed on the either side of the central pipe rack with auxiliary roads. Advantage of this arrangement is that the equipment is located at grade level, which makes it easier to construct, operate and maintain. Disadvantage is that it takes lot of ground area.

7. What is Vertical arrangement of equipment layout?

Answer: -

The structure mounted vertical arrangement has equipment located at multilevel in steel or concrete structure. This could be indoor or outdoor. Advantage is of small coverage area and ability to house the facility to suit process requirement or climate conditions.

8. What are the basic principles of locating the Equipment irrespective of the type of arrangement?

Answer: -

The certain basic principles to be followed while locating the equipment is as: -

A. Economic piping :

In order to minimize the cost of piping, the equipment should be located in process sequence and close enough to suit safety needs, access requirements and flexibility. The equipments are identified which forms the subsystem within the unit. The component within the subsystem to be arranged to have most economical piping and the whole subsystem to be arranged within the unit to have most economic interconnection.

B. Process Requirement:

The equipment layout should support requirement like minimum pressure drop, gravity feed and loop.

C. Common operation:

The equipment that requires common maintenance facilities, common utility and continuous operator attention shall be located the same area.

D. Underground Facilities:

Before deciding the equipment location, the facilities such as storm water drain, effluent drain, fire water, cooling water to be placed underground.

9. What is Line Routing Diagram?

Answer: -

A line routing diagram is a schematic representation of all process and utility-piping system drawn on a copy of plot plan. This diagram does not show the exact locations, elevations or interference but it locates the most congested area.

10. How do you calculate the width of Pipe rack?

Answer: -

$$W = (f \times n \times X \times s) + A + B.$$

...Where, **f** : Safety Factor

= 1.5 if pipes are counted from PFD.

= 1.2 if pipes are counted from P&ID.

n : number of lines in the densest area up to size 450NB.

= 300 mm (Estimated average spacing)

= 225 mm (if lines are smaller than 250 NB)

A : Additional Width for: -

: Lines larger than 450 NB.

: For instrument cable tray / duct.

: For Electrical cable tray.

s : 300 mm (estimated average spacing)

: 225 mm (if lines are smaller than 250 NB)

B : future provision

= 20% of $(f \times n \times X \times s) + A$

11. Up to what limit the width of pipe Rack is restricted? What type of arrangement shall be done if the width of rack calculated is more then the restricted limited?

Answer: -

Normally pipe Rack width is limited to 6.00 Mtrs. If the width of rack calculated is more then the arrangement shall be done in multiple layers. The arrangements adopted are: -

A. Single column Rack 'T' type.

B. Double column Rack with a single tier.

C. Double column Rack with a double tier.

12. How much space is kept in between column of pipe rack?

Answer: -

Normally, 5 to 6 Mtrs. spacing is kept in between the column of pipe rack.

13. At which location the wide spacing (spacing more than the normal) in between the column is necessary?

Answer: -

Wide spacing is necessary at road crossing or where loading or access space is needed.

14. How much Headroom clearance is required under the following type of crossing?

A. Structures/ pipe lines inside operating area.

B. From top of the Rail.

C. Above crest of road for crane movement.

D. Above crest of road for Truck movement.

E. Above crest of road between process units.

Answer: -

The Headroom normally provided is as: -

A. Structures/ pipe lines inside operating area. : 2200

B. From top of the Rail. : 7000

C. Above crest of road for crane movement. : 7000

D. Above crest of road for Truck movement. : 6000

E. Above crest of road between process units. : 4500

15. What sort of drawing/ layout is required for piping layout?

Answer: -

The following Drawing/ Layout are required for piping layout.

A. Piping & instrumentation Diagram (P& ID).

B. Equipment Layout.

C. Piping Specification.

D. Equipment Drawing.

E. Vendor Requirement for proprietary equipment.

16. What care shall be taken while routing piping for instruments?

Answer:-

Following points shall be taken care of while routing piping for instruments.

- A.** Flow measuring instrument needs certain straight length on upstream & downstream of the instruments. Normally, 15D on the upstream and 5D on the downstream is kept.
- B.** The pipe line in which flow meters such as magnetic flow meters, vortex meters, turbinometers etc are located shall be routed in such a way that the line must be filled with liquid all the time. The pipe line shall be supported with robust support on both side of the meter.
- C.** Control valves are located at grade e.g. at about 500mm height from finished ground to provide convenient access for operation and maintenance. Block and bypass valve shall be located to have easy operation/ access from the grade. Locating control valve on the vertical line shall be avoided.
- D.** Isolation valves for level gauges and pressure gauges shall be made accessible. All primary and secondary indicators of pressure, temperature, flow, level, positioners etc shall be visible from the operating area.
- E.** Rotameter shall be placed on vertical line and the inlet shall be from the bottom of the instrument.

Question Related to Mechanical Design Fundamentals:-

1. What are the Failures with reference to the structural design?

Answer:-

Failure of a structural part can occur by:-

- A.** Excessive elastic deformation.
- B.** Excessive non-elastic deformation.
- C.** Fracture.

Any design has to guard against these perceived failures.

2. What are the factors upon which the mechanical properties of material are dependent?

Answer:-

Mechanical properties of any material of construction are dependent on:-

- A.** Chemical composition of the material.
- B.** Method by which the material is manufactured.

3. What is stress?

Answer:-

It is defined as the applied load per unit cross-section of the specimen. The common unit are psi (pound per square inch), kpa, Mpa, kg/cm^2 .

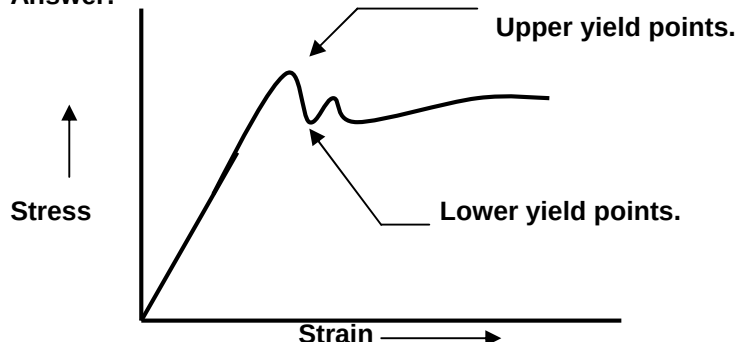
3. What is strain?

Answer:-

For tensile load, it is the ratio of increase in length of the specimen under constant sustained load to the original length of the specimen before the load is applied. For compressive load, it the ratio of decrease in length to the original length under sustained load. Strain is thus an observable and measurable quantity as the extension or compression of the specimen can be directly measured. It is a dimensionless quantity.

4. Draw the Stress- Strain curve showing the behavior of the specimen under stress?

Answer:-



When there is no load, there are no stresses and no strain. When a small tensile load is applied, the strain can be measured and stress derived. If the load is removed, the specimen returns to its original shape. That is there is no residual or permanent strain in the specimen. This situation continues up to a certain level of stress. A stress strain curve in this region is a straight line i.e. stress is proportional to strain. This region of curve is called the elastic region, as the MOC;s behavior is elastic like a rubber.

As the tensile load during the test is increased further, a situation arises when the specimen does not return to the original dimension even when the load is withdrawn. This is also the level or stress level at which the stress strain curve begins to deviate from the elastic straight- line behavior as shown in the graph. Thus, the metal / specimen are undergoing plastic deformation in addition to elastic deformation. When the load is withdrawn, the elastic deformation is recovered but the plastic deformation stays.

5. What is upper yield point with reference to above stress-strain Graph (Ultimate Tensile Strength)?

Answer:-

The highest stress that the metal can withstand under sustained load without continuing to elongate under same load is called the upper yield point.

6. What is lower yield point with reference to above stress- strain Graph?

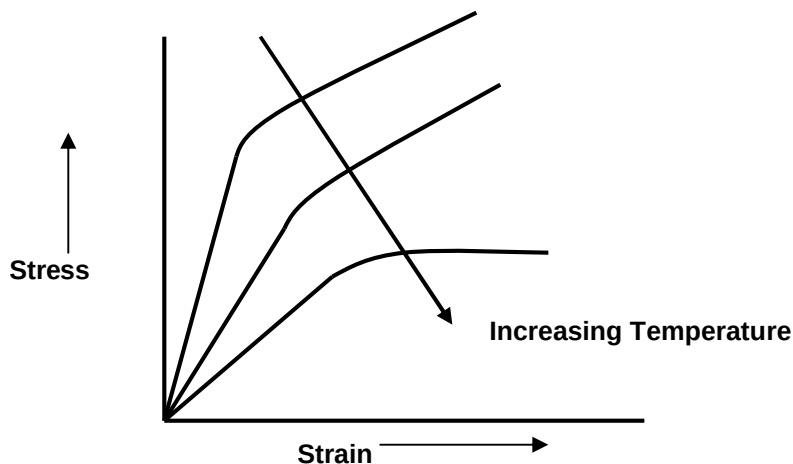
Answer:-

7. What is the effect on the specimen when subjected to a sustained load with higher temperatures?

Answer:-

As the temperature of the test increases, specimen of the same material would elongate more for the same load as compared to specimen tested at lower temperature. It means that the material becomes softer as it is subjected to higher and higher temperatures.

Stress-strain curves are different for different materials and at different temperatures for the same materials.



Stress- strain curves at different Temperatures.

8. What is Allowable Stress?

Answer:-

It is defined as ultimate tensile strength divided by factor of safety. The safety factor is obviously greater than 1. Design which ensure that the stress value anywhere in the structure is less than this allowable stress are considered safe as they do not allow the structure element to come anywhere close to the point where plastic instability leading to disruption or disintegration of element would set in.

9. What is the value of allowable stress if yield stress or 0.2% proof stress value is available at design temperature?

Answer:-

If the yield stress or 0.2% proof stress value is available at design temperature, the same shall be divided by a safety factor of 1.5 to get allowable stress.

10. What is the value of allowable stress if the yield stress is not available at design temperature but is available at room temperature?

Answer:-

If the yield stress is not available at design temperature but is available at room temperature, the same shall be divided by safety factor of 3.0 to get allowable stress.

11. What is the value of allowable stress if the stress value for rupture due to static fatigue or creep failure is available at design temperature?

Answer:-

If the stress value for rupture due to static fatigue or creep failure is available at design temperature, the same shall be divided by safety factor of 1.5 to get allowable stress.

Note: The safety factor considered above is recommended for carbon steel and low alloy steel.

12. How much design temperature shall be considered for the structural parts which are heated by steam, thermic fluid etc?

Answer:-

Design temperature shall be the highest expected temperature of the heating media or highest expected body part temperature plus 10° C. Here, 10° C is the safety margin.

13. What shall be the safety margin (temperature related) considered for fired vessel parts which are shielded (by Refractory) and the parts which are unshielded?

Answer:-

Safety margin for shielded parts	: 20°C.
Safety margin for unshielded parts	: 50°C.

Note: The above safety margins are just guidelines. What should be the safety margin would depends upon the severity of operation

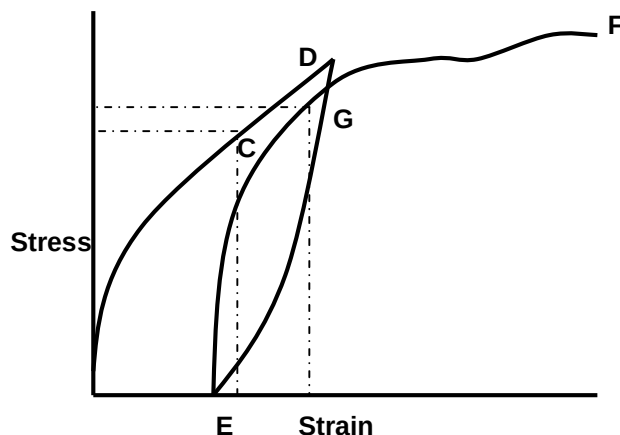
14. Define Proof Stress?

Answer:-

It is also called 0.2% proof stress. It is the stress for 0.2% strain. In simpler terms, it is the stress value for strain value of 0.002 on the stress strain curve.

15. How the proof stress in a material is altered (increased marginally)?

Answer:-



Increase in proof stress due to cold work.

Consider a stress strain curve as shown above. Let a fresh specimen be subjected to gradually increasing tensile loads. A 0.2% proof stress can be marked on the curve as the stress value corresponding to point C on the curve. Let the load be increased beyond this point up to point D on

the curve. The specimen has surely passed the elastic range and crossed over to plastic deformation. On withdrawal of the load, the specimen would return back to point E with a residual permanent strain as shown above. Tensile load test can now be conducted on this specimen which has seen plastic deformation or cold work previously. The specimen would now follow a stress- strain curve with strain zero at point E. Along this stress strain curve (EGF), 0.2% proof stress corresponds to point G which is higher than the proof stress for the fresh specimen.

The material in the above case seems to have hardened with its experience of stress earlier. Most material shows this marginal increase in their proof stress due to cold work.

16. What are the types of failures encountered in Piping?

Answer: -

1. Catastrophic Failure.
2. Fatigue Failure.

17. Define catastrophic failure?

Answer:-

The failures which occurs suddenly as soon as the load crosses the threshold (Ultimate tensile strength). These failures take place on the first occurrence of the loads in excess of yield stress.

18. What is fatigue failure?

Answer:-

The failure which occurs due to damaging of the grain structure of the specimen subjected to prolonged application of sustained load and or tensile –compressive load cycle.

18. What are the types of Fatigue failure?

Answer:-

Types of fatigue failure are:-

- A. Static Fatigue.
- B. Cyclic Fatigue.

19. What is Static Fatigue?

Answer:-

The specimen which fails under sustained load subjected to considerable length of time. The total time for which the load was applied is important. Whether it is applied continuously or in installments is not important.

20. What is cyclic fatigue?

Answer:-

The specimen which fails under a load cycle subjected to considerable numbers of times. The total numbers of cycles for which the load was applied is important. Whether the cycle was frequent or infrequent is not important.

21. Explain the failure of the specimen subjected to cyclic load?

Answer:-

Consider a specimen subjected to a tensile load increasing from zero to X and then this load is gradually withdrawn till it is zero. Now compressive load applied gradually till it is X and then it is drawn till the load is zero. This comprises a cycle and is repeated again and again. With each cycle, the grains in the material get displaced relative to each other and get more and more interlocked. With each cycle, the material loses its ductility in small increments. A time comes when the grains are so badly interlocked that they cannot allow deformation to withstand load and a small crack develops. This crack grows with further cycles and failure occurs.

22. What is creep failure?

Answer:-

Occurrence of static fatigue failure when the material is under prolonged sustained load coupled with high temperature is called creep failure.

23. Write the sequence of stress values at failures for solid rod, sphere and cylinders?

Answer:-

A typical sequence of stress values at failure for solid rods and two most important shapes in process industry namely, sphere and cylinder is Rod > Sphere > Cylinder.

Questions Related to pipe under stress:-

1. What are Primary loads? Mention some of Primary Loads?

Answer:-

These are typically steady or sustained types of loads. These loads have their origin in some force acting on the pipe causing tension, compression, torsion etc leading to normal and shear stress. Primary loads are not self limiting. Some of the primary loads are as:-

- A. Internal fluid pressure
- B. External pressure.
- C. Gravitational forces acting on the pipe such as weight of the pipe & fluid.
- D. Forces due to relief or blow down.
- E. Pressure waves generated due to water hammer effects.

2. What do you mean by self limiting?

Answer:-

It means that the stresses continue to exist as long as long the load persists and deformation does not stop because the system has deformed into a no-stress condition but because strain hardening has come into play.

3. What are secondary loads? Mention some of the secondary loads?

Answer:-

Secondary loads are caused by displacement of some kind. Some of the secondary loads are as:-

- A. Force on piping due to tank settlement.
- B. Vessel nozzle moving up due to expansion of vessel.
- C. Pipe expansion or contraction.
- D. Vibration due to rotational equipment.

4. What is the most used choice of co-ordinate system for defining the stresses?

Answer: -

In a pipe subjected to internal pressure or any other load, the most used choice of co-ordinate system is as:

- A. Axial or Longitudinal direction.
- B. Circumferential or Hooke's direction.
- C. Radial direction.

The stresses in the pipe wall are expressed as axial(S_L), Hooke's (S_H) and Radial (S_R). These stresses which stretch or compress a grain/ crystal are called normal stress because they are normal to the surface of the crystal.

5. What do you mean by Hoop Stresses and how do you calculate it?

Answer: -

Stresses which are generated circumferentially due to the action of Internal pressure of pipe are called Hoop Stress. It is calculated by; -

$$\text{Hoop Stress } (S_h) = \frac{Pd_o}{2t}$$

Where P = Force Acting from Inside.
 d_o = OD of Pipe.
t = Pipe Thickness.

6. How does Hoop Stress affect the system?

Answer: -

As per membrane theory for pressure design of cylinders, as long as hoop stress is less than yield stress of Moc , the design is safe. Hoop stress induced by thermal pressure is twice the axial stress (SL). This is widely used for pressure thickness calculation for pressure vessel.

7. What are the other stresses against which the design of piping is safe guarded?

Answer:-

- A. Principal stress.
- B. Shear stress.

Apart from the stress which is normal to the surface of the crystal as mentioned in question No. 4, the grains would have been oriented in the pipe wall in all possible orientations. The above stresses (Axial, Circumferential and Radial stress) have stress component in direction normal to faces of randomly oriented crystal. Each crystal thus faces normal stresses. One of these orientations must be such that it maximizes one of the normal stresses. Normal stresses for such orientation (maximum normal stress orientation) are called principal stresses and are designated as S_1 (maximum), S_2 and S_3 (minimum).

Principal stresses are way of defining the worst case scenario as far as the normal stresses are concerned.

In addition to the normal stresses, a grain can be subjected to shear stresses as well. These stress act parallel to the crystal surface. The shear stresses occur if the pipe is subjected to torsion, bending etc. Just as there is an orientation for which normal stresses are maximum, there is an orientation which maximizes shear stress. The maximum shear stress in a 3-D state of stress can be shown to be as:-

$$\tau_{\max} = (S_1 - S_3)/2$$

i.e. half of the difference between the maximum and minimum principal stresses.

8. What does the solid mechanics states regarding the Normal stresses?

Answer:-

Solid mechanic states that the sum of the three normal stresses for all orientation is always the same for any given external load as:-

$$S_L + S_H + S_R = S_1 + S_2 + S_3$$

9. Which component of normal stress is considered negligible?

Answer:-

In most pipe design cases, the radial component of normal stresses (S_R) is negligible as compare to the other two component (S_H and S_L).

10. How the two principal stresses and maximum shear stress are calculated?

Answer:-

Use of Mohr's circle allows calculating the two principal stresses and maximum shear stress as:-

$$S_1 = (S_L + S_H)/2 + [\{(S_L - S_H)/2\}^2 + \tau^2]^{0.5}$$

$$S_2 = (S_L + S_H)/2 - [\{(S_L - S_H)/2\}^2 + \tau^2]^{0.5}$$

$$\tau_{\max} = 0.5 [(S_L - S_H)^2 + 4 \tau^2]^{0.5}$$

The third principal stress (minimum i.e. S_3) is zero.

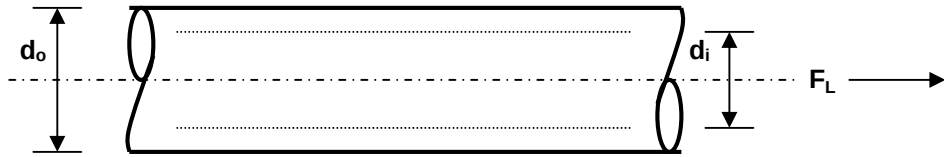
11. What are the potential loads faced by pipes during normal operation? Write their relationship to the stresses developed?

Answer:-

The potential loads faced by a pipe are:-

- A. Axial load.
- B. Internal/ External pressure load.
- C. Bending load.
- D. Shear load.
- E. Torsional load.

A. Axial Load:-



Pipe under Axial load (Tensile)

A pipe may face an axial force (F_L) as shown in figure. The load may be tensile or compressive. In figure only tensile load acting on pipe is shown. The load (F_L) leads to normal stress in axial direction (S_L). The load bearing cross-section is the cross-sectional area of the pipe wall normal to the load direction, A_m . The stress developed is given by:-

$$S_L = F_L / A_m$$

The load bearing cross- section is calculated as:-

$$\begin{aligned} A_m &= \pi (d_o^2 - d_i^2)/4 \text{ (rigorous)} \\ &= \pi (d_o + d_i) t/2 \text{ (based on average Diameter.)} \\ &= \pi d_o t \text{ (based on outer Diameter.)} \end{aligned}$$

Some examples of cause of axial load are as:-

1. The metal cross- section at the base of the column is under the weight of the column section above it including the weight of other column accessories such as insulation, trays, ladders etc.
2. Sometimes the pipe is intentionally cut a little short than the end- to- end length required. It is then connected to the nozzle by forcibly stretching it. The pipe as assembled is under axial tension. When the hot fluids starts moving through the pipe, the pipe expands and the compressive stresses are generated. The cold tensile stresses are thus nullified.

B. Internal / External pressure Load:-

A pipe used for transporting fluid is subjected to the internal pressure load. This internal or external pressure induces stresses in the axial as well circumferential (Hooke's) directions. The pressure also induces stresses in the radial direction but is often neglected.

Axial Stress

The internal pressure exerts an axial force equal to pressure times the internal cross-section of pipe as:-

$$F_L = P [\pi d_i^2/4]$$

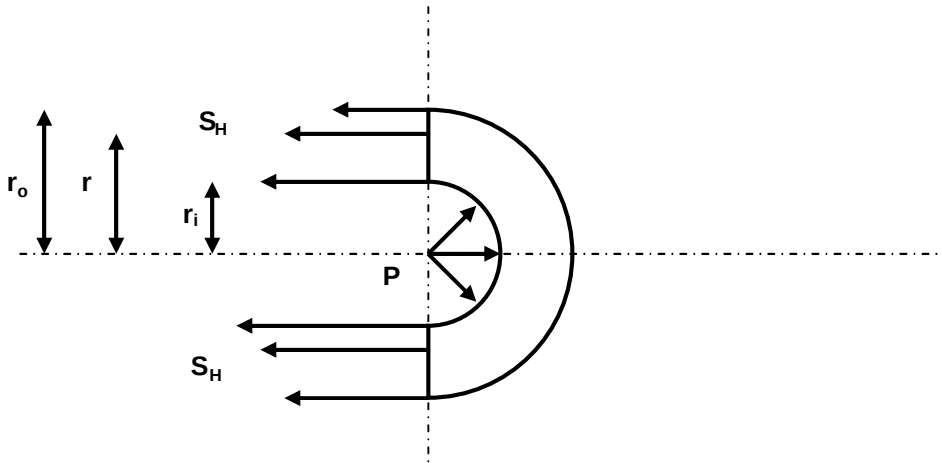
This then induces axial stress calculated as:-

$$S_L = Pd_o/4t$$

(Outer diameter is used for calculating metal cross-section as well as pipe cross- section.)

Hooke's or Circumferential Stress

The internal pressure also induces stresses in the circumferential direction as shown in figure.



Hooke's Stress Due to Internal Pressure.

The stresses are maximum for grains situated at the inner radius and minimum for those situated at the outer radius. The Hooke's stress at any point in between radial position (r) is given as:-

$$S_H \text{ at } r = P (r_i^2 + r_i^2 r_o^2) / (r_o^2 - r_i^2) \text{ ----- (Lame's equation)}$$

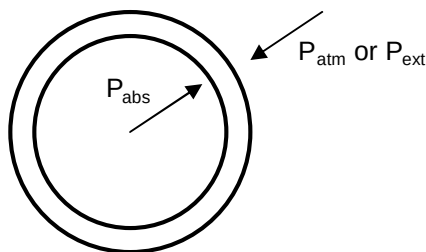
From membrane theory, S_H is calculated as:-

$$S_H = Pd_o / 2t \quad \text{or} \quad Pd_i / 2t$$

Radial Stress

For thin walled pipes, the radial stress variation can be neglected.

Radial stresses are also induced due to internal pressure as shown in figure.



Radial Stresses Due to Internal Pressure.

At the outer skin, the radial stress is compressive and equal to the atmospheric pressure (P_{atm}) or external pressure (P_{ext}) on the pipe. At the inner radius, it is also compressive but equal to absolute fluid pressure (P_{abs}). In between it varies. But it is often neglected.

C. Bending Load:-

Pipe bending is caused mainly due to two reasons:

- A.** Uniform weight load
- B.** Concentrated weight load.

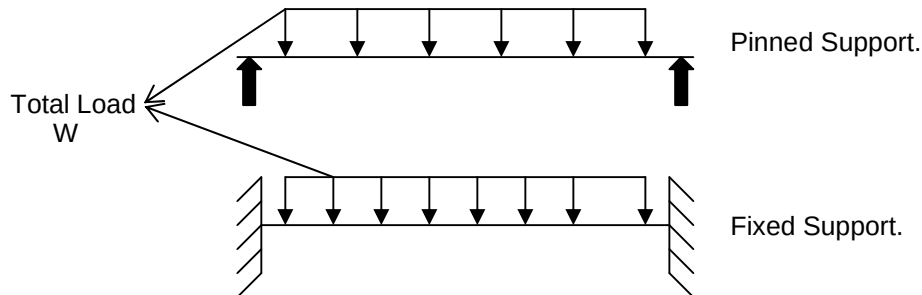
Uniform Weight Load.

A pipe span supported at two ends would sag between the supports due to the following:

- A.** Self weight of the pipe and weight of the insulation when not in operation.
- B.** Self weight and weight of hydrostatic test fluid during hydrostatic test.
- C.** Self weight, weight of insulation and weight of fluid it is carrying during operation.

All these weights are distributed uniformly across the unsupported span and lead to maximum bending moment either at the centre of the span or at the end points of the span.

Let the total weight of the pipe, insulation and fluid be W and the length of unsupported span be L as shown in figure.



Uniformly Distributed Load.

The weight per unit length,

$$w = W/L$$

The maximum bending moment ($M_{\max}$) which occurs at the centre for the pinned support.

$$M_{\max} = wL^2/8$$

For fixed support, the maximum bending moment occurs at the end.

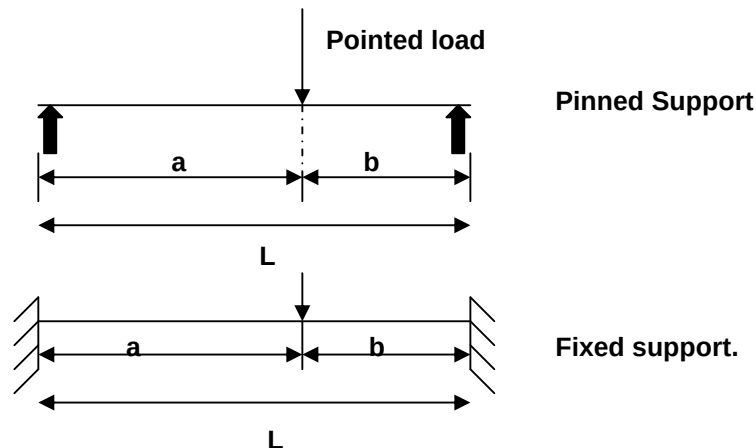
$$M_{\max} = wL^2/12$$

The pipe configuration and support used in process industry do not confirm to any of the above ideal support and is considered somewhere in between. The common practice is to use the following average formula to calculate bending moment for practical pipe configuration.

$$M_{\max} = wL^2/10$$

Concentrated Weight Load.

The example of concentrated load is a valve on a pipe run.



The load is acting at the centre of gravity of the valve and the maximum bending moment occurs at the point of loading for pinned support is given by:

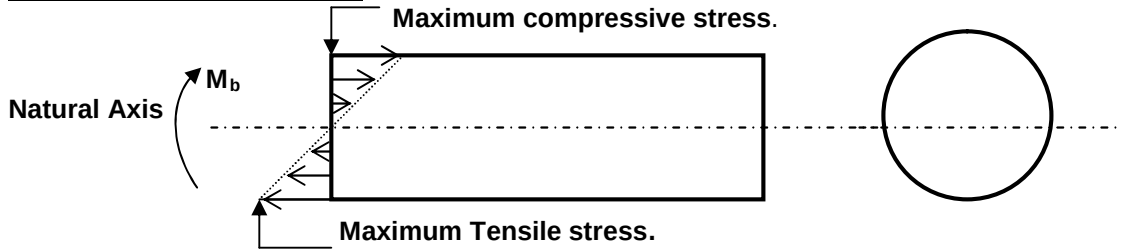
$$M_{\max} = W a b / L$$

For rigid support, the maximum bending moment occurs at the end nearer to the pointed load and is given by:

$$M_{\max} = W a^2 b / L^2 \text{ ('a' is taken as the longer of two arm in using the formula.)}$$

The bending moment in the above case can be reduced to zero by making either 'a' or 'b' zero i.e. locating one of the supports right at the point where the load is acting. In actual practice, it would mean supporting the valve itself. As it is not possible, the common practice is to locate one of the supports as close to the valve (or any other pointed and significant load). By this, the bending moment due to pointed load is minimal and can be neglected.

Axial Stress due to Bending



Whenever the pipe bends, the skin of the pipe wall experiences both tensile and compressive stresses in the axial direction as shown in the figure. The axial stress changes from maximum tensile on one side of the pipe to maximum compressive on the other side. Obviously, there is natural axis along which the bending moment does not induce any axial stress. This is also the axis of the pipe.

The axial tensile stress for bending moment M_b at location c as measured from natural axis is given by:

$$S_L = M_b c / I$$

I is the moment of inertia of the pipe cross-section. For a circular cross-section pipe, I is given by:

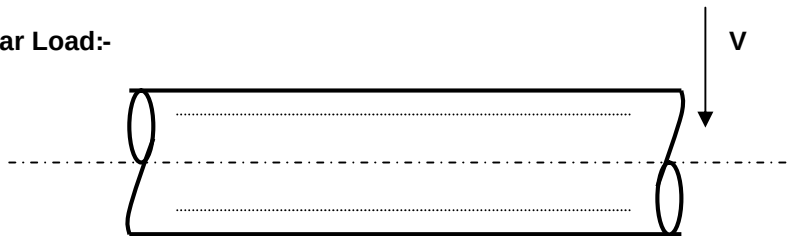
$$I = \pi(d_o^4 - d_i^4) / 64$$

The maximum tensile stress occurs where c is equal to the outer radius of the pipe and is given by:

$$S_L \text{ at outer radius} = M_b r_o / I = M_b / Z$$

Where $Z (=I/r_o)$ is the section modulus of the pipe.

D. Shear Load:-

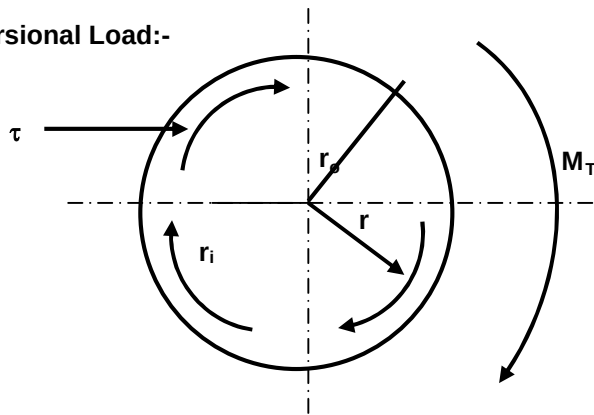


Shear Force on a pipe

Shear force (V) acting on the pipe is shown in the figure. It causes shear stresses which are maximum along the pipe axis and minimum along the outer skin of the pipe. This is exactly opposite of the axial stress pattern caused by bending moment. These stresses are small in magnitude hence not taken in account in pipe stress analysis. If necessary these are calculated as:

$$\tau_{\max.} = VQ/A_m \text{ where, } Q \text{ is shear form factor and } A_m \text{ is metal cross-section.}$$

E. Torsional Load:-



This load causes shear stresses. The shear stress caused due to torsion is maximum at outer pipe radius. The Torsional moment is given by:

$$\tau \text{ (at } r = r_o) = M_T r_o / R_T = M_T r_o / (2I) = M_T / 2 Z$$

where, R_T is the Torsional resistance = twice the moment of inertia.

12. What are the Theories of failure?

Answer:-

Important theories in common use are:-

- A. Maximum Stress Theory or Rankine Theory.
- B. Maximum Shear Theory or Tresca Theory.
- C. Octahedral Shear Theory or Von Mises Theory.

13. What is Maximum stress theory?

Answer:-

According to this theory, failure occurs when the maximum principal stress in a system (S_1) is greater than the maximum tensile principal stress at yield in a specimen subjected to uniaxial test. In uniaxial test, the applied load give rise to axial stress (S_L) only and Hooke's stress (S_H) & Radial stress (S_R) as well as the shear stress are absent. In a specimen under uniaxial tension test at yield the following holds.

$$\begin{aligned} S_L &= S_Y, S_H = 0, S_R = 0 \\ S_1 &= S_Y, S_2 = 0, \text{ and } S_3 = 0 \end{aligned}$$

The maximum tensile principle stress at yield is thus equal to the conventionally reported yield stress (load at yield / cross- sectional area of specimen)

The Rankine theory thus says that the failure occurs when the maximum principal stress in a system (S_1) is more than the yield stress of the material (S_Y).

14. What is Maximum Shear Theory?

Answer:-

According to this theory the failure occurs when the maximum shear stress ($\tau_{\max}$) is greater than the maximum shear stress at yield in a specimen subjected to uniaxial tension test.

$$\tau_{\max} = 0.5 [(S_L - S_H)^2 + 4\tau^2]^{0.5}$$

Since, in the uniaxial tension test S_H and τ is Zero. Thus,

$$\tau_{\max} = S_L/2 = S_Y/2$$

The Tresca Theory thus says that the failure occurs when the maximum shear stress in a system ($\tau_{\max}$) is more than half the yield stress of the material.

15. What is Octahedral Shear Theory?

Answer:-

According to this theory, the failure occurs when the octahedral shear stress in a system (τ_{oct}) is greater than the octahedral shear stress at the yield in a specimen subjected to uniaxial tension test. The octahedral shear stress is given by:

$$\tau_{\text{oct}} = 1/3 [(S_1 - S_2)^2 + (S_2 - S_3)^2 + (S_3 - S_1)^2]^{0.5}$$

The octahedral shear stress at yield in the specimen subjected to uniaxial tension test is given by:

$$\tau_{\text{oct}} = 2/3 S_Y^{0.5}$$

Questions Related to Stress Analysis:-

1. What is the objective of stress analysis?

Answer: -

- A. To ensure that the stresses in piping components in the system are within allowable limits.
- B. To solve dynamic problems developed due to mechanical vibration, fluid hammer, pulsation, relief valves, etc.
- C. To solve problems associated due to higher or lower operating temperature as: -
 - I. Displacement stress range.
 - II. Nozzle loading on connected equipment.
 - III. Pipe displacements.
 - IV. Loads & moments on supporting structure.

2. What are the steps involved in stress analysis (or any stress package carries out)?

Answer: -

- A. Identify the potential loads that the piping system would encounter during the life of the plant.
- B. Relate each of these loads to the stresses and strains developed.
- C. Get the cumulative effect of the potential loads in the system.
- D. Decide the allowable limits the system can withstand without failure as per code.
- E. After the system is designed to ensure that the stresses are within safe limits.

3. How the loads are classified in stress analysis package?

Answer: -

- A. Sustained Loads : Those due to forces present during normal operation.
- B. Occasional Loads : Those present during rare intervals of operation.
- C. Displacement Loads : Those due to displacement of pipe.
(Self-limiting stresses due to thermal effects).

4. What are the sources of sustained load generated in piping system?

Answer: -

- A. Internal fluid pressure.
- B. Dead weight of Pipe with fluid and its attachments.

Sustained load is calculated as: -

Weight of Pipe with Fluid + Internal fluid pressure load + Load due to springs (W+P1).

5. What are the Inputs required for stress analysis of a piping system?

Answer: -

- A. Pipe Size.
- B. Fluid Temperature.
- C. Pipe Material.
- D. Model.
- E. Design pressure.
- F. Insulation Thickness.
- G. Specific gravity.
- H. Friction coefficient.

6. How do you calculate the operating load?

Answer: -

W+P1+T1

T1 – Load due to thermal expansion.

7. Give some Examples for occasional Loads.

Answer: -

- A. Wind load.
- B. Seismic load.
- C. Forces due to relief or blow down.
- D. Pressure wave generated due to water hammer effects.

8. What is the failure theory subscribed under ASME B31.3?

- A. Maximum principal stress theory (Rankines Theory).
- B. Maximum Shear Theory.
- C. Octahedral Shear Theory.

Answer: - A. Maximum principal stress theory or Rankines theory.

9. Select the failure stress range for fatigue failure due to thermal expansion as per B31.3?

- A. $S_A = (S_c + S_h) 1.6f$
- B. $S_A = 1.25 (S_c + S_h)$
- C. $S_A = (1.25 S_c + 0.25 S_h)f$

Where, S_A = Allowable Expansion stress Range.

S_c and S_h = Basic Allowable material stress in cold & hot conditions respectively.

f = Stress range reduction factor (1 for 7000 cycles.)

Answer: - C

10. What is the desired life cycle for Piping in operation?

Answer: -

Desired life cycle for Piping in operation is 20 Years (7000 Cycles).

The normal no. of cycles for which the displacement or thermal stresses are designed is 7000 cycles.

11. How do you calculate the stress developed due to thermal expansion?

Answer: -

Stress developed, $\epsilon = E \times \alpha$, ($\alpha = \Delta L/L$)

..... Where, E = Young's Modulus.

ΔL = Increase in length due to thermal expansion.

L = Original Length of the pipe.

12. How do you calculate the thermal expansion in a pipe?

Answer: -

$$\Delta L = \alpha \times \Delta T \times L$$

In the codes and many reported calculations, α is used as inclusive of ΔT . Thus the above formula is written as:-

$$\Delta L = \alpha \times L$$

Where, α = Coefficient of thermal expansion from ambient to operating temperature.

L = Length of the pipe.

13. What do you mean by Stress Intensity Factor (SIF)? Give some examples.

Answer: -

Stress Intensity Factor (SIF) is the ratio of maximum stress intensity to normal stress. It is used as safe factor to account for the effect of localised stress on piping under respective loading. In piping it is applied to welds, fittings, branch connections etc where stress concentration and possible fatigue failure may occur.

Example: - SIF for Reducer and Weldneck Flange is 1.0

SIF for socket weld flange is 1.3

14. How much should be the pressure for Hydro-Test?

Answer: -

Hydrotest pressure should be calculated as follow except as provided against point No D.

A. 1.5 Times of Design Pressure.

B. For a design temperature above the test temperature, minimum test pressure can be calculated as:

$$P_t = (1.5 \times P \times S_t) / S$$

.....Where, P_t : Minimum Test Pressure.

P : Internal design pressure.

S_t : Allowable stress at test temperature.

S : Allowable stress as design temperature.

C. If a test pressure as per above would produce a stress in excess of the yield strength at test temp.the test pressure may be reduced to maximum pressure that will not exceed the yield strength at test temp.

D. If the test pressure of piping exceeds the vessel pressure and it is not considered practicable to isolate piping from vessel, the piping and vessel may be tested together at test pressure of the vessel when approved by owner and provided the test pressure for vessel is not less than 115% of piping design pressure adjusted for temperature as per point No.B.

15. How do you calculate the pipe spacing?

Answer: -

Pipe Spacing (mm) = $(D_o + D_t) / 2 + 25\text{mm} + \text{Thickness of Insulation (mm)}$.

Where: D_o : OD of Small size Pipe (mm).

D_t : OD of Flange of Large size Pipe (mm).

16. Which fluid is used in Heat Exchanger in shell side and tube side?

Answer: -

Generally corrosive fluid is used from the tube side (as tube can be easily replaced) and cleaner fluid is used from shell side. Sometimes Hot fluid is also used from the shell side.

17. What is Reynolds number and what is the value of Reynolds number upto which the flow is laminar?

Answer: -

It's a dimensionless number to classify the nature of flow.

$$R_e = a v d / f$$

.....Where, R_e : Reynold's no.

a : Density of fluid.

d : Diameter of Pipe.

v : Average velocity of fluid.

f : Viscosity of fluid.

Flow is laminar upto $Re=2100$

18. Why do we provide Drip Leg in Steam Line?

Answer: -

To remove condensate when there is a rise of same in the pipe along the flow direction. If drip leg is not provided in steam line, the condensate which forms inside the pipe will result in Water Hammer effect causing damage to piping system.

19. What is the design standard followed for the calculation of allowable forces / Moments in nozzles of centrifugal compressor & Steam turbines nozzle?

Answer: -

The strain sensitive equipment piping to be routed and supported to limit nozzle loading and moment in equipment within allowable limits furnished by respective vendors or in absence of vendor data API 560/610/615/621/661 & NEMA SM23. (Referred by API 617) is used for compressor & steam turbine nozzle.

20. What is the mill tolerance to be considered for the thickness of pipe during stress analysis as per ASME B31?

(i) 1%

ii) 2.5%

(iii) 7.5%

iv) 12.5%

Answer : iv

21. Differentiate between static load and dynamic load?

Answer: -

Static loads are those which are applied slowly enough so that the system has time to react and internally distribute the loads, thus remaining in equilibrium. In equilibrium, all forces and moments are resolved (i.e., the sum of the forces and moments are zero), and the pipe does not move.

Dynamic loads are those which changes quickly with time. The piping system may not have time to internally distribute the loads, so forces and moments are not always resolved & resulting in unbalanced loads, and therefore pipe movement. Since the sum of forces and moments are not necessarily equal to zero, the internally induced loads can be different either higher or lower than the applied loads.

22. Give different types of dynamic loads with example?

Answer: -

A. Random – Wind, Earthquake.

B. Harmonic – Equipment Vibration, Pulsation, Acoustic Vibration.

C. Impulse – Fluid Hammer, relief valve opening, slug flow.

23. What is Dynamic Analysis and why it is used?

Answer: -

Dynamic analysis is performed for all two phase lines in order to ensure that the line supported is safe from vibrations loads which may occur during normal operation as well as in start up or any upset condition. (Diesel mixed with hydrogen in DHDT process).

24. What are WRC 107 / WRC 297?

Answer: -

Localised stresses at Nozzle to Shell is calculated by WRC 107 / 297 and these computed stress values shall be limited in accordance with ASME Sec VIII for Pressure Vessels.

25. Why loop is provided in piping system?

Answer: -

To adjust thermal expansion.

26. What is the maximum expansion absorbed in loops in normal design?

Answer: -

10 Inches.

27. What is the allowable stress range for CS pipes?

Answer: -

2070 kg/cm².

Question related to Non- destructive Testing: -

1. Describe different types of destructive and non-destructive tests?

Answer: -

DESTRUCTIVE TEST: Bend test, Tensile test, Impact test, and Hardness test.
NON-DESTRUCTIVE TEST: DPT, MPT, Radiography and ultrasonic test.

2. What are the different types of hardness tests carried out?

Answer: -

Brinell Hardness Test.
Rockwell Hardness Test.
Vicker Hardness Test.

3. What is the relation between Brinell Hardness No. and Rockwell Hardness No.?

Answer: -

22 HRC (Rockwell Hardness) = 238 BHN (Brinell Hardness No) Harder.

Questions related to wrapping & coating/ insulation/ cathodic protection: -

1. What is the procedure for application of wrapping and coating?

Answer: -

Procedure for application of Coating and wrapping: -

- A. Prior to application of wrapping & coating, the surface of pipe should be made free from all loose Mill scale, dirt, rust, grease, moisture and other foreign material. This is achieved by blast cleaning to grade Sa 2 ½ .
- B. The pipe exterior surface or blast surface shall be coated with primer within four hours of shot blasting. The primer shall not be applied when the pipe surface temperature is below 7°C and above 70°C. when moisture is present on the surface, the same is heated for sufficient time to dry the surface.
- C. The pipe after priming shall be coated with two-flood coat of hot enamel incorporating the simultaneous application of inner & outer wrapping.

2. What is the content of primer applied on the pipe surface before coating?

Answer: -

The primer consists of processed coal – tar pitch and refined coal – tar oil.

3. What is the enamel applied on the pipe surface for coating?

Answer: -

The enamel is plasticised coal tar pitch suitable for hot application and filled with inert mineral filler which have minimum tendency to settle down in fluid state.

4. Which material is used as inner and outer wrapping?

Answer: -

Fibre glass tissue consisting of a uniformly porous mat of chemically resistant boro – silicate glass containing not less than 5% B_2O_3 .

5. What should be the minimum thickness of enamel on any point on pipe?

Answer: -

The enamel shall have minimum thickness of 2.4 mm when measured on top of the weld with an overall thickness of 4mm.

6. How much should be the depth of pulling of inner Fibre – glass tissue into the hot enamel?

Answer: -

The inner wrap of Fibre – glass tissue pulled in such a manner that the same is imbedded half way into the enamel without touching the steel surface.

7. What should be the overlap between inner & outer wrap?

Answer: -

The inner and outer wraps shall be overlapped by 25mm.

8. What should be the minimum staggering of inner & outer wraps?

Answer: -

The overlaps of the inner and outer wraps shall be staggered from each other by minimum distance of 100mm.

9. What is cold type of wrapping?

Answer: -

PVC backed bituminous compound tape used for field wrapping is called cold wrapping.

10. What is the minimum overlap of field wrapping (cold Tape) on shop wrapping?

Answer: -

Wrapping shall start and finish to give a minimum 75mm overlap onto the adjoining shop coating.

11. What is the material applied on the flanges or valves to obtain smooth surface for application of cold Tape?

Answer: -

Moulding compound shall be hand applied to obtain the smooth surface for application of cold tape on flanges / valves.

12. What is the device used to locate the defects on surface of coating & wrapping?

Answer: -

Holiday Detector.

13. How much crest voltage of Holiday Detector shall be set?

Answer: -

The crest voltage of Holiday Detector shall be set as high as practical.

14. What is the test to ensure the proper thickness, adhesion and the position of inner wrap?

Answer: -

A square of 25mm X 25mm shall be cut from wrapping for determination of thickness, adhesion and position of the inner wrap. This shall be carried out at the rate of one pipe per 50 coated.

15. What are different types of Anodes used in cathodic protection?

Answer: -

Different types of Anodes are Magnesium, Zinc, High Silicon Iron, Aluminum etc.

16. What are Insulating Gasket Kits?

Answer: -

Insulation gasket kits are designed to restrict the effects of corrosion often found in flanged pipe systems. The most common example is fire water line running inside the ground and turned upward on above ground with flanged connection.

It consists of following kits: -

- A. Gasket : - Neoprene faced Phenolic /Glass Reinforced Epoxy (G10).
- B. Insulation sleeve : - Reinforced Phenolic/Nylon/Polyethylene/(G10).
- C. Insulation washer : - Reinforced Phenolic/Nylon/Polyethylene/(G10).
- D. Plated Washer : - Electro plated steel washer.

17. What is the temperature limit for application of insulation for personnel protection?

Answer: -

Insulation for personnel protection shall be required when the line operating temperature exceeds 60°C.

18. What short of paint is applied on the inside surface of Aluminium metal Jackets for pipe insulation?

Answer: -

All pipe insulation shall be provided with an Aluminum metal jacket with site applied moisture barrier of bituminous paints.

19. Which material is used for securement of insulation on pipe?

Answer: -

For securement of insulation following material are applied:

- A. Stainless steel wire (SS –304) of 1 mm thickness with 225 mm intervals.
- B. Aluminium bands of 0.6 X 20 mm with 225 mm intervals.

20. What shall be layers of insulation for different thickness?

Answer: -

The insulation shall be single layer up to 75mm thickness and double layer at 90mm thickness and greater.

21. What care shall be taken before applying insulation?

Answer: -

The surface to be insulated shall be free from oil, grease and all other foreign matter and shall be free from moisture prior to the application of any insulation.

22. What is the minimum circumferential lap of metal jacket applied on the insulation?

Answer: -

Questions related to Pump/ Alignment/ pump piping: -

1. What are different types of pumps?

Answer: -

Basically there are two types of pumps.

- A. Centrifugal Pump.
- B. Positive Displacement pump.

2. What are the different types of centrifugal pump?

Answer: -

Different types of Centrifugal Pump are: -

- A. Single Stage or
- B. Multi-stage

3. What is the basic difference between single stage and multi-stage centrifugal pump?

Answer: -

The Single stage pump has one impeller and multi-stage pump has two or more impellers in series. The discharge of one impeller is the suction of the next one and the head developed in all the stages are totaled.

4. How many types of centrifugal pump are available based on the Suction and Discharge arrangement?

Answer: -

Based on the suction and discharge arrangement, the type of centrifugal pumps available is: -

- A. End Suction Top Discharge.
- B. Top Suction Top Discharge.
- C. Side Suction Side Discharge.

5. What are the main components of a centrifugal pump?

Answer: -

A centrifugal pump has two main components as:-

- A. A rotating component comprised of an impeller and a shaft.
- B. A stationary component comprised of a casing, casing cover, and bearings.

The general components, both stationary and rotary are shown in Figure B.01.

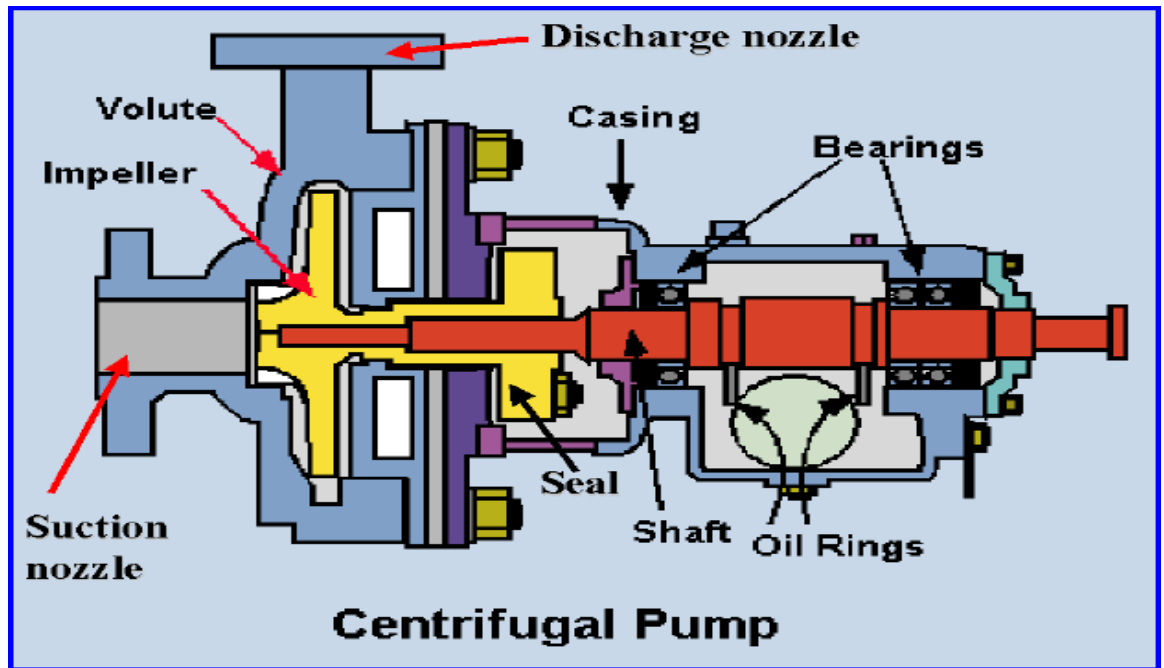


Figure B.01: General components of Centrifugal Pump

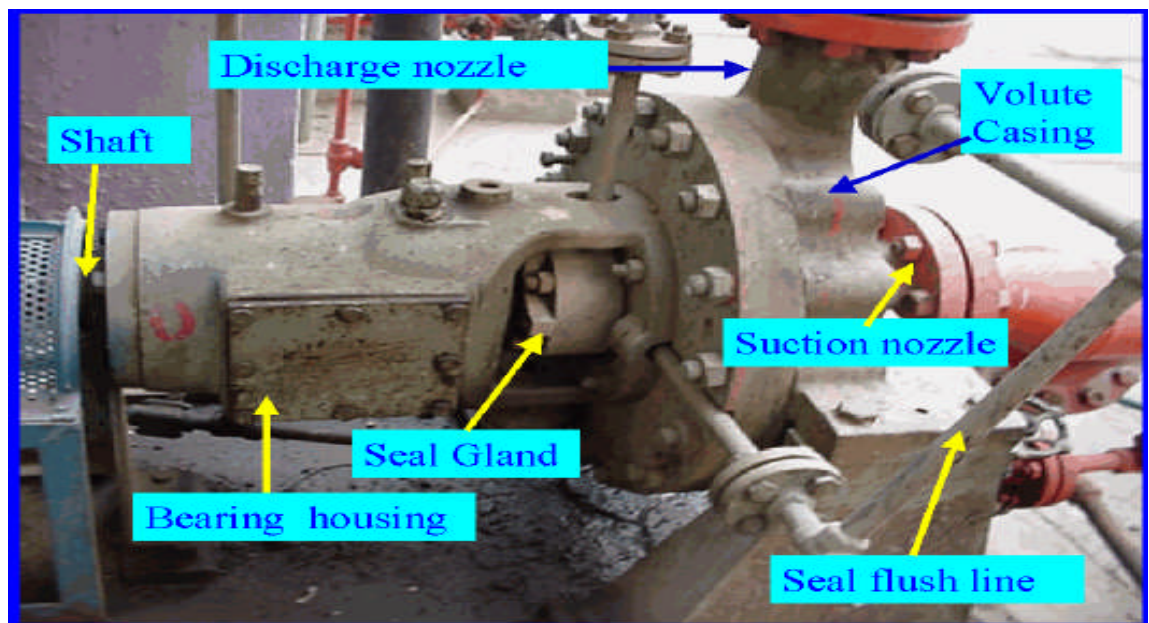


Figure B.02: General components of a Centrifugal Pump

6. What are the different types of casing?

Answer: -

Casings are generally of two types: volute and circular. The impellers are fitted inside the casings.

7. Define the working mechanism of centrifugal pump?

Answer: -

A centrifugal pump is one the simplest pieces of equipment in any process plant. Its purpose is to convert energy of prime mover (an electric motor or turbine) first into velocity or kinetic energy and then into pressure energy of a fluid that is being pumped. The energy changes occur by virtue of two main parts of the pump, the impeller and the volute or diffuser. The impeller is rotating part that converts drivers energy into the kinetic energy. The volute or diffuser is the stationary part that converts the kinetic energy into pressure energy.

8. How the centrifugal force generated in the centrifugal pump?

Answer: -

The process liquid enters the suction nozzle and then into the eye (center) of the revolving device known as an Impeller. When the impeller rotates, it spins the liquid sitting in the cavities between the vanes outward and provides centrifugal acceleration. As the liquid leaves the eye of the impeller a low – pressure area is created causing more liquid to flow towards the inlet. Because the impeller blades are curved, the fluid is pushed in a tangential and radial direction by centrifugal force. The figure below depicts a side cross-section of a centrifugal pump indicating the movement of the liquid.

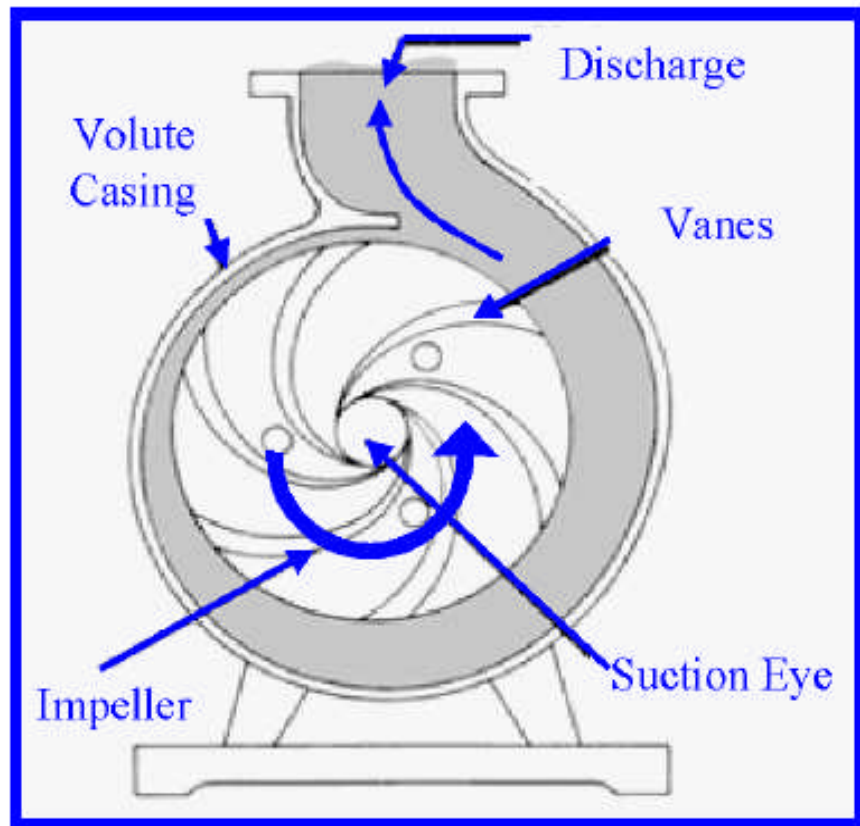


Figure A.01: Liquid flow path inside a centrifugal pump

9. How the kinetic energy created by centrifugal force is converted to pressure energy?

Answer: -

The energy created by centrifugal force is kinetic energy. The amount of energy given to the liquid is proportional to the velocity at the edge or vane tip of the impeller. The faster the impeller revolves or the bigger the impeller is then the higher will be the velocity of the liquid at the vane tip and the greater the energy imparted to the liquid. This kinetic energy of the liquid coming out of an impeller is harnessed by creating a resistance to the flow. The first resistance is created by the pump volute (casing) that catches the liquid and slows it down. In the discharge nozzle, the liquid further decelerates and its velocity is converted to pressure according to Bernoulli's principle.

Therefore, the head (pressure in terms of height of the liquid) developed is approximately equal to the velocity energy at the periphery of the impeller expressed by the following formula as: -

$$H = v^2 / 2g$$

Where,

H = Total head developed in feet.

V = Velocity at periphery of impeller in ft/sec.

G = Acceleration due to gravity-32.2ft/sec²

Formula for calculating peripheral velocity:

$$V = \frac{N \times D}{229}$$

Where,

V = Peripheral velocity in impeller in ft/sec.

N = The impeller rpm (Revolution per minute)

D = Impeller diameter in inches.

One fact that must always be remembered: A pump does not create pressure, it only provides flow. Pressure is a just an indication of the amount of resistance to flow.

10. What do you mean by Cavitation in Pump?

Answer: -

A pump is designed to handle liquid, not vapor. The satisfactory operation of pump requires that vaporization of the liquid does not occur at any condition of operation. This is so desired because when a liquid vaporizes its volume increases very much. For example, 1 ft³ of water at room temperature becomes 1700 ft³ of vapor at the same temperature. The vaporization begins when vapor pressure of the liquid at the operating temperature equals the external system pressure, which in an open system is always equal to atmospheric pressure. Any decrease in external pressure or rise in operating temperature can induce vaporization. The vapor pressure occurs right at the impeller inlet where a sharp pressure drop occurs. The impeller rapidly builds up the pressure, which collapses vapors bubbles causing cavitation and damage the pump internals. This is avoided by maintaining sufficient NPSH. (Cavitation implies cavities or holes in the fluid we are pumping. These holes can also be described as bubbles, so cavitation is really about the formation of bubbles and their collapse. Bubbles form whenever liquid boils. It can be avoided by providing sufficient NPSH.)

11. What do you mean by NPSH or NPSH_r?

Answer: -

When the liquid passes from the pump section to the eye of the impeller, the velocity increases and the pressure decreases. There are also pressure losses due to shock and turbulence as the liquid strikes the impeller. The centrifugal force of the impeller vanes further increases the velocity and decreases the pressure of the liquid. Thus, the Net positive suction Head required (NPSH_r) or sometimes in short as NPSH is the total head at the pump section to overcome these pressure drops in the pump and maintain the majority of the liquid above its vapor pressure.

The term "NET" refers to the actual pressure head at the pump section flange and not the static section head. NPSH required is a function of the pump design and is determined based on actual pump test by vendor.

12. What do you mean by NPSH_a (Net positive suction head available)?

Answer: -

Net Positive Suction Head Available is a function of the system in which the pump operates. It is the excess pressure of the liquid in feet absolute over its vapor pressure as it arrives at the pump suction, to be sure that the pump selected does not cavitate. It is calculated based on system or process conditions. NPSH_a calculation is stated below:

$$\text{NPSH}_{aS} = h_{p_s} + h_s - h_{vp_s} - h_{f_s}$$

Where,

h_{p_s} = Pressure Head i.e. Barometric pressure of the suction vessel converted to head.

h_s = Static Suction Head i.e. the vertical distance between the eye of first stage impeller centerline and suction liquid level.

h_{vp_s} = Vapor pressure Head i.e. vapor pressure of liquid at its maximum pumping temperature converted to Head.

h_{f_s} = Friction Head i.e. friction and entrance pressure losses on suction side converted to Head.

Note:

1. It is important to correct for the specific gravity of the liquid and to convert all terms to units of "feet absolute" in using the formula.
2. Any discussion of NPSH or cavitation is only concerned about the suction side of the pump. There is almost always plenty of pressure on the discharge side of the pump to prevent the fluid from vaporizing.

NPSH_a in a nutshell

In a nutshell, NPSH available is defined as:

$\text{NPSH}_a = \text{Pressure head} + \text{Static head} - \text{Vapor pressure head of the product} - \text{Friction head loss in the piping, valves and fittings. "All terms in feet absolute"}$

In an existing system, the NPSH_a can also be approximated by a gauge on the pump suction using the formula:

$$\text{NPSH}_a = h_{ps} - h_{vps} + h_{gs} + h_{vs}$$

✍ h_{ps} = Barometric pressure in feet absolute.

✍ h_{vps} = Vapor pressure of the liquid at maximum pumping temperature, in feet absolute.

✍ h_{gs} = Gauge reading at the pump suction expressed in feet (plus if above atmospheric, minus if below atmospheric) corrected to the pump centerline.

✍ h_{vs} = Velocity head in the suction pipe at the gauge connection, expressed in feet.

Significance of NPSH_r and NPSH_a

The NPSH available must always be greater than the NPSH required for the pump to operate properly. It is normal practice to have at least 2 to 3 feet of extra NPSH available at the suction flange to avoid any problems at the duty point.

13. What care shall be taken while doing layout for pump piping?

Answer:-

The following point shall be taken care of while doing layout for pump piping.

- A.** Pump location affects the piping routing and its supporting. Pumps dedicated for hydrocarbon services and carrying materials above 230° C shall not be located below pipe rack, structures, air fin coolers and vessels. Pumps which are dedicated for non – flammable service may be located beneath the pipe rack without obstructing the access bay and other maintenance requirements of the respective process unit.
- B.** Pump shall be located as close to the source of suction in order to minimize pressure drop in the system.
- C.** A preliminary piping layout (study layout) shall be made to determine the requirement of spacing between pumps especially in case of side suction/ side discharge, top suction/ top discharge pumps where straight length requirement/ platform /CPS requirement etc have to be considered.
- D.** Eccentric reducer in pump suction lines shall be flat on top side in order to prevent cavitation.
- E.** Reducers in pump suction lines shall be as close as possible to the pump suction nozzle.
- F.** Normally reducers in pump discharge shall be concentric type. Eccentric reducers may be used in both suction and discharge piping for top suction/ top discharge pump in order to obtain clearance between suction and discharge piping.
- G.** Piping for lube oil and seal oil system of pump shall be such that it shall not block access to the pump seal and bearing. For very large pumps these may be separate on skids.
- H.** As per OSID- 118 (Oil industries Safety Directorate stipulation) there shall be minimum 1 meter spacing between pumps e. g a minimum space of 1 meter must be provided in between the pumps and any potential obstructions (large block valves, steam turbine piping and tee type support from grade.)
- I.** Auxiliary piping shall be such that it shall not obstruct inspection covers, bearing caps, upper halves of casing or any other items which require access for operation or maintenance. Piping for lubricating oil, seal oil etc shall not be routed in the vicinity of hot process or hot utility pipes in order to avoid fire hazard.
- J.** Cooling water lines to pumps and compressors shall not be less than 20NB. Pipes 25NB or less shall have the take-off connection from the top of the header in order to prevent plugging during operation.
- K.** Every efforts must be made to minimize maintenance obstructions by running the piping either outside the area directly over the pump or at high enough elevation to permit the removal of the pump or driver.
- L.** The pump shall be placed in such a manner that the suction nozzle elevation is always below the vessel /tank nozzle and suction pipe shall be routed to prevent any pockets in the line.
- M.** Pump in the vacuum service operates at a negative pressure and very high temperature shall be located very close to the suction source. This is often directly below the tower or immediately outside the tower support column. Pumps located directly beneath the tower can be mounted on a special spring base.

14. What care shall be taken while doing layout for End section – Top discharge Horizontal type Centrifugal pump piping?

Answer: -

The following point shall be taken care of while doing layout for End section- Top discharge pump piping.

- A.** Clear access in between the valve handle and pump shall be ensured. The valve in suction line shall be installed with the stem in the horizontal position i.e. install valve in the vertical run of pipe.
- B.** Suction Strainer shall be located at grade to ease easy maintenance and removal for cleaning. The drain connection from strainer assembly shall have a break up flange immediately after the isolation valve and the drain line shall be routed in such way that the strainer can be removed with ease for maintenance.
- C.** Discharge piping shall be taken to grade for making valve accessible.
- D.** Do not route the suction and discharge piping above prim mover otherwise it may create hindrance while dismantling the same.
- E.** Small bore piping shall be routed in such a manner that tripping hazards are avoided.
- F.** Care shall be taken while routing discharge line not to block access to couplings. 0
- G.** Some examples of end suction- top discharge pump piping are shown in sketches 4, 5 & 6.

14. What are the different types of misalignment with regards to rotating machinery?

Answer: -

Different types of misalignment are:-

- A.** Parallel or Radial Misalignment : The centre line of two shafts is parallel but do not lie on the same line. It is also called offset misalignment.
- B.** Angular or Axial Misalignment : Condition which describes the angularity between the centerline of the two shafts. It can be corrected by rotating a shaft about the centre of the coupling face.
- C.** Combined Angular and Parallel Misalignment : It occurs when the centerline of the two shafts is not lying along the common centerline and the one coupling face is not parallel to other coupling face in any of the plane, horizontal or vertical. It is the combination of the above two.

15. What are the pre- alignment checks to be carried out in aligning rotating machinery?

Answer:-

The pre- alignment checks involved in aligning rotating machinery are:-

- A.** Check the machine is properly secured to foundation.
- B.** Check for excessive run- out conditions i.e. Eccentric coupling bore, Bent Shaft.
- C.** Machine to base plate interface problems i.e. soft foot.
- D.** Ensure that no piping loads are coming on the machine.

17. What are the basic steps involved in aligning rotating machinery?

Answer:-

The basic steps involved in aligning rotating machinery are:-

- A.** Carry out pre-alignment checks as mentioned above.
- B.** Arrange all the necessary alignment tools & measuring tools.
- C.** Collect necessary data for the equipment to be aligned as:
 - Any special tools needed to measure the alignment.
 - Any data available on shaft movement from position of rest.
 - Tolerance on alignment.
- D.** Inspect the coupling for any damage or worn out component.
- E.** Measure shaft or coupling hub run out.
- F.** Mount the alignment tools & measuring instruments, rotate the shaft.
- G.** Record one set data & determine the shaft positions with respect to each other. Compare the shaft positions with desired shaft positions. If shaft positions are within tolerance no further movement of machine is required.

18. What is soft foot as indicated in pre-alignment checks?

Answer:-

When rotating machinery is set in place on its base frame/ sole plate, one or more than one of the 'feet' may not make good contact at the 'foot points' on the frame. This is due to bowed/ warped frames, improper machining of feet.

19. What are the steps involved to detect & correct the soft foot problem?

Answer:-

- A. Before installation of the machine on the base frame, ensure that all mounting pads on the base frame are flat enough. (Check with straight edge across the pads & no gap underside of the straight edge.) If pad is not flat enough, correction can be done by machining the frame.
- B. Clean the mounting area & install the machine on the base frame.
- C. Fully tightened all the mounting bolts. Place dial indicator at one of the feet near the bolthole with stem resting on frame. Loose all bolts one by one & observe the dial movement, if is not exceeding 0.05mm, no correction is required & no soft foot exists.
- D. In case of higher movement of dial indicator, mark the feet. Check the gap between the feet & mounting pad. If there is gap & it is uniform then insert shim plate of thickness equal to the gap. If the gap is not uniform, it shall be corrected.

20. What is Blue matching with reference to the alignment of rotating machinery?

Answer:-

It is a type of check. By this method, the flatness of the mounting pad is checked. In this method blue colour (Blue mixed with oil) is applied with the help of brush on to surface of a glass of suitable size. The glass with the painted surface pointing towards the mounting pad is place on to the mounting pad and is rotated with little pressure. Now the glass is removed from the mounting pad. The surface of mounting pad which is slightly up is now clearly visible as the blue colour stick on these portions. Now these coloured surfaces shall be flattened by using rotating disc. Repeat the above procedure till 80% of the mounting pad surface gets coloured.

21. What are the Tools required for measuring the shaft centre line during alignment?

Answer:-

Following Tools are required for measuring the shaft centre line.

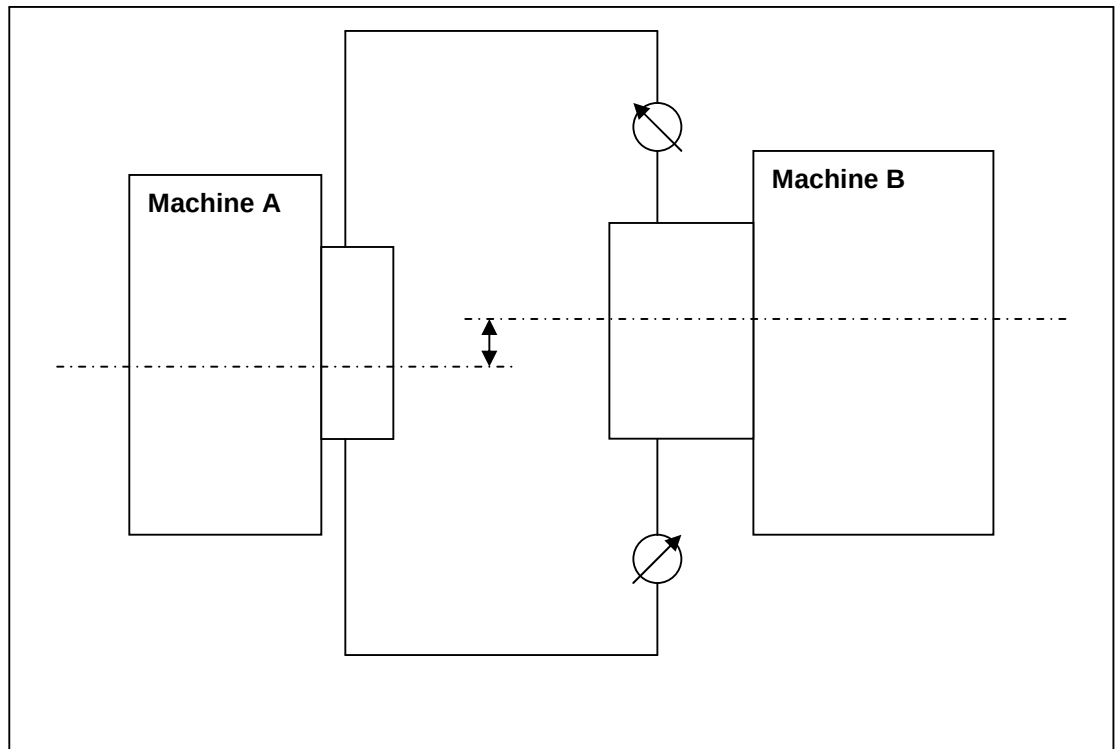
- A. Straight edge.
- B. Feeler Gauge.
- C. Taper Gauge.
- D. Measuring Tape & Ruler.
- E. Alignment Bracket.
- F. Vernier caliper.
- G. Dial Indicator.

22. How the Dial Indicator reading is interpreted? Mention method of measurement by Dial indicator?

Answer:-

The inward movement is indicated by clockwise movement of indicator or in (+) direction. The outward movement is indicated by anti-clockwise movement or in (–) direction.
Different measurement methods are:-

- A. Vertical Move : The figure shows how the vertical offset of 0.02mm of a shaft with respect to the other shaft will be displayed.
- B. Sweep Reading : Sweeping reading is obtained by zeroing the dial at the top position on the coupling to be indicated. Slowly rotate the shaft so that the dial indicator is rotated by 360° in 90° increment. Obtain reading at top (T), bottom (B), right (R) and left (L). Refer figure.7
- C. Horizontal move : The figure (7) displays how the alignment of two shaft having 0.02mm vertical offset and 0.02mm horizontal offset will look alike.



Machine A is 0.02 mm lower with respect to the machine A

22. What are the different alignment techniques adopted for aligning rotating machinery?

Answer:-

Following alignment techniques are adopted for aligning rotating machinery.

- A. Straight edge & feeler gauge Method.
- B. Shaft alignment using dial indicator.
 - 1.0 Face-rim method.
 - 1.1 Two indicator method.
 - 1.2 Three indicator method.
 - 2.0 Reverse indicator method.
 - 2.1 Face- Face- Distance method.
- C. Laser Alignment method.

23. Describe 'Face-OD method using Two Dial Indicator?'

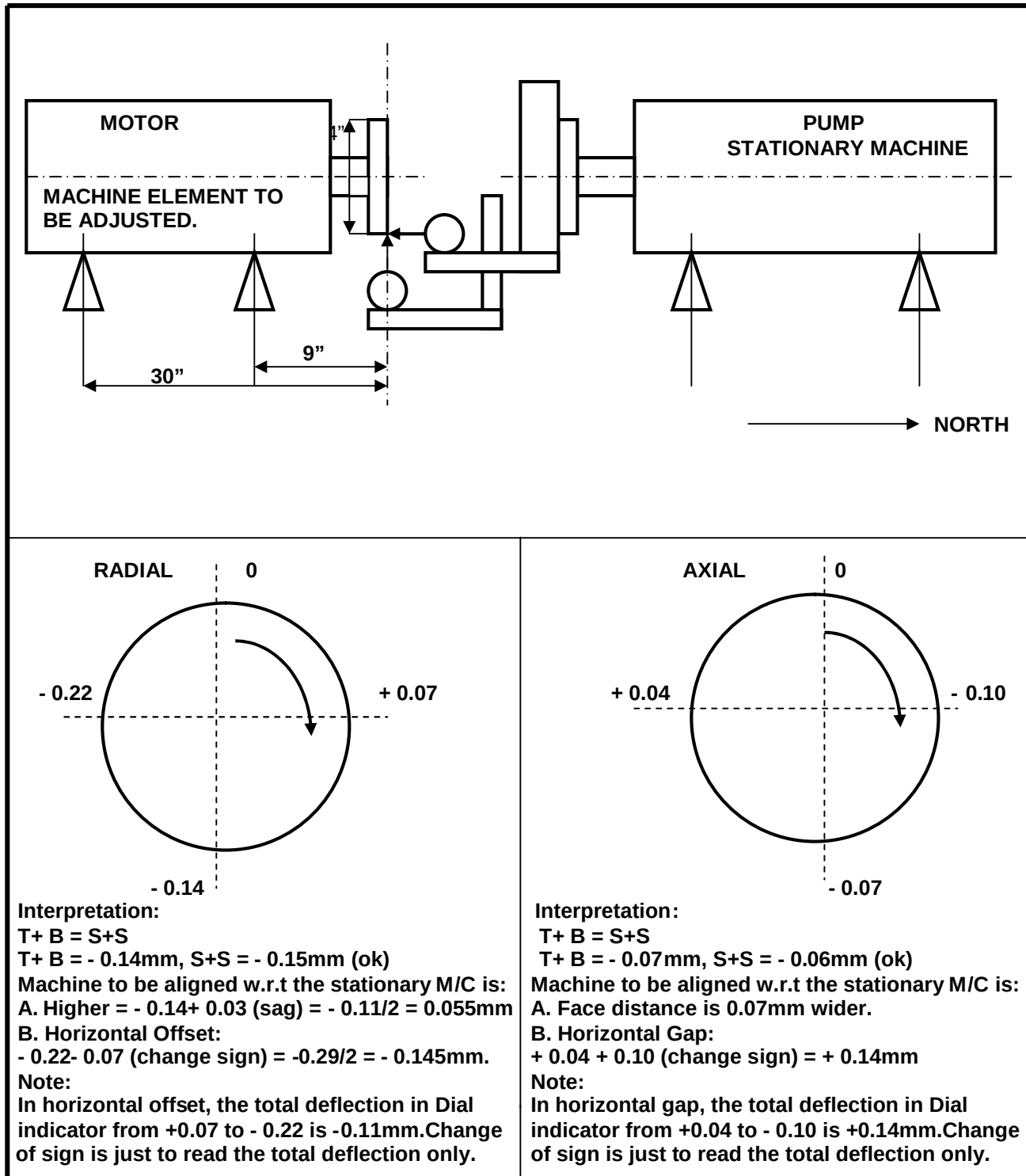
Answer:-

It is the most widely used method for alignment. In this method a bracket is attached to one of the shaft and extends near the coupling hub on the other shaft. Dial indicators are attached to the bracket with the stem of one indicator resting on OD or rim of opposite coupling hub & other stem resting on face of same coupling hub. Offset of the shaft or parallel misalignment is determined by the OD reading whereas angularity is determined by 'face' reading. Normally both the shafts are rotated together to eliminate errors due to face and rim irregularities.

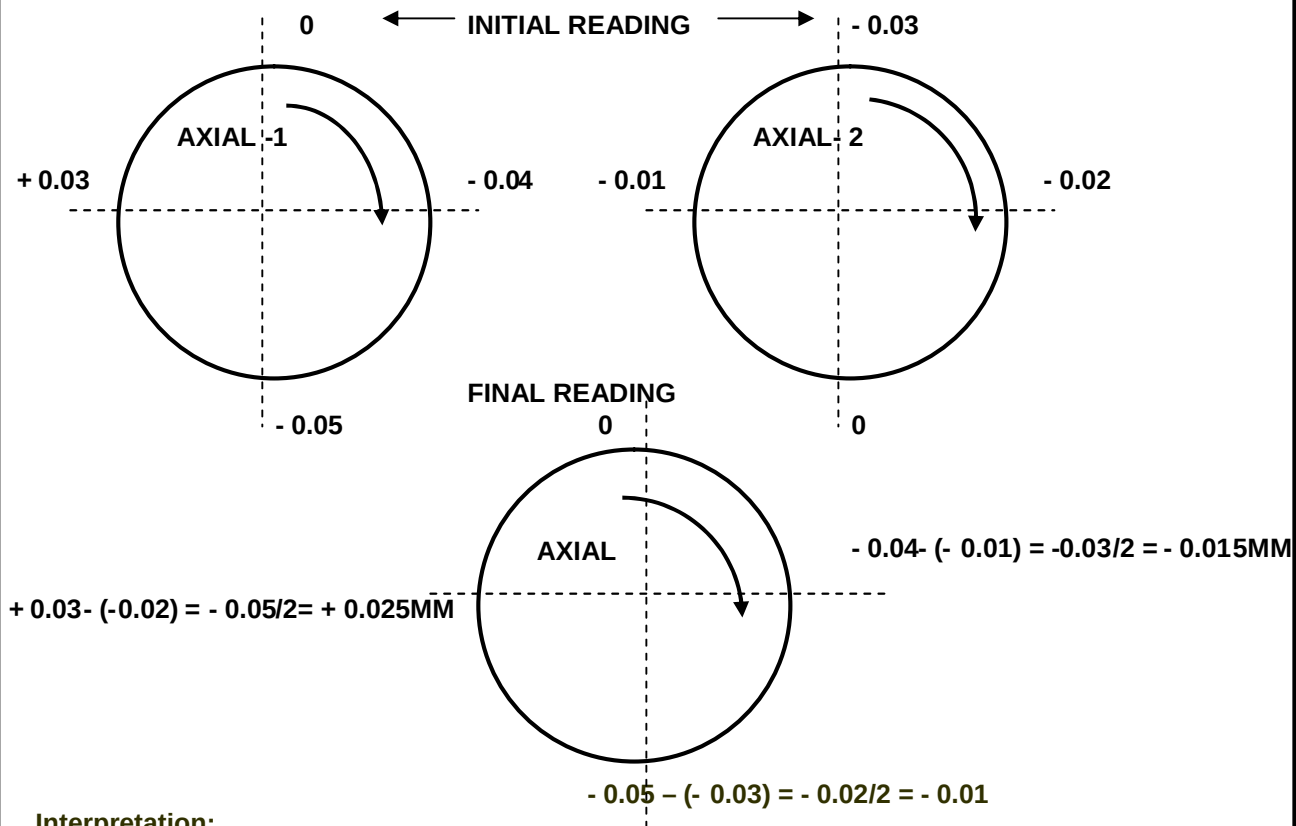
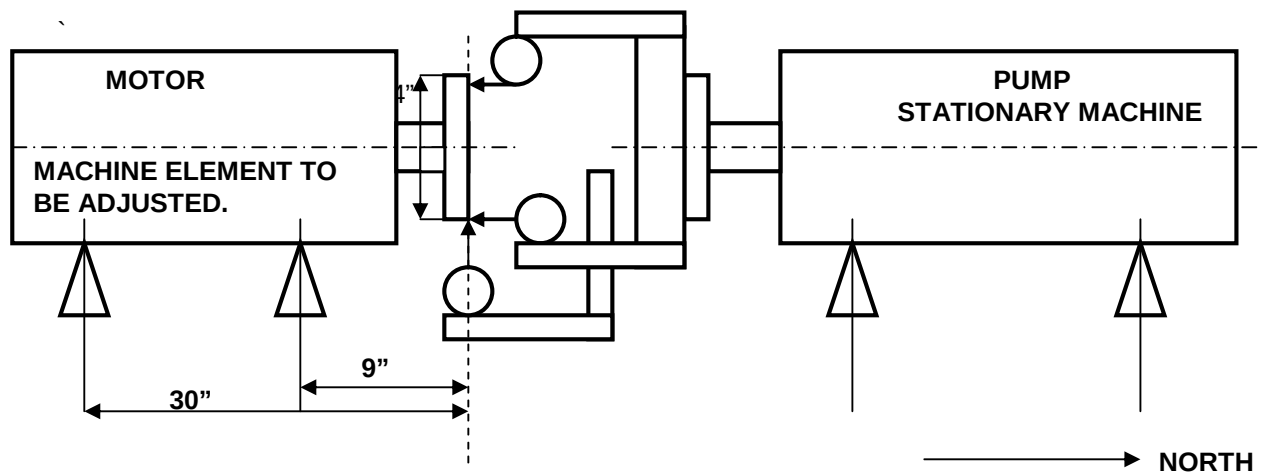
24. Write the procedure for recording the indicator reading and its interpretation by Two indicator method?

Answer:-

- Dial Indicator with the pointer indicating zero to be mounted on the bracket first.
- Rotate both the shafts simultaneously in clockwise direction.
- Note the reading in top, bottom, left and right position of the shaft.
- Interpret the final reading and do the required adjustment.



25. Write the procedure for recording the indicator reading and its interpretation by Three indicator method?



Interpretation:

T+ B = S+S

T+ B = - 0.01mm, S+S = - 0.01mm (ok)

Machine to be aligned w.r.t the stationary M/C is:

A. Face distance is 0.01mm wider

B. Horizontal Gap:

+ 0.025 + 0.015 (change sign) = + 0.04mm

Note:

In horizontal gap, the total deflection in Dial indicator from +0.025 to - 0.015 is +0.04mm. Change of sign is just to read the total deflection only. Here two dial indicator is used to note axial reading. The final axial reading is the average of the two indicator reading.

Question Related to Norms & Assumptions For Piping & Structural Work:-**1. Write the estimation for welding consumables for piping work (Groove& Fillet welding)?****Answer:-****WELDING CONSUMABLE ESTIMATION FOR PIPING WORK WITH SINGLE V HAVING INCLUDED ANGLE OF 75 DEGREES**

WALL THICKENSS (MM)	GROOVE AREA (SQ.MM)	WELD METAL WEIGHT gm/inch dia	ELECTRODE/FILLER WIRE CONSUMPTION (where root welding by E6010 -consumption of E6010 will be 30 gm/inch dia)			
			gm/inch dia			
			SINGLE	SINGLE	COMBINATIONAL	
			GTAW	SMAW	GTAW	SMAW
4	23	15	20	26	0	0
5	33	21	28	37	19	11
6	46	29	38	51	19	25
7	59	38	50	67	19	41
8	75	48	63	84	19	59
9	91	58	77	102	19	76
10	110	70	92	123	19	98
11	130	83	110	146	19	120
12	151	97	128	171	19	145
13	174	111	147	195	19	170
14	198	127	168	224	19	198
15	224	143	189	252	19	226
16	252	161	213	283	19	258
17	281	180	238	317	19	291
18	311	199	263	350	19	325
19	343	220	290	387	19	362
20	377	241	318	424	19	398
21	412	264	348	465	19	439
22	449	287	379	505	19	479

WELDING CONSUMABLE ESTIMATION FOR PIPING WORK WITH SINGLE V HAVING INCLUDED ANGLE OF 75 DEGREES

WALL THICKNESS (MM)	GROOVE AREA (SQ. MM)	WELD METAL WEIGHT (gm/inch dia)	ELECTRODE/FILLER WIRE CONSUMPTION (gm/inch dia)			
			SINGLE	SINGLE	COMBINATIONAL	
			GTAW	SMAW	GTAW	SMAW
23	464	297	392	523	19	497
24	479	307	405	540	19	515
25	495	317	418	558	19	532
26	512	327	432	576	19	550
27	529	339	447	597	19	571
28	547	350	462	616	19	590
29	566	362	478	637	19	611
30	586	375	495	660	19	634
31	607	388	512	683	19	657
32	628	402	531	708	19	682
33	650	416	549	732	19	706
34	673	431	569	759	19	733
35	697	446	589	785	19	759
36	722	462	610	813	19	787
37	747	478	631	841	19	816
38	773	495	653	871	19	846
39	800	512	676	901	19	875
40	828	530	700	933	19	907
41	857	548	723	964	19	939
42	886	567	748	998	19	972
43	916	586	774	1031	19	1006
44	947	606	800	1067	19	1041
45	979	627	828	1104	19	1078
46	1012	647	854	1139	19	1113
47	1045	669	883	1177	19	1152
48	1079	691	912	1216	19	1190
49	1114	713	941	1255	19	1229
50	1150	736	972	1295	19	1270
51	1187	759	1002	1336	19	1310
52	1224	783	1034	1378	19	1352
53	1262	808	1067	1422	19	1396
54	1301	833	1100	1466	19	1440
55	1341	858	1133	1510	19	1484
56	1382	884	1167	1556	19	1530
57	1423	911	1203	1603	19	1578
58	1465	938	1238	1651	19	1625
59	1508	965	1274	1698	19	1673
60	1552	993	1311	1748	19	1722
61	1597	1022	1349	1799	19	1773
62	1642	1051	1387	1850	19	1824
63	1688	1080	1426	1901	19	1875
64	1735	1111	1467	1955	19	1930
65	1783	1141	1506	2008	19	1982

WELDING CONSUMABLE ESTIMATION FOR FILLET WELDING

FILLET SIZE	FILLET AREA	WELD METAL WEIGHT	ELECTRODE/FILLER WIRE CONSUMPTION			
			gm/meter			
			SINGLE		COMBINATIONAL	
			GTAW	SMAW	GTAW	SMAW
2	8	64	84	113	0	0
3	13	100	132	176	0	0
4	18	144	190	253	132	77
5	25	196	259	345	132	169
6	32	256	338	451	132	275
7	41	324	428	570	132	394
8	50	400	528	704	132	528
9	61	484	639	852	132	676
10	72	576	760	1014	132	838
11	85	676	892	1190	132	1014
12	98	784	1035	1380	132	1204
13	113	900	1188	1584	132	1408
14	128	1024	1352	1802	132	1626
15	145	1156	1526	2035	132	1859
16	162	1296	1711	2281	132	2105
17	181	1444	1906	2541	132	2365
18	200	1600	2112	2816	132	2640
19	221	1764	2328	3105	132	2929
20	242	1936	2556	3407	132	3231
21	265	2116	2793	3724	132	3548
22	288	2304	3041	4055	132	3879
23	313	2500	3300	4400	132	4224
24	338	2704	3569	4759	132	4583
25	365	2916	3849	5132	132	4956
26	392	3136	4140	5519	132	5343
27	421	3364	4440	5921	132	5745
28	450	3600	4752	6336	132	6160
29	481	3844	5074	6765	132	6589
30	512	4096	5407	7209	132	7033
31	545	4356	5750	7667	132	7491
32	578	4624	6104	8138	132	7962
33	613	4900	6468	8624	132	8448
34	648	5184	6843	9124	132	8948
35	685	5476	7228	9638	132	9462
36	722	5776	7624	10166	132	9990
37	761	6084	8031	10708	132	10532
38	800	6400	8448	11264	132	11088
39	841	6742	8899	11866	132	11690
40	882	7056	9314	12419	132	12243

WELDING CONSUMABLE ESTIMATION FOR FILLET WELDING

FILLE T SIZE	FILLE T AREA	WELD META L WEIGH T	ELECTRODE/FILLER WIRE CONSUMPTION			
MM	SQ MM	gm/ meter	gm/meter			
41	925	7396	9763	13017	132	12841
42	968	7744	10222	13629	132	13453
43	1013	8100	10692	14256	132	14080
44	1058	8464	11172	14897	132	14721
45	1105	8836	11664	15551	132	15375
46	1152	9216	12165	16220	132	16044
47	1201	9604	12677	16903	132	16727
48	1250	10000	13200	17600	132	17424
49	1301	10404	13733	18311	132	18135
50	1352	10816	14277	19036	132	18860

2. What are the consumption norms for grinding/cut-off wheel?

Answer:-

For piping work:-

- | | | |
|--|---|--------------------------|
| A. Grinding wheel for fabrication | : | 0.035 Numbers/ inch dia. |
| B. Grinding Wheel for joint grinding for UT | : | 0.012 Numbers/ inch dia. |

For structural work:-

- | | | |
|--|---|-------------------|
| A. Grinding Wheel AG 7 (7"*7MM) | : | 0.75 Numbers/ MT. |
| B. Grinding Wheel AG 5 (5"*5MM) | : | 0.25 Numbers/ MT. |

For support fabrication at shop:-

- | | | |
|--------------------------|---|----------------|
| A. Grinding Wheel | : | 2 Numbers/ MT. |
|--------------------------|---|----------------|

3. What are the consumption norms for Dissolved Acetylene and Oxygen?

Answer:-

For piping work:-

- | | | |
|--------------------------------------|---|------------------------|
| A. Dissolved Acetylene (D.A.) | : | 0.0140 Cu-M/ inch dia. |
| B. Oxygen (O ₂) | : | 0.0510 Cu-M/ inch dia. |

For structural work:-

- | | | |
|--------------------------------------|---|---------------------|
| A. Dissolved Acetylene (D.A.) | : | 2.2 Cu-M/ inch dia. |
| B. Oxygen (O ₂) | : | 8.0 Cu-M/ inch dia. |

For support fabrication at shop:-

- | | | |
|--------------------------------------|---|---------------------|
| A. Dissolved Acetylene (D.A.) | : | 3.5 Cu-M/ inch dia. |
| B. Oxygen (O ₂) | : | 12 Cu-M/ inch dia. |

4. What are the manpower deployment norms for structural steel work?

Answer:-

For fabrication of 1 MT of structural steel per day, the manpower required is as:-

A. Welder	:	02
B. Fitter	:	02
C. Gas cutter	:	01
D. Grinders	:	01
E. Riggers	:	02
F. Helpers & others	:	02

For erection of 1 MT of structural steel per day, the manpower required is as:-

A. Welder	:	0.75
B. Fitter	:	01
C. Gas cutter	:	01
D. Grinders	:	0.5
E. Riggers	:	03
F. Helpers & others	:	02

5. What are the manpower deployment norms for piping erection work?

Answer:-

Normally, 90 to 120 IM is erected per day per gang. One gang comprises the following:

A. Welder	:	01
B. Fitter	:	01
C. Gas cutter	:	0.5
D. Grinders	:	0.5
E. Riggers	:	04
F. Helpers & others	:	02

6. What is the productivity of the welder for plant piping and for off-site piping?

Answer:-

PIPE SIZE	FOR PLANT PIPING	FOR OFF-SITE PIPING
Upto Dia. 1 ½ "	10 ID/welder/day	12 ID/welder/day
Dia. 2" to 12"	16 ID/welder/day	18 ID/welder/day.
Dia. 8" to 12"	18 ID/welder/day	20 ID/welder/day
Dia.14" & above	20 ID/welder/day	22 ID/welder/day

7. How many pipe joints for plant piping & for offsite piping are assumed?

Answer:-

PIPE SIZE	FOR PLANT PIPING	FOR OFF-SITE PIPING
Upto Dia. 1 ½ "	1JT/MTR.	1JT/2MTRS.
Dia. 2" to 6"	1JT/1.5MTR	1JT/4MTRS
Dia. 8" to 12"	1JT/2MTR	1JT/4MTRS
Dia.14" & above	1JT/2.5MTR	1JT/4MTRS

8. What are the consumption norms for Electrodes & Filler wire?

Answer:-

Consumption Norms for Welding Electrode & Filler Wires

2

DESCRIPTION OF JOB	UOM	Weld metal weight gms/ UOM	ELECTRODE CONSUMPTION (gms/UOM.)						TUNGSTEN ELECTRODE CONSUMPTION (EA/UOM)	TUNGSTEN ELECTRODE CONSUMPTION (EA/UOM)	Remarks
			SINGLE GTAW	SINGLE SMAW	COMBINATION GTAW	COMBINATION SMAW	COMBINATION SMAW	COMBINATION FCAW			
									Full GTAW	Root GTAW	
Piping-Shop welding											
CS-NIBR ---											
T < 10 mm (FULL TIG)	ID	48	83	-	-	-	-	-	0.06336		
10 mm <= t < 12 mm(Full Tig)	ID	83	110	-	-	-	-	-	0.10956		
12 mm <= t < 15 mm(Full Tig)	ID	127	168	-	-	-	-	-	0.16764		
t < 10 mm (TIG+SMAW)	ID	48	-	-	19	59	-	-		0.019	
10 mm <= t < 12 mm(Tig+SMAW)	ID	83	-	-	19	121	-	-		0.019	
12 mm <= t < 15 mm(Tig+SMAW)	ID	127	-	-	19	198	-	-		0.019	
t < 10 mm (BY SMAW/SSFCFAW)	ID	48	-	84	-	-	26	49	NA		
10 mm <= t < 12 mm(BY SMAW/SSFCFAW)	ID	83	-	146	-	-	26	100	NA		
12 mm <= t < 15 mm(BY SMAW/SSFCFAW)	ID	127	-	224	-	-	26	165	NA		
15 mm <= t < 19 mm(BY SMAW/SSFCFAW)	ID	180	-	317	-	-	26	243	NA		
19 mm <= t < 24mm(BY SMAW/SSFCFAW)	ID	267	-	505	-	-	26	400	NA		
24 mm <= t < 30 mm(BY SMAW/SSFCFAW)	ID	339	-	597	-	-	26	477	NA		
30 mm <= t < 37 mm(BY SMAW/SSFCFAW)	ID	431	-	759	-	-	26	612	NA		
CS-IBR ---											
t < 10 mm (FULL TIG)	ID	48	83	-	-	-	-	-	0.06336	NA	
10 mm <= t < 12 mm(Full Tig)	ID	83	110	-	-	-	-	-	0.10956	NA	
12 mm <= t < 15 mm(Full Tig)	ID	127	168	-	-	-	-	-	0.16764	NA	
t < 10 mm (TIG+SMAW)	ID	48	-	-	19	59	-	-	NA	0.019	
t < 10 mm (BY SMAW/SSFCFAW)	ID	48	-	84	-	-	26	49	NA	NA	
10 mm <= t < 12 mm(BY SMAW/SSFCFAW)	ID	83	-	146	-	-	26	100	NA	NA	
12 mm <= t < 15 mm(BY SMAW/SSFCFAW)	ID	127	-	224	-	-	26	165	NA	NA	
15 mm <= t < 19 mm(BY SMAW/SSFCFAW)	ID	180	-	317	-	-	26	243	NA	NA	
19 mm <= t < 24mm(BY SMAW/SSFCFAW)	ID	267	-	505	-	-	26	400	NA	NA	
24 mm <= t < 30 mm(BY SMAW/SSFCFAW)	ID	339	-	597	-	-	26	477	NA	NA	
30 mm <= t < 37 mm(BY SMAW/SSFCFAW)	ID	431	-	759	-	-	26	612	NA	NA	
LTCS :											
t < 10 mm	ID	48	83	84	19	59	-	-	0.06336	0.019	
10 mm <= t < 12 mm	ID	83	110	146	19	121	-	-	0.10956	0.019	
12 mm <= t < 15 mm	ID	127	168	224	19	198	-	-	0.16764	0.019	
15 mm <= t < 19 mm	ID	180	238	317	19	291	-	-	0.2376	0.019	
19 mm <= t < 24mm	ID	267	379	505	19	480	-	-	0.37884	0.019	
24 mm <= t < 30 mm	ID	339	447	597	19	571	-	-	0.44748	0.019	
30 mm <= t < 37 mm	ID	431	569	759	19	733	-	-	0.56892	0.019	
SS-NIBR											
t < 10 mm	ID	48	83	84	19	59	-	-	0.06336	0.019	
10 mm <= t < 12 mm	ID	83	110	146	19	121	-	-	0.10956	0.019	
12 mm <= t < 15 mm	ID	127	168	224	19	198	-	-	0.16764	0.019	
15 mm <= t < 19 mm	ID	180	238	317	19	291	-	-	0.2376	0.019	
19 mm <= t < 24mm	ID	267	379	505	19	480	-	-	0.37884	0.019	
24 mm <= t < 30 mm	ID	339	447	597	19	571	-	-	0.44748	0.019	
30 mm <= t < 37 mm	ID	431	569	759	19	733	-	-	0.56892	0.019	
AS-NIBR											
t < 10 mm	ID	48	83	84	19	59	-	-	0.06336	0.019	
10 mm <= t < 12 mm	ID	83	110	146	19	121	-	-	0.10956	0.019	
12 mm <= t < 15 mm	ID	127	168	224	19	198	-	-	0.16764	0.019	
15 mm <= t < 19 mm	ID	180	238	317	19	291	-	-	0.2376	0.019	
19 mm <= t < 24mm	ID	267	379	505	19	480	-	-	0.37884	0.019	
24 mm <= t < 30 mm	ID	339	447	597	19	571	-	-	0.44748	0.019	
30 mm <= t < 37 mm	ID	431	569	759	19	733	-	-	0.56892	0.019	
AS-IBR											
t < 10 mm	ID	48	83	84	19	59	-	-	0.06336	0.019	
10 mm <= t < 12 mm	ID	83	110	146	19	121	-	-	0.10956	0.019	
12 mm <= t < 15 mm	ID	127	168	224	19	198	-	-	0.16764	0.019	
15 mm <= t < 19 mm	ID	180	238	317	19	291	-	-	0.2376	0.019	
19 mm <= t < 24mm	ID	267	379	505	19	480	-	-	0.37884	0.019	
24 mm <= t < 30 mm	ID	339	447	597	19	571	-	-	0.44748	0.019	
30 mm <= t < 37 mm	ID	431	569	759	19	733	-	-	0.56892	0.019	

Item Code	DESCRIPTION OF JOB	UOM	Weld metal weight gms/ UOM	ELECTRODE CONSUMPTION (gms/UOM.)						TUNGSTEN ELECTRODE CONSUMPTI ON (EA/UOM)	TUNGSTEN ELECTRODE CONSUMPTI ON (EA/UOM)	Remarks
				SINGLE		COMBINATION		COMBINATION				
				GTAW	SMAW	GTAW	SMAW	SMAW	FCAW			
										Full GTAW	Root GTAW	
	<u>U/G piping ---</u>											
2121806	U/G piping CS T<10 mm	ID	48	63	84	19	59			0.06336	0.019	
	<u>Fillet welding ---</u>											
2012501	CS Fillet of Size 6 mm	Mtr	256	338	451	132	275	-	-	0.33792	0.132	
2012502	CS Fillet of size 8 mm	Mtr	400	528	704	132	528	-	-	0.528	0.132	
2012503	CS fillet of size 10 mm	Mtr	576	760	1014	132	838	-	-	0.76032	0.132	
2012504	CS fillet of size 12 mm	Mtr	784	1035	1380	132	1204	-	-	1.03488	0.132	
2012505	CS fillet of size 14 mm	Mtr	1024	1352	1802	132	1626	-	-	1.35188	0.132	
2012506	CS fillet of size 16 mm	Mtr	1296	1711	2281	132	2105	-	-	1.71072	0.132	
2012508	CS fillet of size 20 mm	Mtr	1936	2556	3407	132	3231	-	-	2.55552	0.132	
2012400	Erection of Structure											
2012425	Erection of Structure from ground level to 10M height	MT	NA	NA	600	NA	NA	NA	NA	NA	NA	
2012426	Erection of Structure from ground level to 10M to 20M height	MT	NA	NA	600	NA	NA	NA	NA	NA	NA	
2012427	Erection of Structure from ground level to 20M to 30 M height	MT	NA	NA	600	NA	NA	NA	NA	NA	NA	
2012500	Modification of Structure in erected position											
2012502	CS fillet size 8mm	Mtr	400	NA	704	NA	NA	NA	NA	NA	NA	
2012503	CS fillet size 10mm	Mtr	576	NA	1013.76	NA	NA	NA	NA	NA	NA	
2080804	Steam Tracing in ISBL Racks	Mtr	NA	37	NA	NA	NA	NA	NA	NA	NA	0.037
2160700	Fabrication of pipe supports											
2160701	CS Material	MT	NA		NA	NA	20000	NA	NA	NA	NA	
2160800	Erection of Pipe Supports											
2160801	CS Material	MT	NA		NA	NA	1000	NA	NA	NA	NA	
2011700	Strengthening of rolled steel section by welding plates											
2011701	Fillet of 6mm size	Mtr	256	NA	451	NA	NA	176	229.32	NA	NA	
2011702	Fillet of 8mm size	Mtr	400	NA	704	NA	NA	176	441	NA	NA	
2012100	Fabrication of Structure											
2012144	Fabrication of Light Steel Shapes (Wt. 25 Kg or less/RM or Plate upto 10mm thk).	MT	NA	NA	20000	NA	NA	NA	NA	NA	NA	
2012145	Fabrication of Medium Steel Shapes (Wt. Above 25 Kg upto and including 75 Kg/RM or Plate above 10mm thk upto 20mm thk)..	MT	NA	NA	16000	NA	NA	NA	NA	NA	NA	
2012146	Fabrication of Heavy Steel Shapes (Wt. Above 75 Kg upto and including 150 Kg/RM or Plate above 25mm thk upto 50mm thk)..	MT	NA	NA	14000	NA	NA	NA	NA	NA	NA	
2012147	Fabrication of Extra Heavy Steel Shapes (Wt. Above 150 Kg /RM or Plate above 50mm thk)..	MT	NA	NA	12000	NA	NA	NA	NA	NA	NA	
2012151	Welding of Nuts for fireproofing	SQM	NA	NA	26	NA	NA	NA	NA	NA	NA	
2012154	Fabrication of channel boxes	MT	NA	NA	18000	NA	NA	NA	NA	NA	NA	
2013806	Handrailing & Standards	Lin Mtr	NA	NA	125	NA	NA	NA	NA	NA	NA	
2013807	Ladders and Cages	Lin Mtr	NA	NA	125	NA	NA	NA	NA	NA	NA	

Note

1. For erection of structure, 0.6 Kg (i.e. 5% of average MT wise consumption) electrode consumption have been considered. This is in addition to the consumption against item code available for the modification of erected structure.
2. For steam tracing, equivalent to 100 mm weld, 6mm fillet per meter has been considered.
3. For welding of nuts for fire proofing, 5 nuts/Sq Feet with single welding 3mm fillet, 4mm length has been considered.
4. For handrailing, ladders & Cages erection, consumption norms has been converted to linear meter considering 25Kg/Meter weight. 50% has been considered for field welding.
5. Where root welding is carried out by E6010, consumption of E6010 shall be 30 gm/Inch Dia

BENCH MARK QUIZ

Note: Encircle the letter of only one alternative, which you think is most appropriate.

- 1. For 8" ND Sch 40 and 8" ND Sch 80 pipes,**
 - a. OD for both pipes will be same
 - b. IDs and ODs for both pipes will be different
 - c. Average pipe diameters for both will be same
 - d. ID for both pipes will be same

- 2. Hot tapping is best described by statement:**
 - a. It is technique of heating the pipe to specified temperature and gently tapping with 1 lb. rounded hammer to detect thinning of pipe wall
 - b. It is technique of providing a tapping connection while pipe system is in operation
 - c. It is technique of fixing a water tap on hot water lines for use during winter
 - d. It is act of using the tap and die for threading the pipe when the pipe is hot

- 3. Which of the following defines the term hold point?**
 - a. The point at which a pipe hanger is attached to a pipe.
 - b. A point at which a U-clamp is fixed on the pipe.
 - c. A point at pipe beyond which work may not proceed until inspections have been performed and documented
 - d. A trunnion, or sliding shoe used for piping support systems

- 4. Which of the following statements is true?**
 - a. Flange rating indicates flange diameter.
 - b. Other factors remaining same, ERW pipes can withstand higher pressure than seamless pipes.
 - c. Deadlegs means pipes with broken supports.
 - d. API 570 is applicable for metallic pipes only.

- 5. Post weld heat treatment is carried out**
 - a. To increase Hardness
 - b. To increase Tensile strength
 - c. To release locked-up stresses in the weld
 - d. None of above.

6. What section of the ASME boiler and pressure vessel code is the basic document for welding procedure qualification?
- Section III
 - Section VIII
 - Section IX
 - ASME Section II C
7. What can be caused to ferrous metals by the low operating temperatures?
- Increase of ductility
 - Loss of ductility and toughness
 - Increase in plasticity or deformation
 - Decrease in yield strength
8. API 570 is intended to apply to:
- New piping in the chemical Industry
 - Piping that has been placed in service
 - New piping in the Petroleum Refinery
 - New piping in the Paper Industry
9. If a welder is to be qualified in all positions he must pass test in which positions?
- 1G, 2G, 3G and 4G
 - 5G and 4G
 - 6G
 - 5G and 4G
10. ASTM A 106 Gr B pipes belong to which type?
- Seamless only
 - ERW only
 - Seamless or ERW depending on type of Grade
 - None of above
11. Choose correct statement.
- “REPAIR” of piping means change of original Design conditions
 - “ALTERATION” of piping means change of original Design conditions
 - Both are one and same
 - Repair is temporary, alteration is permanent

12. ANSI/ ASME B 31.3 code is meant for:

- a. Steam piping in Power stations
- b. Piping in Refinery and process plants
- c. Cross-country piping
- d. Gas transmission piping

13. The term “NPS 10 pipe” means:

- a. A pipe with National Pressure Standard of 10 bar
- b. A pipe whose minimum thickness is 10 mm
- c. A pipe whose outside diameter is 10"
- d. A pipe whose Nominal diameter is 10"

14. Most of the fluids normally covered by B 31.3 code fall under what category?

- a. Category M
- b. Category K
- c. Category D
- d. Normal

15. The requirements of the latest edition of ASME Code Section B 31.3 and any subsequent Addenda become effective:

- a. As soon as the latest edition is issued
- b. Immediately from date of issue and all piping installed per earlier editions must be upgraded to latest edition/addenda
- c. After 6 months from date of issue
- d. After 1 year from date of issue

-----End-----

BENCH MARK QUIZ

ANSWER KEY

Q. No.	Answer
1	A
2	B
3	C
4	D
5	C
6	C
7	B
8	B
9	C
10	A
11	B
12	B
13	D
14	D
15	C

API 570

Practice Questions (Closed Book)

1. **API 570 covers inspection, repair alteration, and re-rating procedures for metallic piping systems that_____.**
 - a. are being fabricated
 - b. does not fall under ASTM B31.3
 - c. have been in-service
 - d. has not been tested
2. **API 570 was developed for the petroleum refining and chemical process industries**
 - a. It shall be used for all piping systems.
 - b. It may be used, where practical, for any piping system
 - c. It can be used, where necessary, for steam piping
 - d. It may not be used unless agreed to by all parties
3. **API 570_____ be used as a substitute for the original construction requirements governing a piping system before it is placed in-service.**
 - a. shall not
 - b. should
 - c. may
 - d. can
4. **API 570 applies to piping systems for process fluids, hydrocarbons, and similar flammable or toxic fluid services. Which of the following services is not specifically applicable**
 - a. Raw, intermediate and finished petroleum products
 - b. Water, steam condensate, boiler feed water
 - c. Raw, intermediate, and finished chemical products
 - d. Hydrogen, natural gas, fuel gas, and flare systems
5. **Some of the classes of piping systems that are excluded or optional for coverage under API 570 are listed bellow. Which one is a mandatory included class?**
 - a. Water
 - b. Catalyst lines
 - c. Steam
 - d. Boiler feed water

6. The _____ shall be responsible to the owner-user for determining that the requirements of API 570 for inspection, examination and testing are met.
- pipng Engineer
 - Inspector
 - Repair Organization
 - Operating Personal
7. Who is responsible for the control of piping system inspection programs, inspection frequencies and maintenance of piping?
- Authorized piping Inspector
 - Owner-User
 - Jurisdiction
 - Contractor
8. An authorized piping inspector shall have the following qualifications. Pick the one that does not belong to this list
- Four years of experience inspecting in-service piping systems
 - High school education plus 3 years of experience in the design, construction, repair, operation, or inspection of piping system.
 - Two year certificate in engineering or technology plus 2 years of experience in the design, construction, repair, operation or inspection of piping systems
 - Degree in engineering plus one year experience in the design, construction, repair, operation or inspection of piping.

ALL SHOULD HAVE MINIMUM ONE YEAR IN THE INSPECTION FIELD

9. Risk based inspections include which of the following:
- Likelihood assessment
 - Consequence analysis
 - Operating and inspection histories
 - All of the above
10. An RBI assessment can be used to alter the inspection strategy provided:
- The degradation methods are identified
 - The RBI is fully documented
 - A third party conducts the RBI
 - Both A and B above
11. Which one of the following is not a specific type of an area of deterioration?
- Rectifier performance
 - Injection points
 - Deadlegs
 - Environmental cracking

12. Injection points subject to accelerated or localised corrosion may be treated as

- a. The focal point of an inspection circuit
- b. Separate inspection circuits
- c. Piping that must be renewed on a regular schedule
- d. Locations where corrosion inhibitors must be used

13. The recommended upstream limit of inspection of an injection point is a minimum of

- a. 12 feet or 3 pipe lengths whichever is smaller
- b. 12 inches or 3 pipe diameters whichever is smaller
- c. 12 inches or 3 pipe diameters whichever is greater
- d. 12 feet or 3 pipe length which is greater

14. The recommended downstream limit of inspection of an injection point is a minimum of

- a. second change in flow direction past the injection point, or 25 feet beyond the first change in flow direction whichever is less
- b. second change in flow direction past the injection point, or 25 feet beyond the first change in flow direction whichever is greater
- c. second change in flow direction past the injection point, or 25 inches beyond the first change in flow direction whichever is less
- d. second change in flow direction past the injection point, or 25 inches beyond the first change in flow direction whichever is greater

15. Select thickness measurement location (TMLs) within injection point circuits subjected to localised corrosion according to the following guidelines. Select the one that does not belong

- a. Establish TMLs on appropriate fittings within the injection point circuit
- b. Establish atleast one TML at a location atleast 25 feet beyond the downstream limit of the injection point
- c. Establish TMLs on the pipe wall at the location of the expected pipe wall impingement or injected fluid
- d. Establish TMLs at both the upstream and downstream limits of the injection point circuit

B Gives 25 feet beyond the down stream limit of the injection point. So it is wrong. Please not it is not given as 25 feet beyond the Down stream injection point. The word LIMIT makes the entire difference

16. What are the preferred methods of inspecting injection points ?

- a. Radiography and/ or ultrasonics
- b. Hammer test and/ or radiograph
- c. Ultrasonics and / or liquid penetrant
- d. Liquid Penetrant and / or eddy current

In general UT is More for thickness Measurement , But RRT also can be used for small sizes where UT is not possible (Profile radiography) But For defect detection RT is Better

- 17. During periodic scheduled inspections, more extensive inspection should be applied to an area beginning _____ upstream of the injection nozzle and continuing for atleast _____ pipe diameters downstream of the injection point**
- 10 inches, 20
 - 12 feet, 10
 - 12 inches, 10
 - 10 feet, 10

Injection Point Inspection upstream 12 inch or 3 times dia which ever is more
Injection point Downstream Second change in flow direction or 25 feet beyond the first change in flow direction which ever is less
More extensive inspection up stream 12 inch, Down stream 10 times Dia

18. Why should deadlegs in piping be inspected?

- API 510 mandates the inspection of deadlegs
- Acid products and debris build up in deadlegs
- The corrosion rate in deadlegs can vary significantly from adjacent active piping
- Caustic products and debris build up in deadlegs

19. Both the stagnant end and the connection to an active line of a deadleg should be monitored. In a hot piping system, why does the high point of a dead leg corrode and need to be inspected?

- Corrosion occurs due to directed currents set up in the deadleg
- Erosion occurs due to convective currents setup in the deadleg
- Corrosion occurs due to convective currents setup in deadleg
- Erosion occurs due to directed currents set up in the deadleg

20. What is the best thing to do with dead legs that are no longer in service?

- Ultrasonically inspect often
- Radiograph often
- Inspect often
- Remove them

21. What are the most common forms of corrosion under insulation (CUI)

- Localised corrosion of non-ferrous metals and chloride stress corrosion cracking of carbon steel
- Localised corrosion of chrome-moly steel and chloride stress corrosion cracking of ferritic stainless steel
- Localised corrosion of carbon steel and chloride stress corrosion of cracking of austenitic stainless steel
- Localised corrosion of nickel-silicon alloy and caustic stress corrosion of austenitic stainless steel

22. What climatic area may require a very active program for corrosion under insulation?

- a. Cooler northern continent locations.
- b. Cooler drier, mid-continent locations
- c. Warmer, marine locations
- d. Warmer drier, desert locations

23. Certain areas and types of piping systems are potentially more susceptible to corrosion under insulation. Which of the items listed is not susceptible to CUI?

- a. Areas exposed to mist over-spray from cooling water towers.
- b. Carbon steel a pipings system that normally operates in-service above 250 degrees but are in intermittent service.
- c. Deadlegs and attachments that protrude from insulated piping and operate at a different temperature than the temperature of the active line.
- d. Carbon steel piping systems operating between 250 degrees F and 600 degree F.

24. What location is subject to particular attention related to corrosion under insulation and inspection contributes to it?

- a. Location where pipe hangers and other supports exist.
- b. Locations where insulators has been stripped to permit inspection of the piping.
- c. Locations where insulation plugs have been removed to permit piping thickness measurements.
- d. Locations where there is damaged or missing insulation jacketing.

25. Soil-to-Air (S/A) interfaces of buried piping are a location where localized corrosion may take place. If the buried part is excavated for inspection, how deep should the excavation be to determine if there is hidden damage?

- a. 12 to 18 inches
- b. 6 to 12 inches
- c. 12 to 14 inches
- d. 6 to 18 inches

26. At concrete-to-air and asphalt-to-air interfaces of buried piping without cathode protection, the inspector look for evidence that the caulking or seal at the interface has deteriorated and allowed moisture ingress. If such a condition exists on piping system over _____ years old, it may be necessary to inspect for corrosion beneath the surface before resealing the joint.

- a. 8
- b. 5
- c. 15
- d. 10

27. An example of service specific and localized corrosion is:

- a. Corrosion under insulation in areas exposed to steam vents
- b. Unanticipated acid or caustic carryover from process into non-alloyed piping
- c. Corrosion in Deadlegs
- d. Corrosion of underground piping at soil-to-air interface where it ingresses or egresses

28. Erosion can be defined as:

- a. Galvanic corrosion of material where uniform losses occur.
- b. Removal of surface material by action of numerous impacts of solid or liquid particles
- c. Gradual loss of material by a corrosive medium acting uniformly on the material surface
- d. Pitting on the surface of the material to the extent that a rough uniform loss occurs

29. A combination of corrosion and erosion results in significantly greater metal loss that can be expected from corrosion or erosion alone. This type of loss occurs at

- a. High velocity and high turbulence areas
- b. Areas where condensation or exposure to wet hydrogen sulphide or carbonates occur
- c. Surface-to-air interfaces of buried piping
- d. Areas where gradual loss of material occurs because of a corrosive medium

30. Environmental cracking of austenite stainless steel is caused many times by:

- a. Exposing areas to high-velocity and high-turbulence streams
- b. Excessive cyclic stresses that are often very low
- c. Exposure to chlorides from salt water, wash-up water, etc
- d. Creep of the material by long time exposure to high temperature and stress

31. When the inspector suspects or is advised that specific piping circuits may be susceptible to environmental cracking, the inspector should:

- a. Call in piping engineer for consultation
- b. Investigate the history of the piping circuit
- c. Obtain advice from a Metallurgical Engineer
- d. Schedule supplemental inspection

32. If environmental cracking is detected during internal inspection of pressure vessels, what should the inspector do?

- a. The inspector should designate appropriate piping spools upstream and downstream of the vessel to be inspected if piping is susceptible to environmental cracking.
- b. The inspector should consult with a metallurgical engineer to determine extent of the problems
- c. The inspector should review history of adjacent piping to determine if it has ever been affected
- d. The inspector should consult with a piping engineer to determine the extend of the problem

33. If external or internal coating or refractory liners on a piping circuit are not in good condition, what should an inspector do?

- a. After inspection, select a portion of the liner for removal
- b. The entire liner should be removed for inspection
- c. Selected portions of the liner should be removed for inspection
- d. After inspection, if any separation, breaks, holes or blisters are found, it may be necessary to remove portions of the lining to determine the condition under it.

34. What course of action should be followed if a coating of coke is found on the interior of a large pipe of a reactor on a fluid catalytic cracking unit?

- a. Determine whether such deposits have active corrosion beneath them. If corrosion is present, thorough inspection in selected areas may be required.
- b. The coke deposits should be removed from the area for inspection.
- c. The coke deposits may be ignored - the deposit may probably protect the line from corrosion.
- d. Consult with a Process Engineer and a Metallurgist on the necessity of removing the coke deposit.

35. Fatigue cracking of pipe system may result from

- a. Embrittlement of the metal due to operating below its transition temperature
- b. Erosion or corrosion /erosion that thin the piping where it cracks
- c. Excessive cyclic stress that are often well below the static yield strength of the material
- d. Environmental cracking caused by stress corrosion due to the presence of caustic, amine, or other substance.

36. Where can fatigue cracking typically be first detected?

- a. At points of low-stress intensification such as reinforced nozzles
- b. At points of high-stress intensification such as branch connections
- c. At points where cyclic stresses are very low
- d. At points where there are only bending or compressive stresses.

37. What are the preferred NDE methods for detecting fatigue cracking?

- a. Eddy current testing, ultra sonic A-scan testing and / or possibly hammer testing
- b. Liquid Penetrant testing, magnetic particle testing and / or possibly acoustic emission testing
- c. Visual testing, eddy current testing and/ or possibly ultrasonic testing
- d. Acoustic emission testing, hydro-testing and / or possibly ultrasonic testing

To detect fatigue crack (Surface in nature) usually MT & PT Is used, RT & UT are not preferred

38. Creep is dependent on:

- a. Time, temperature and stress
- b. Material, product contained and stress
- c. Temperature, corrosive medium and load
- d. Time, product contained and load

39. An example of where creep cracking has been experienced in the industry is in the problems experienced with cracking of 1.25% chrome steels operating at temperature above _____ degree F

- a. 500
- b. 900
- c. 1000
- d. 1200

40. Brittle fracture can occur in carbon, low-alloy and other ferritic steels at or below _____ temperature.

- a. 140 degree
- b. Ambient
- c. 100 degree
- d. 30 degree

41. Water and aqueous solutions in piping systems may freeze and cause failure because of the

- a. Expansion of these materials
- b. Contraction of these materials
- c. Construction of these materials
- d. Decrease of these materials

42. Different types of inspection and surveillance are appropriate depending on the circumstances and the piping system. Pick the one that does not belong in the following list:

- a. Internal and external visual inspection
- b. Thickness measurement inspection
- c. Vibrating piping inspection
- d. Chemical analysis inspection

43. Internal visual inspections are _____ on piping unless it is a large diameter transfer line, duct, catalyst line or other large diameter piping system

- a. The most effective inspection
- b. The most useful means of inspection
- c. Not normally performed
- d. The major means of inspection

44. Name an additional opportunity for a normal non-destructive internal inspection of piping

- a. When the piping fails and the interior is revealed
- b. When maintenance asks for an internal inspection
- c. When piping flanges are disconnected
- d. When a fire occurs and the pipe is in the fire

45. Why is the thickness measurement inspection performed?

- a. To satisfy jurisdictional requirements
- b. To determine the internal condition and remaining thickness of the piping components
- c. To determine the external condition and amount of deposits inside the piping
- d. To satisfy heat transfer requirements of the piping

46. Who performs the thickness measurement inspection?

- a. The operator or control man
- b. The inspector or examine
- c. The maintenance workers or supervisors
- d. The jurisdiction or OSHA

47. When corrosion product build-up is noted during an external visual inspection at a pipe support contact area, lifting of such supports may be required for inspection. When doing this, care should be

- a. exercised if the piping is in-service
- b. used when determining the course of action
- c. practiced so as not to disturb the supports
- d. taken that a complete record of the problem is made

48. Qualified operating or maintenance personnel also may conduct external visual inspection when:

- a. Satisfactory to the owner-user
- b. Acceptable to the inspector
- c. Agreeable to the maintenance supervisor
- d. Permissible to the operation supervisor

Here it is not owner user, because it comes into the scope of authorised inspector

49. Who would normally report vibrating or swaying piping to engineering or inspection personnel?

- a. Operating personnel
- b. Jurisdictional personnel
- c. Maintenance personnel
- d. OSHA personnel

50. Thermography is used to check for:

- a. Vibrating sections of the pipe system
- b. Detecting localized corrosion in the piping system
- c. Abnormal thermal expansion of piping system
- d. Hot spots in refractory lined piping systems

51. Thickness measurement locations (TMLs) are specific _____ along the piping circuit where inspections are to be made

- a. Points
- b. Areas
- c. Items
- d. Junctures

52. The minimum thickness at each TML can be located by

- a. Electromagnetic techniques
- b. Ultrasonic scanning or radiography
- c. Hammer testing
- d. MT and / or PT

53. Where appropriate, thickness measurements should include measurements at each of _____ on pipe and fittings

- a. Two quadrants
- b. Three locations
- c. Four quadrants
- d. Six points

54. Where should special attention be placed when taking thickness measurements of an elbow?

- a. The outlet end
- b. The inlet end
- c. The inside and outside radius
- d. The sides

55. TMLs should be marked on inspection drawings and _____ to allow repetitive measurements

- a. On the inspectors notes
- b. On a computer system
- c. On the piping system
- d. On maintenance department charts

- 56. What is taken into account by an experienced inspector when selecting TMLs?**
- a. The amount of corrosion expected
 - b. The patterns of corrosion that would be expected
 - c. The number and the cost of reading the TMLs
 - d. Whether the TMLs are easily accessed
- 57. In theory, a piping circuit subject to perfectly uniform corrosion could be adequately monitored with _____ TMLs**
- a. 1
 - b. 2
 - c. 3
 - d. 4
- 58. More TMLs should be selected for piping systems with any of the following characteristics**
- a. Low potential for creating a safety or environmental emergency in the event of a leak
 - b. More complexity in terms of fittings, branches, deadlegs, injection points, etc
 - c. Relatively non-corrosive piping systems
 - d. Long, straight – run piping systems
- 59. Fewer TMLs can be selected for piping systems with any of the following characteristics**
- a. More complexity in terms of fittings, branches, deadlegs, injection points, etc
 - b. Higher expected or experienced corrosion rates
 - c. Long, straight-run piping systems
 - d. Higher potential for localized corrosion
- 60. TMLS can be eliminated fro piping systems with the following characteristics**
- a. Higher potential for creating a safety or environmental emergency in the event of a leak
 - b. Low potential for creating a safety or environmental emergency in the event of a leak
 - c. Extremely low potential for creating a safety of environmental emergency in the event of a leak
 - d. More complexity in terms of fitting, branches, deadlegs, injection points, etc
- 61. What is usually the most accurate means for obtained thickness measurements on installed pipe larger than NPS?**
- a. MT
 - b. UT
 - c. PT
 - d. ET

62. What thickness measuring technique does not require the removal of some external piping insulation?

- a. AE
- b. UT
- c. ET
- d. RT

63. When ultrasonic thickness measurements are taken above _____ degrees F, instruments couplants, and procedures should be used that will result in accurate measurements at the higher temperature

- a. 150
- b. 175
- c. 200
- d. 250

150 ° F Special Procedure,

200°F – 1 % to 5% error,

1% error in thickness measurement for every 100 °F above ambient temperature,

Above 1000 °F do not use delay line probe – Use Special probe

64. Typical digital thickness gages may have trouble measuring thickness less than _____ inches

- a. 0.2188
- b. 0.1875
- c. 0.1562
- d. 0.1250

65. When pressure testing of piping systems are conducted, they shall be performed in accordance with the requirements of

- a. ASME B31.3
- b. ASME B&PV Code section VIII
- c. SA B 16.5
- d. API 510

66. If a lower pressure test (lower than prescribed by code) is used only for tightness of piping systems, the _____ may designate the pressure

- a. Owner-user
- b. Inspector
- c. Jurisdiction
- d. Contractor

67. The preferred medium for a pressure test is _____

- a. Steam
- b. Air
- c. Water
- d. Hydrocarbon

68. If a non-toxic hydrocarbon (flammable) is used as the test medium, the liquid flash point shall be at least _____ degrees F or greater

- a. 95
- b. 100
- c. 110
- d. 120

It is separate requirement. So Mug it up. Any way temperature Dapa is as follows.

PT temp is from 50 Deg F or 60 Deg F to 125 Deg F,

LT tem is from 40 Deg F to 125,

For MT Dry it is above 600 Deg F. For wet usually 135 Deg F. But if the choice is given as by the manufacturer then prefer that

FOR UT

150 ° F Special Procedure,

200°F – 1 % to 5% error,

1% error in thickness measurement for every 100 °F above ambient temperature,

Above 1000 °F do not use delay line probe – Use Special probe

Flash Point for Penetrant in the open tank is 93 Deg C,

Flashpoint for Non toxic Hydrocarbon test medium is 120 Deg F

General Flash Point for PT is 57 DEG C. Check with OP disc

69. Piping fabricated of or having components of 300 series stainless steel should be tested with _____

- a. Water with a pH of 4
- b. Water with a pH of 6
- c. Water with a chloride content of less than 400 ppm chlorides
- d. Steam condensate

70. For sensitized austenitic stainless steel, piping subject to polythionic stress corrosion cracking, consideration should be given to using _____ for pressure testing

- a. An acidic-water solution
- b. An alkaline-water solution
- c. A water with a pH of 5
- d. A water with a pH of 4

SS 300 should be tested with Potable water or steam condensate. Potable water should Have chlorine content less than 250 ppm. If potable water or steam condensate are not available use very low chloride or high PH water to reduce the risk of pitting (acid) & MIC

For Sensitized AUS SS use alkaline solution

71. When a pipe requires post weld heat treatment, when should the pressure test be performed?

- a. During heat treatment
- b. Before any heat treatment
- c. After any heat treatment
- d. No test is required

72. During a pressure test, where test pressure will exceed the set pressure of the safety relieve valve or valves on a piping system, the safety relief valve or valves should be _____ when carrying out the test

- a. Altered by screwing down the adjusting screw
- b. Reset to exceed the test pressure
- c. Checked or tested
- d. Removed or blanked

Test pressure should never exceed set pressure of valves

73. When using block valves to isolate a piping system for pressure test, what precaution should be taken?

- a. Do not use a globe valve during a test
- b. Makes sure the packing gland of the valves is tight
- c. Do not exceed the permissible seat pressure of the valve
- d. Check the bonnet bolts to make sure they are right

74. Several method may be used to verify that the correct alloy piping is in a system pick the incorrect methods from the list below

- a. Holography
- b. Optical spectrographic analyzer
- c. X-ray fluorescent analyzer
- d. Chemical spot checking

75. Name a part of a piping system that thickness measurements are not normally routinely taken

- a. Elbows
- b. Expansion loops
- c. Tees
- d. Valve

76. If environmental cracking is found during in-service inspection of welds, who assesses the problem?

- a. Owner-user
- b. Inspector
- c. Piping Engineer
- d. Metallurgist

Inspector will check and measure and inspect environmental cracking but assessing is to done only by the piping engineering

77. If an inspector finds an imperfection in an original fabrication weld and

- a. An API 510 inspector, WPS inspector, A Pressure Vessel Engineer
- b. An API 570 inspector, a CWI inspector, a piping engineer
- c. An owner-user, a B31.3 inspector, an industrial engineer
- d. A Jurisdictional representative, a API 574 inspector, a Chemical Engineer

78. According to API 570, some welds in a piping system that has been subjected to radiography according to ASME B 31.3

- a. Will meet random radiograph requirements, and will perform satisfactorily in-service without a hydrotest
- b. Will not meet random radiograph requirements, and will not perform satisfactorily in-service even though hydrotested
- c. Will meet random radiograph requirements, and will not perform satisfactorily in-service after a hydrotest
- d. Will not meet random radiograph requirement, but will still perform satisfactorily in-service after being hydrotested

79. How should fasteners and gaskets be examined to determine whether they meet the material specifications

- a. All fasteners and gaskets should be checked to see if their marking are correct according to ASME and ASTM standards
- b. A representative sample of the fasteners and gaskets should be checked to see if their markings are correct according to ASME and ASTM standards
- c. Purchase records of all fasteners and gaskets should be checked to see if the fasteners and gaskets meet ASME and ASTM standards
- d. A representative sample of the purchase records of fasteners and gaskets should be checked to see if the fasteners and gaskets meet ASME and ASTM standards

80. When checking flange and valve bonnet bolts for corrosion what type of NDT is usually used?

- a. RT
- b. UT
- c. VT
- d. AE

81. What course of action is called for when an inspector finds a flange joint that has been clamped and pumped with sealant?

- a. Disassemble the flange joint; renew the fasteners and gaskets. The flanges may also required renewal or repair
- b. Renew all the fasteners and renew the gasket if leakage is still apparent
- c. Check for leakage at the bolts; if re-pumped is contemplated, affected fasteners should be renewed
- d. No action is required since the joint has been pumped with a sealant

82. All process piping systems must be categorised into different classes. On what are the classifications selection based?

- a. Requirements of jurisdiction and the proximity of population areas
- b. Potential safety and environmental effects should a leak occur
- c. Liability to the owner-user and the requirements of the jurisdiction
- d. Access to the systems for inspection and closeness to population areas

82. (1) Inspection strategy based on likelihood and consequence of failure is called

- a. RBI
- b. FFS
- c. BIR
- d. MSOS

82. (2) An RBI assessment can be used to _____ the inspection interval limits in Table 6.1 of API 570 or the extent of the inspection conducted

- a. Increase
- b. Decrease
- c. Either a or b above
- d. None of the above

82. (3) When an RBI assessment is used to increase or decrease inspection intervals, the assessment shall be conducted on Class 1 system at a maximum interval of _____ years

- a. 5
- b. 10
- c. 15
- d. 3

83. Listed below are several example of a CLASS1 piping system. Which one does not belong?

- a. Anhydrous hydrogen chloride
- b. Hydrofluoric acid
- c. Piping over or adjacent to water and piping over public thoroughways
- d. Distillate and product lines to and from storage and loading

84. Of the three classification of piping systems, which includes the majority of unit processes and selected off-site piping?

- a. Class 3
- b. Combination of classes 1 and 2
- c. Class 1
- d. Class 2

H₂ gas, natural gas, fuel gas, catalyst, hydrocarbons which slowly vaporize

85. Class 3 piping is described as being in services

- a. With the highest potential of resulting in an immediate emergency if a leak occurs
- b. That are flammable but do not significant vaporise when they leak and are not located in high-activity areas
- c. That are not flammable and pose no significant risk to populated areas
- d. That are not classes 1 and 2

86. Who establishes inspection interval for thickness measurements, external visual inspections and for internal and supplemental inspection?

- a. Piping engineer
- b. Owner-user or the inspector
- c. Chemical Engineer
- d. Piping engineer and the jurisdiction

87. Thickness measurement inspection should be scheduled based on the calculation of not more than

- a. One half the remaining life determined from corrosion rates or the maximum interval of 5 years whichever is shorter
- b. One half the remaining life determined from corrosion rates or the maximum interval allowed by API 570 in Table 6.1, whichever is shorter
- c. One fourth the remaining life determined from corrosion rates or the maximum interval of 10 years whichever is shorter
- d. One quarter the remaining life determined from corrosion rates or the maximum interval allowed by API 570 in Table !, whichever is shorter

88. For external inspection for potential corrosion under insulation (CUI) on Class1 systems, the examination should include at least _____ percent of all suspect areas and _____ percent of all areas of damaged insulation

- a. 50,75
- b. 50,33
- c. 75,50
- d. 25,10

89. Piping system that are known to have a remaining life of over _____ years or that are protected against external corrosion need not have insulation removed for the periodic external inspection

- a. 10
- b. 15
- c. 5
- d. 20

- 90. For Class 3 piping systems, the examination for corrosion under insulation (CUI) should include at least _____ percent of all suspect areas**
- 50
 - 30
 - 10
 - 0
- 91. For Class 2 piping, the extent of CUI inspections on a system operating at -45°F will be**
- 75% of damaged areas, 50% of suspect areas
 - 50% of suspect areas, 33% of damaged areas
 - 33% of damaged areas, 50% of suspect areas
 - None of the above
- 92. Small bore piping (SBP) that is Class I shall be inspected**
- Where corrosion has been experienced
 - At the option of the inspector
 - To the same requirement as primary process piping
 - Only if it has dead legs
- 93. Inspection of small bore piping (SBP) that is secondary and auxiliary (associated with instruments and machinery) is**
- Only required where corrosion has been experienced
 - Optional
 - Only if it has dead legs
 - Only if it is threaded
- 94. If an inspector finds threaded small bore piping (SBP) associated with machinery and subjected to fatigue damage, he should**
- Plan periodically to assess it and consider it for possible renewal with a thicker wall or upgrade it to welded components
 - Inspect it only if it is corroded and the class of service requires an inspection
 - Call for dismantling the threaded joints for close inspection to determine if any cracks are in the roots of the threads
 - have all the threaded piping renewed at each inspection period
- 95. An eight-inch diameter piping system is installed in December 1979. The installed thickness if measured as 0.34". The minimum thickness of the pipe is 0.2". It is inspected 12/83 and the thickness is found to be 0.32". An inspection 12/87 reveals a loss of 0.01" from the 12/85 inspections. During 12/89 the thickness was found to be 0.29". The last inspection was during 12/95 and the thickness was found to be 0.26". What is the long-term corrosion rate of this system?**
- 0.005"/year
 - 0.0075"/year
 - 0.00375"/year
 - 0.0025"/year

- a. 0.005"/year
- b. 0.0075"/year
- c. 0.00375"/year
- d. 0.0025"/year

97. Using the information in question 95 and 96, determine the remaining life of the system

- a. 18years
- b. 15 years
- c. 12 years
- d. 6 years

98. You have a new piping system that has just been installed. It is completely new and no information exists to establish a corrosion rate. Also, information is not available on a similar system. You decide to put the system in service and NDT it later to determine the corrosion rate. How long do you allow the system to stay in service before you take your first thickness readings?

- a. 1 month
- b. 3 month
- c. 6 month
- d. 12 month

99. After an inspection interval is completed and if calculations indicate that an inaccurate rate of corrosion has been assumed in a piping system, how do you determine the corrosion rate for the next inspection period?

- a. Check the original calculations to find out what the error is in the original assumption
- b. Unless the corrosion rate is higher, the initial rates shall be used
- c. The corrosion rate shall be adjusted to agree with the actual rate found
- d. If the corrosion rate is higher than originally assumed, call in a corrosion specialist.

100. If a piping system is made up of unknown materials and computations must be made to determine the minimum thickness of the pipe, what can the inspector or the piping engineer do establish the minimum thickness?

- a. The lowest grade material and joint efficiency in the applicable code may be assumed for calculations
- b. Samples must be taken from the piping and testing for maximum tensile stress and yield strength will determine the allowable stress to be used
- c. The piping made of the unknown material must be removed from service and current piping of known material must be installed
- d. The piping of unknown material may be subjected to a hydrostatic stress tests while having strain gages on it to determine its yield strength and thus allowable stress

101. A piping engineer is designing a piping service with high potential consequences if a failure occurs, i.e. a 350-psi natural gas line adjacent to a high density population area what should be consider doing for unanticipated situations?

- a. Have all his calculations checked twice
- b. Increase the required minimum thickness
- c. Notify the owner-user and the jurisdiction
- d. Set up an emergency evacuation procedure

102. When evaluating locally thinned areas, the surface of the weld includes _____ on either side of the weld or _____ times the minimum measured thickness on either side of the weld, whichever is greater

- a. 0.5", 3
- b. 1", 2
- c. 2", 1
- d. 1.5", 1.5

103. An inspector finds a thin area in a fabricated 24" diameter pipe. The thin area includes a longitudinal weld in the pipe and is 10 feet long and 2 foot circumferentially. Calculations show that with 0.85 joint factor, the pipe must be repaired, renewed, etc. or the pressure in the pipe must be lowered. The owner does not want to do any hot work on the pipe and the dose not wish to lower the pressure what other course could you follow?

- a. Write the results of the inspection up and leave it with the owner
- b. Radiograph the weld 100% and increased the joint factor to one
- c. Insist that the weld be repaired or renewed or that the pressure be lowered
- d. Call in a regulator agency to force the owner to repair, renew, etc the line

Only for new pipes increasing the joint factors by additional RT is allowed For inservice pipe is not allowed.

104. Piping stress analysis is done during the system's original design. How can the inspector make use of stress analysis information/

- a. An inspector cannot use this information. It is only meaningful to a piping engineer
- b. It can be used to make sure the piping system was originally evaluated and designed correctly
- c. It can be used to concentrate inspection efforts at locations most prone to fatigue or creep damage, and to solve vibration problems
- d. The inspector should use this information t o evaluate the need for conducting additional piping stress analysis

- 105. You are inspecting a piping system. You find a significant loss of material (a major increase of corrosion rate) in gas oil piping (used as reboiler oil, temperature 500 degrees F) on a Fluid Catalytic Cracking Unit. What is the best course of action for you to take?**
- a. The losses may be reported to your supervisor for corrective response
 - b. The losses should be recorded and reported in your final report after unit has start-up
 - c. It shall be reported to the owner-user for appropriate action
 - d. Replace excessively thin piping and note replacement in the final report after unit start-up
- 106. The _____ shall maintain appropriate permanent and progressive records of each piping system covered by API 570**
- a. Inspector
 - b. Owner-user
 - c. Jurisdiction
 - d. Examiner
- 107. When making repairs and alterations to piping systems, the principles of _____ or the code to which the piping system was built shall be followed**
- a. ASME B31.3
 - b. API 570
 - c. API 574
 - d. ASME B&PV code
- 108. Repair and alteration work must be done by a repair organisation as defined in API 570 and must be authorized by the _____ prior to its commencement**
- a. Jurisdiction
 - b. Inspector
 - c. Owner-user
 - d. Examiner
- Repair organization must be authorized by API Inspector. For alteration work piping engineer's approval is needed
- 109. Authorization for alteration work to a piping system may be given by the inspector after**
- a. Notifying the jurisdiction and getting their approval
 - b. Consulting API 570 and getting the approval of the owner-user
 - c. Consultation with and approval by a piping engineer
 - d. Discussing with and consent by an examiner

- 110. A repair procedure involving welding requires that the root pass of the weld be inspected before continuing the weld. A “hold” on the repair is required at this point Who designates this “hold”?**
- A metallurgist
 - The owner-user
 - An API 570 inspector
 - The welder supervisor
- 111. What type of repairs and procedures may the inspector give prior general authorisation to continue (provided the inspector is satisfied with the competency of the repair organisation)?**
- Major repairs and minor procedures
 - Limited or routine repairs and procedures
 - Alterations and re-rating
 - Minor re-ratings and alterations
- 112. Who approves all proposed methods of design, execution, materials, welding procedures, examination and testing of in-service piping?**
- The jurisdiction or the piping engineer as appropriate
 - The analyst and the operator as appropriate
 - The examiner and the piping programmer as appropriate
 - The inspector or the piping engineer as appropriate
- Owner - user NO
- 113. Who must give approval for any on-stream welding?**
- Owner-user
 - Jurisdiction
 - Examiner
 - Analyst
- This is only for owner user. Increased overall responsibility – owner user
Inspection, decisions, Hold point – API Inspector and piping engineer
- 114. An inspector finds a crack in the parent metal of a pipe adjacent to a support lug. The pipe was being inspected after a 5 year run. Before repairing the should**
- Notify the jurisdiction prior to the start of any repairs
 - Write a detailed procedure for the repair organizations use in repairing the crack
 - Consult with the piping engineer to identify and correct the cause of the crack
 - Consult with a metallurgist prior to writing a procedure to repair the crack

115. A full encirclement welded split sleeve designed by a piping engineer may be applied over damage or corroded area of a pipe. This is considered a temporary repair when should a permanent repair be made?

- a. If the owner-user designates the welded split sleeves as permanent if may remain
- b. A full encirclement welded split sleeve is permanent if okayed by the inspector
- c. A full encirclement welded split sleeve is considered a permanent repair
- d. A permanent repair must be made at the next available maintenance opportunity

116. What type of defect, corrosion, pitting and / or discontinuity should not be repaired by a full encirclement welded split sleeve?

- a. A longitudinal crack
- b. A circumferential crack
- c. Pits that are one half through wall
- d. General corrosion in the longitudinal direction

117. If a repair area is localized (for example, pitting or pin-holes) and the specified minimum yield strength (SMYS) of the pipe is not more than _____ psi, a temporary repair may be made by fillet welding a properly designed plate patch over the pitted area

- a. 30,000 psi
- b. 55,000 psi
- c. 40,000 psi
- d. 36,000 psi

For fillet welding it is 40,000 psi, for low strength bolting it is 30 ksi (for class 150 and class 300)

118. Insert patches (flush patches) may be used to repair damaged or corroded areas of pipe if several requirements are met. One of these is that an insert patch (flush patch) may be of any shape but it shall have rounded corners with _____ minimum radii

- a. 0.375"
- b. 0.50"
- c. 0.75"
- d. 1"

119. An inspector finds a pin-hole leak in a weld during an on-stream inspection of a piping system. A permissible temporary repair is

- a. The use of plastic steel to seal off the leak
- b. Driving a wooden plug into the hole
- c. Screwing a self tapping screw into the hole
- d. The installation of a properly designed and fabricated bolted leak clamp

- 120. Temporary leak sealing and leak dissipating devices shall be removed and the pipe restored to original integrity**
- As soon as the piping system can be safely removed from service
 - At a turnaround or other appropriate time
 - When the leak seal and leak dissipating device ceases to work
 - As soon as possible – must be done on a safe, emergency shut-down basis
- 121. Which of the following is NOT an item for consideration by an inspector when a leak sealing fluid (“pumping”) is used for a temporary leak seal repair**
- Consider the compatibility of the sealant with the leaking material
 - Consider the pumping pressure on the clamp (especially when re-pumping)
 - Consider the pressure testing of the piping in question
 - Consider the number of times the seal area is re-pumped
- 122. Any welding conducted on piping components in operation must be done in accordance with**
- NFPA 704
 - API Standard 510
 - ASME B31.3
 - API Publication 2201
- 123. All repair and alteration welding to piping systems shall be done in accordance with the**
- Exact procedures of ASME B31.3 or to the code to which it was built
 - Standards of ASME B31.3 or the code to which it was built
 - Principles of ASME B31.3 or the code to which it was built
 - Ideals of ASME, NBIC, or API standards
- 124. Welders and welding procedure used in making piping repairs, etc shall be qualified in accordance with**
- ASME B31.3 or the code to which the piping was built
 - NBIC or the system to which the piping was built
 - NACE or the method to which the piping was built
 - ASTM or the law to which the piping was built
- 125. The repair organisation responsible for welding shall maintain records of welding procedures and welder performance qualifications. These records shall be available to the inspector**
- At the end of the job
 - After the start of welding
 - Following the start of welding
 - Before the start of welding

126. Preheating to not less than _____ degrees F may be considered as an alternative to post weld heat treatment for alterations or repairs of P-L, piping initially post weld heat treated as a code requirement (may not be used if the piping was post weld heat treated due to environment cracking prevention)
- 150
 - 200
 - 300
 - 350
127. When using local PWHT as a substitute for 360-degree banding on local repairs of PWHT' d piping, which of the following items is **NOT** considered
- The application is reviewed, and a procedure is developed by the piping engineer
 - The locally PWHT' d area of the pipe must be RT'd or UT'd
 - A preheat of 300°F or higher is maintained while welding
 - The PWHT is performed for code compliance and not for environmental cracking
128. Piping butt joints shall be :
- double spiral fillet welds
 - single fillet lap welds
 - double fillet lap welds
 - full-penetration groove welds
129. When should piping components that need repair to be replaced?
- When enough time remains on a turnaround to allow replacement
 - When repair is likely to be inadequate
 - When the cost of repair is as high as renewal
 - When replacement is preferred by maintenance personnel
130. Fillet weld patches (lap patches) shall be designed by
- An engineer
 - The inspector
 - The piping engineer
 - The repair organization
131. Fillet welded lap patches (overlay patches) shall have
- no membrane stresses
 - right-angle corners
 - rounded corners
 - burnished corners
132. Materials used in making welding repairs or alterations _____ be of known weldable quality:
- may
 - shall
 - should

- 133. Acceptance of a welded repair or alteration shall include _____ in accordance with the applicable code and the owner-user's specification, unless otherwise specified in API 570**
- a. Nominal pragmatic sizing (NPS)
 - b. NBE
 - c. Safeguards
 - d. Non-destructive examination
- 134. After welding is completed on a repair or alteration, _____ in accordance with API 570 shall be performed if practical and deemed necessary by the inspector**
- a. NPS
 - b. Safety sanctions
 - c. NBE
 - d. A pressure test
- 135. When a pressure tests normally required?**
- a. Pressure test normally required after alteration and any repair
 - b. Pressure test normally required after alteration and major repairs
 - c. Pressure test normally required after major and minor repairs
 - d. Pressure test normally required only as specified by the owner-user
- 136. When a pressure test is not necessary or practical, what shall be utilised in lieu of a pressure test?**
- a. NPS
 - b. Non-destructive examination
 - c. Vacuum visual examination
 - d. NBE
- 137. Special procedures in place of a pressure test after an alteration or repair may be done only after consultation with:**
- a. The operations and repair organisation
 - b. The inspector and the piping engineer
 - c. The jurisdiction
 - d. The examiner and the inspector

138. When it is not practical to perform a pressure test for a final closure weld that joins a new or replacement section of piping to an existing system, several requirements shall be satisfied. Which of the following is NOT one of the requirements?

- a. The closure weld is a full-penetration fillet weld between a weld neck flange and standard piping component or straight sections of pipe of equal diameter and thickness, axially aligned or equivalent materials. For design cases up-to Class 150 and 500° F, slip on flanges are acceptable alternates.
- b. MT or PT shall be performed on the root pass and the completed butt weld. Fillet weld must have PT/MT on the completed weld.
- c. The new or replacement piping is pressure tested.
- d. Any final closure butt weld shall be of 100% radiographic quality, or angle beam UT may be used, provided the appropriate acceptance criteria is established.

There is no full penetration fillet weld

139. Which of the following is NOT a requirement for re-rating a piping system by changing the temperature or the MAWP :

- a. The existing pressure relieving devices are still in place and set as they were originally.
- b. Calculations are performed by the piping engineer or the inspector.
- c. Piping flexibility is adequate for design temperature changes.
- d. A decrease in minimum operating temperature is justified by impact test results, if required by the applicable code.

140. Why is the inspector of buried process piping (not regulated by DOT) different from other process piping inspection?

- a. The insulating effect of the soil increases the possibility of more internal combustion
 - b. Internal corrosion has to be controlled by cathodic protection
 - c. Significant external deterioration can be caused by corrosive soil conditions
 - d. Internal corrosion must be controlled by internal coating
- So, Old PRV should be changed

141. Indications of leaks in buried piping may include several indications. Which of the ones listed below is NOT one of the indications?

- a. A change in surface contour of the ground
- b. Water standing on the pipeline right-of-way
- c. Discoloration of the soil
- d. Notice odour

- 142. Corrosion cells can form on both bare and coated pipe where bare steel contacts the soil. How can the cells be detected?**
- Run an acoustic emission test on the piping
 - Visually survey the route of buried piping
 - The potential at the area of corrosion will be measurable different than other areas and a close-interval potential survey can detect the location of corrosion
 - Run an interval survey of the piping using a video camera
- 143. A pipe coating holiday survey is used to locate coating defects on coated pipes. It can be used on newly constructed pipe systems to ensure that the coating is intact and holiday-free. More often, it is used in buried pipes to :**
- Show the measurable differences in electrical potential in corroded areas
 - Evaluate coating serviceability for buried piping that has been in-service for a long time.
 - Determine depth of piping for resistivity testing
 - Evaluate the cathodic protection components of the underground pipe.
- 144. Cathodically protected buried piping should be monitored _____ to assure adequate levels of protection.**
- regularly
 - intermittently
 - erratically
 - frequently
- 145. If an intelligent pigging system is used to inspect buried piping, what types of bends are usually required in the piping system?**
- Five diameter bends
 - 90 degree pipe ells
 - Ten diameter bends
 - Three diameter bends
- 146. How often should above-grade visual surveillance of a buried pipeline right-of-way be made?**
- Once a month
 - Approximately 6 months intervals
 - Once a year
 - Once every 3 months
- 147. How often should poorly coated pipes with inconsistent cathodic protection potentials have a pipe-to-soil potential survey made?**
- Yearly
 - Every 2 years
 - Every 5 years
 - Every 7 years

For fully cathodically protected it is annual

- 148. On buried piping, what is the frequency of pipe coating holiday surveys?**
- The frequency is governed by the leak test interval of the pipe
 - It is usually based on indication that other forms of corrosion control are ineffective.
 - Surveys are normally made every 5 years
 - Pipe coating holiday surveys are made when the pipe is excavated.
- 149. For a piping buried in lengths greater than _____ feet and not cathodically protected, evaluation of soil corrosivity should be performed at 5-years interval.**
- 50
 - 75
 - 100
 - 150
- 150. If buried piping is cathodically protected, the system should be monitored at intervals in accordance with section 10 of NACE RP0169 or section 90 of API RP 651. API RP 651 specifies _____ interval.**
- Annual
 - Biannual
 - Biennial
 - Trennial
- 151. Buried excavation of buried piping, if inspection reveals damaged coating or corroded piping**
- 2 to 4**
 - 4 to 6**
 - 6 to 8**
 - 8 to 10**
- 152. After excavation of buried piping, if inspection reveals damaged coating or corroded piping:**
- The condition should be noted in the records and the inspection interval shortened.
 - The complete piping system should be day-lighted (excavated) for repair or replacement
 - The damaged coating or corroded piping must be repaired or replaced
 - Additional piping shall be excavated until the extent of the condition is identified.
- 153. If buried piping is contained inside a casing pipe, the casing should be:**
- Capable of carrying the same pressure as the product pipe.
 - Checked to see if its protective coating is intact and serviceable
 - Pressure tested to make sure it is serviceable.
 - Inspected to determine if water and / or soil has entered the casing.

operating pressure at intervals $\frac{1}{2}$ the length of those shown in table 9-1 of API 570 for piping NOT cathodically protected and at the same intervals shown in Table 9-1 for cathodically protected piping.

- a. 5
- b. 10
- c. 25
- d. 50

155. The leak testing of buried piping should be for a period of _____ hours

- a. 4
- b. 8
- c. 12
- d. 24

156. The leak test for 8" diameter buried piping system is 300 psi. After 7 hours, the pressure reacts 273 psi. What should the inspector do?

- a. Nothing is required. The loss of pressure is negligible and will not affect the test. The loss can be disregarded.
- b. The system should be re-pressurized to the original leak test pressure and the test should begin again.
- c. The test chart and the temperature should be reviewed to determine if any change in temperature caused the pressure drop.
- d. The piping should be visually inspected externally and / or inspected internally to find the leak and assess the extent of corrosion.

157. A buried piping system that is not cathodically protected has to have an inspection interval set. The soil resistivity is checked and found to be 3400 ohm/cm. As the inspector, what interval would you set?

- a. 2.5 years
- b. 7.5 years
- c. 5 years
- d. 10 years

158. Buried piping also may be surveyed for integrity by removing the line from service and performing a leak test. This inspection method typically involves pressuring the line with a _____ allowing time for the _____ to diffuse to the surface and surveying the buried line with a gas specific detector to detect the _____.

- a. Tracer gas (such as helium or sulphur hexafluoride)
- b. Light hydrocarbon (such as butane)
- c. Smoke type material (such as chemical smoke)
- d. Water vapor (such as steam)

159. **Repairs to coating on buried piping may be tested using**
- A low voltage holiday detector
 - Light taps with an inspection hammer
 - A flaw indicator fluid
 - A high-voltage holiday detector
160. **If buried piping leaks are clamped and reburied:**
- No further action is required unless the piping leaks again
 - The date of installation shall be marked on the clamp for future identification
 - A record of the location and the date of installation shall be maintained
 - The clamped line shall be leak tested
161. **A 10" diameter piping system with 4" diameter 6" and diameter reinforced branch connection is to have changes made to it. Which of the following is considered an alteration?**
- A new 1" diameter un-reinforced nipple is installed
 - A new 8" diameter reinforced branch connection is installed
 - A new 4" diameter reinforced branch connection is installed
 - A new 3" diameter reinforced branch connection is installed
- Below 2" – so no, they existing branch is 4" and 6" so alteration is for only above 6 in
162. **Which of the following would not be classified as an applicable code to which a piping system was built?**
- ASME B 31.3
 - ASME B31.1
 - ASME B31.1-1955, Section 3
 - ASME A-20
163. **Which of the inspection agencies listed below is NOT an *Authorised Inspection Agency* as defined in API 570?**
- Jurisdictional inspection organization
 - Owner-user inspection organization
 - ASTM inspection organization
 - Independent inspection organization
164. **An authorised piping inspector is an employee of an authorised inspection agency who is qualified to perform the functions specified in API 570. Which individual listed is NOT usually an *authorized piping inspector*?**
- An owner-user inspector
 - A jurisdictional inspector
 - An NDE examiner
 - An insurance inspector

165. Which of the following qualifies as auxiliary piping?

- a. control valve manifolds
- b. bypass lines around exchangers
- c. pump seal oil lines, drains, vents, flush lines, analyzer lines
- d. orifice runs

Definition of auxiliary pipe it is a small bore secondary process piping that can be isolated from the primary process piping example. Seal oil line, flush lines, analyzer lines, balance lines, buffer gas lines, drains, vents, instruments and machinery piping lines. But control valve piping does not come in this category

Secondary process piping – small bore piping (less than 2” down stream of normally closed block valves

166. CUI stands for:

- a. Control unit inspector
- b. Corrosion under insulation
- c. Corrected unobtrusive inserts
- d. Corroded underground installation

167. Dead legs leg of a piping system are:

- a. The upstream piping of a control valve manifolds
- b. Supports attached to a pipeline that has no product in them
- c. The upstream part of an orifice runs
- d. Section that normally have no significant flow

168. A defect is an imperfection of a type or magnitude exceeding the _____ criteria

- a. Non-specific
- b. Imprecise
- c. General
- d. Acceptable

169. The design temperature of a piping system component is the temperature at which under the coincident pressure, the _____ is required.

- a. smallest thickness or highest component rating
- b. greatest thickness or highest component rating
- c. maximum thickness or lowest component rating
- d. minimum thickness or minimum component rating

Design temperature is the temperature at a particular pressure for highest thickness and highest component rating.

170. An examiner is a person who _____ the inspector

- a. Supplants
- b. Assists
- c. Supervises
- d. Directs

- a. PWHT required
- b. Required inspection
- c. RT required
- d. Ultra sonic testing

172. What is imperfection?

- a. It is a flaw or discontinuity noted during inspection that may be subject to acceptance criteria.
- b. It is a defect noted during inspection that is unacceptable
- c. It is a weld flaw noted during an inspection that may be subject to repair
- d. It is a blemish that is only cosmetic and acceptable under all condition

173. _____ is a response or evidence resulting from the application of a non-destructive evaluation technique.

- a. Indication
- b. Imperfection
- c. Breach
- d. Division

174. What are points where chlorine is introduced in reformers, water is added in overhead systems, etc called?

- a. primary process points
- b. level bridle points
- c. injection points
- d. test points

175. What is the loss of ductility and notch toughness in susceptible low-alloy steels such as 1.25 and 2.5 Cr, due to prolonged exposure to high-temperature service called?

- a. Creep
- b. Temper embrittlement
- c. Incipient melting
- d. Graphitization

176. Secondary process piping is small-bore (less than or equal to _____) process piping downstream of normally closed block valves

- a. NPS $\frac{3}{4}$
- b. NPS 1
- c. NPS 2
- d. NPS 3

- 177. A test point is an area defined by a circle having a diameter not greater than _____ inches for a line diameter not exceeding 10 inches or not greater than _____ inches for larger lines.**
- a. 3,4
 - b. 2,3
 - c. 1,2
 - d. $\frac{3}{4}$, 1
- 178. When making repair utilizing a welded full encirclement repair sleeve material is different from the pipe material, you should**
- a. Consult the piping engineer
 - b. Use a weld rod matching the higher strength material
 - c. Use a weld rod matching the lower strength material
 - d. Use an alloy weld rod such as Inco-A
- 179. What type of electrode should be used when welding a full encirclement repair sleeve?**
- a. Low-hydrogen electrode
 - b. Low-phosphorous electrode
 - c. Low-chrome electrode
 - d. Low-nitrogen electrode
- 180. Which of the following welding electrodes is low-hydrogen?**
- a. E6010
 - b. E7016
 - c. E7011
 - d. E7014
- 181. When welding a small repair patch, the diameter of the electrode used should not exceed:**
- a. $\frac{1}{8}$ "
 - b. $\frac{3}{16}$ "
 - c. $\frac{5}{32}$ "
 - d. $\frac{1}{4}$ "

ANSWER KEY

Q.NO.	ANS	REFERENCE	Q.NO.	ANS	REFERENCE
1	C	API 570,1.1.1	41	A	API 570,5.3.12
2	B	API 570,1.1.2	42	D	API 570, 5.4
3	A	API 570,1.1.3	43	C	API 570,5.4.1
4	B	API 570,1.2.1	44	C	API 570, 5.4.1
5	B	API 570,1.2.1	45	B	API 570,5.4.2
6	B	API 570,4.3.4	46	B	API 570,5.4.2
7	B	API 570,4.1	47	A	API 570,5.4.3
8	A	API 570,A.2.1	48	B	API 570,5.4.3
9	D	API 570,5.1	49	A	API 570,5.4.3
10	D	API 570,5.1	50	D	API 570,5.4.5
11	A	API 570,5.3	51	B	API 570,5.5.1
12	B	API 570,5.3.1	52	B	API 570,5.5.2
13	C	API 570,5.3.1	53	C	API 570,5.5.2
14	A	API 570,5.3.1	54	C	API 570,5.5.2
15	B	API 570,5.3.1	55	C	API 570,5.5.2
16	A	API 570,5.3.1	56	B	API 570,5.5.3
17	C	API 570,5.3.1	57	A	API 570,5.5.3
18	C	API 570,5.3.2	58	B	API 570,5.5.3
19	C	API 570,5.3.2	59	C	API 570,5.5.3
20	D	API 570,5.3.2	60	C	API 570,5.5.3
21	C	API 570, 5.3.3	61	B	API 570,5.6
22	C	API 570,5.3.3	62	D	API 570,5.6
23	D	API 570,5.3.3.1	63	A	API 570,5.6
24	C	API 570,5.3.3.2	64	D	API 570, 5.6
25	B	API 570,5.3.4	65	A	API 570,5.7
26	D	API 570,5.3.4	66	A	API 570,5.7
27	B	API 570,5.3.5	67	C	API 570,5.7
28	B	API 570,5.3.6	68	D	API 570,5.7
29	A	API 570,5.3.6	69	D	API 570,5.7
30	C	API 570,5.3.7	70	B	API 570,5.7
31	D	API 570,5.3.7	71	C	API 570,5.7
32	A	API 570,5.3	72	D	API 570,5.7
33	D	API 570,5.3.8	73	C	API 570,5.7
34	A	API 570,5.3.8	74	A	API 570,5.8
35	C	API 570,5.3.9	75	D	API 570,5.9
36	B	API 570,5.3.9	76	C	API 570,5.10
37	B	API 570,5.3.9	77	B	API 570,5.10
38	A	API 570,5.3.10	78	D	API 570,5.10
39	B	API 570,5.3.10	79	B	API 570,5.11
40	B	API 570,5.3.11	80	C	API 570,5.11

81	C	API 570,5.11	116	A	API 570,8.1.3.1
82	B	API 570,6.2	117	C	API 570,8.1.3.1
82(1)	A	API 570,6.1	118	D	API 570,8.1.3.2
82(2)	C	API 570,6.1	119	D	API 570,8.1.4
82(3)	A	API 570,6.1	120	B	API 570,8.1.4
83	D	API 570,6.1.1	121	C	API 570,8.1.4
84	D	API 570, 6.1.2	122	D	API 570,8.2
85	B	API 570,6.2.3	123	C	API 570,8.2
86	B	API 570,6.3	124	A	API 570,8.2.1
87	B	API 570,6.3	125	D	API 570,8.2.1
88	A	API 570,6.4	126	C	API 570,8.2.2.1
89	A	API 570,6.4	127	B	API 570, 8.2.2.1
90	C	API 570,6.3	128	D	API 570,8.2.3
91	D	API 570,6.4	129	B	API 570,8.2.3
92	C	API 570,6.5.1	130	C	API 570,8.2.3
93	B	API 570,6.5.2	131	C	API 570,8.2.3
94	A	API 570,6.6.3	132	B	API 570,8.2.4
95	A	API 570,7.1.1	133	D	API 570,8.2.5
96	A	API 570,7.1.1	134	D	API 570,8.2.6
97	C	API 570,7.1.1	135	B	API 570,8.2.6
98	B	API 570,7.1.2	136	B	API 570,8.2.6
99	C	API 570,7.1.3	137	B	API 570,8.2.6
100	A	API 570,7.2	138	A	API 570,8.2.6
101	B	API 570,7.3	139	A	API 570,8.3
102	B	API 570,7.4	140	C	API 570,Section 9
103	B	API 570,7.4	141	B	API 570,9.1.1
104	C	API 570, 7.5	142	C	API 570,9.1.2
105	C	API 570,7.6	143	B	API 570,9.1.3
106	B	API 570,7.6	144	A	API 570,9.1.5
107	A	API 570,8.1	145	A	API 570,9.1.6
108	B	API 570,8.1.1	146	B	API 570,9.2.1
109	C	API 570,8.1.1	147	C	API 570, 9.2.2
110	C	API 570,8.1.1	148	B	API 570,9.2.3
111	B	API 570,8.1.1	149	C	API 570,9.2.4
112	D	API 570,8.1.2	150	A	API 570,9.2.5
113	A	API 570,8.1.2	151	C	API 570,9.2.6
114	C	API 570,8.1.2	152	D	API 570,9.2.6
115	D	API 570,8.1.3.1	153	D	API 570,9.2.6

Q.NO.	ANS	REFERENCE	Q.NO.	ANS	REFERENCE
154	B	API 570,9.2.7	171	B	API 570,3.13
155	B	API 570, 9.2.7	172	A	API 570,3.14
156	D	API 570,9.2.7	173	A	API 570,3.15
157	D	API 570,9.2.7	174	C	API 570,3.16
158	A	API 570,9.2.7	175	B	API 570, 3.44
159	D	API 570,9.3.1	176	C	API 570, 3.40
160	C	API 570,9.3.2 & 9.4	177	B	API 570, 3.46
161	B	API 570,3.1	178	A	API 570,Appendix C
162	D	API 570,3.3	179	A	API 570, Appendix C
163	C	API 570,3.4	180	B	API 570, Appendix C
164	C	API 570,3.5	181	C	API 570, Appendix C
165	C	API 570,3.6			
166	B	API 570,3.8			
167	D	API 570,3.9			
168	D	API 570,3.10			
169	B	API 570,3.11			
170	B	API 570,3.12			

DAY 1- API 570 OPEN BOOK QB

- 1. The following data is presented for a class 2 pipe,**
Thickness = 0.36 inch (after inspection)
Corrosion rate = 10 mpy
Remaining life = 16 years

When is the next thickness measurement inspection due?

- a. After 8 years
 - b. After 5 years
 - c. After 10 years
 - d. None of the above
- 2. Please calculate remaining corrosion allowance for piping in Question 1 above.**
- a. 0.20 inch
 - b. 0.28 inch
 - c. 0.12 inch
 - d. 0.16 inch
- 3. When will be the next inspection schedule from now on for external inspection for pipe in Q.1?**
- a. 10 years
 - b. 8 years
 - c. 5 years
 - d. none of the above
- 4. The pipe in Q.1 above has an insulated area of 200 sq. ft., which is exposed to susceptible temperature and mist spray of cooling tower. According to API 570, how much of minimum area is recommended for NDT survey for CUI during external inspection?**
- a. 100 square feet
 - b. 50 square feet
 - c. 66 square feet
 - d. 50 square feet
- 5. For piping buried in soil with resistivity of 5000-ohm cm and not cathodically protected, evaluations of pipe thickness should be performed at:**
- a. 10 year interval
 - b. 5 year interval
 - c. 3 year interval
 - d. None of the above

- 6. For a certain Natural gas piping system, which is in operation for 16 years, it is estimated that it has remaining life of 12 years. Considering the stipulation of API 570, which of the following will determine maximum interval for next proposed date for thickness measurement examination and visual examination?**
- 6 years and 5 years respectively
 - 3 years and 10 years respectively
 - 10 years and 5 years respectively
 - 6 years and 6 years respectively
- 7. The document referenced in API 570 for determining “fitness for service” of piping system is:**
- API 579
 - API 574
 - ASME B 31.1
 - None of the above
- 8. Actual thickness measured at a TML was 0.4 inch. The corrosion rate is 10 mpy. If next planned thickness inspection is after 6 years, what thickness will be used for MAWP calculation?**
- 0.4 inch
 - 0.34 inch
 - 0.28 inch
 - None of the above
- 9. For external inspections for potential corrosion under insulation (CUI) on Class 1 systems, the examination should include at least _____ percent of all suspect areas and _____ percent of all areas of damaged insulation:**
- 50, 75
 - 50, 33
 - 75, 50
 - 25, 10
- 10. For Class 2 piping, the extent of CUI inspections on a system operating at – 45°F will be (as a minimum) of:**
- 75 % of damaged areas, 50 % of suspect areas
 - 50 % of suspect areas, 33 % of damaged areas
 - 33 % damaged areas, 50 % of suspect areas
 - None of the above

11. Which of the following fluid services or classes of piping are excluded from the specific requirements of API 570?

- a. Hazardous fluid services below threshold limits defined by jurisdictional requirements
- b. Piping or tubing with an outside diameter not exceeding that of NPS 1½"
- c. Non-metallic piping and polymeric or glass-lined piping
- d. All of the above

12. The recommended downstream limit of circuit of an injection point is a minimum of:

- a. Second change in flow direction past the injection point, or 25 feet beyond the first change in flow direction whichever is less
- b. Second change in flow direction past the injection point, or 25 feet beyond the first change in flow direction whichever is greater
- c. Second change in flow direction past the injection point, or 25 inches beyond the first change in flow direction whichever is less
- d. Second change in flow direction past the injection point, or 25 inches beyond the first change in flow direction whichever is greater

13.5.9 As per API 570, in case of normal uniform corrosion, compared to other piping. The thickness measurements on valves:

- a. Must be routinely taken at same frequency while inspecting, other piping components as valve thickness is less than other piping components
- b. Must be routinely taken at twice the frequency as other piping components as valves are very critical components and essential for reliable operation.
- c. Are not routinely taken unless unusual corrosion pattern and thinning is observed during servicing and repair.
- d. Are routinely at twice the frequency of other components because valves are more expensive items compared to rest of the piping and must be more frequently checked.

14. An eight-inch diameter piping system is installed in December 1979. The installed thickness is measured as 0.34". The minimum thickness of the pipe is 0.20". It is inspected in Dec/83 and the thickness is found to be 0.32". An inspection Dec/87 reveals a loss of 0.01" from the 12/85 inspection was during Dec/89 the thickness was found to be 0.29". The last inspection was during Dec/95 and the thickness was found to be 0.26". What is the long-term corrosion rate of this system?

- a. 0.005"/year
- b. 0.0075"/year
- c. 0.00375"/year
- d. 0.0025"/year

15. Using the information in question above, calculate the short-term corrosion rate.

- a. 0.005" / year
- b. 0.0075" / year
- c. 0.00375" / year
- d. 0.0025" / year

16. Using the short-term corrosion rate in questions above, determine the remaining life of the system.

- a. 18 years
- b. 15 years
- c. 12 years
- d. None of the above

17.8.2.2.1 Preheating to not less than _____ degrees F may be considered as an alternative to post weld heat treatment for alterations or repairs of P-1, piping initially post weld heat treated as a code requirement (may not be used if the piping was post weld heat treated due to environmental cracking prevention)

- a. 150
- b. 200
- c. 300
- d. 350

18. If an "intelligent pigging" system is used to inspect buried piping, what type of bends is usually required in the piping system?

- a. Five diameter bends
- b. 90 degree pipe ells
- c. Ten diameter bends
- d. Three diameter bends

19. How often should poorly coated pipes with inconsistent cathodic protection potentials have a pipe-to-soil potential survey made?

- a. Yearly
- b. Every 2 years
- c. Every 5 years
- d. Every 7 years

20. Buried piping inspected periodically by excavation shall be inspected in lengths of _____ feet at one or more location judged to be most susceptible to corrosion.

- a. 2 to 4
- b. 4 to 6
- c. 6 to 8
- d. 8 to 10

21. A buried piping system that is not cathodically protected has to have an inspection interval set. The soil resistivity is checked and found to be 3400 ohm/cm. As the inspector, what interval would you set?

- a. 2.5 years
- b. 7.5 years
- c. 5 years
- d. 10 years

22. Determine the MAWP of the following piping system, at the next inspection, based on the following (ref table 7.1)

Design Pressure/Temperature	100 psig/100°F
Pipe description:	NPS 2, S/80 A 106-B
Outside diameter of pipe, D:	2.375 in.
Thickness determined from inspection:	.190 in.
Observed corrosion rate:	.03 in/year
Next planned inspection:	5 years

MAWP = _____

- a. 674 psig
- b. 323 psig
- c. 125 psig
- d. Metal loss exceeds the requirements for 5 year inspection interval

23. A leak test is an alternative to inspection of buried piping. What is the minimum liquid pressure to adequately conduct this test? 9.2.7

- a. 1 ½ times the MAWP
- b. 1 ¼ times the MAWP
- c. 10% greater than MAWP
- d. Actual MAWP

24. What is the inspection interval for buried piping without cathodic protection, if the soil resistivity is 6,500 ohm-cm?

- a. 10 years
- b. 15 years
- c. 5 years
- d. Whenever a leak is suspected

25. A piping system that operates at a design pressure of 100 psi at 950°F was originally built from NPS 20 EFW (100% radiographed), ½ inch wall, A-516 Grade 70, A-671 material. During the last inspection, the thickness was determined to be .370 inches. The records indicated the corrosion rate to be .009 inches per year. What is the MAWP if the next inspection is planned in 5 years?

- a. 126 psi
- b. 285.17 psi
- c. 98.23 psi
- d. Not enough information given

DAY 1- API 570 OPEN BOOK QB**ANSWER**

Q.NO.	ANS	Code
1	A	6.1
2	D	7.1.1& 6.1
3	C	6.1
4	C	6.2
5	A	9.1
6	A	6.1
7	A	Sec2
8	C	7.1
9	A	6.2
10	D	6.2
11	D	1.2.2
12	A	5.3.1
13	C	5.9
14	A	7.1.1
15	A	7.1.1
16	C	7.1.1
17	C	8.2.2.1
18	A	9.1.6.a
19	C	9.2.2
20	C	9.2.6 3 rd para
21	D	9.1
22	D	7.1
23	C	9.2.7
24	A	9.1
25	A	7.1

API- 570

PIPING INSPECTION CODE, INS, REPAIR, ALTERATION & RERATING OF INSPECTION

- API new edition may be used beginning with the date of issuing but it be comes immediately after six month from the date of issuance.
- During the six months time, uses shall specify to which addition, agenda the equipment is to be rerated & inspected.
- For 31.3 the above requirement is applicable unless a specific agreement between contracts parties to use another addition or agenda.
- API-570 is applicable for repair, alteration and re rating of **METALIC PIPING** that are **IN INSERVICE.**
- It is developed for petroleum refining & chemical process industries, may be used where practical for other piping system.
- It is intended for use by organizations that maintain Inspection department, repair capabilities, qualified Piping Engineer, Inspector & Examiners.
- It shall not be used as a substitute for the original construction requirements governing a piping system before it is placed in service.
- Fluid service like water (including fire protection system) steam, steam-condensate, Boiler feed water & category 'D' fluid service are **EXCLUDED** from API 570.
- Following class of piping system are excluded :
 - Piping on Truck,barg, other mobile equipment (movable structure)
 - Piping on pump, compressors, turbines, generators, Engine & Hydraulic or Pneumatic cylinder (Integral part of component)
 - Internal piping of fired heaters boilers, tubes, tube header.
 - Internal piping & External connection of pressure vessels etc.
 - Plumbing, sanitary sources, process work server, storm sources.
 - Piping or tubing outside water that of NPS 1/2" (<1/2").
 - Non metallic piping, polymeric or glass line piping.
- API-RP-579- Fitness for service (provide generate requirements and detailed assessment procedure for specific types of degradation.
- Publ 2201- Hot-tapping procedure.
- API-RP-574- Inspection of piping system components.
- API-RP-578- Material verification program.
- Authorized Inspection Agencies :
 - Owner or User
 - Contractor to owner.
 - Govt Jurisdiction.
 - Govt approved agency
 - Insurance.
- Auxiliary piping- Instrument & machinery piping like small bore piping ex: Flush line, Seal oil lines, analyzer line, drain 7 vents etc.

- Dead legs- no significant flow – spare pump piping, control valve by pass lines, level bridle, relief valve inlet & outlet, height point vents, sample points, drains, bleeders, instrument connections.
- Hold point- work may not proceed until inspection done.
- Injection point: Locations where two process stream joining are not considered as injection point (Mixing Tees).
Example of Injection points: Chlorine in re-formers, Polysulfide in Catalytic cracking wet gas, Antifoam injections, and Inhibitors neutralizers.
- NPS; Nominal pipe size, specific size designation without an inch symbol.
- Piping circuit: Section of piping that has all points exposed to an environment of similar corrosivity, design condition & Construction material.
- Piping system; Assembly of interconnected piping that is subjected to the same set of design condition.
- Primary process piping: In normal active service that can not be isolated greater than 2" NPS.
- Rerating: A change in design temp or MAWP of piping system may consists of an increase, decrease or a combination of both Derating below original design condition is a means to provide increased corrosion allowance.
- Soil to air (S/A) Interface: Corrosion will vary depending on factors such as moisture, oxygen content in the soil & operating temp. Zone in 6" above 12" below the soil 6/12.
- Temperature embrittlement: Loss of ductility & notch toughness in low alloy steels **(1¼ Cr 2¼ Cr)** due to prolonged exposure to high temp service **(370°- 575°C)**.
- Test point: Area defined by circle **2"dia upto 10" pipe line, 3" dia above 10" pipe line.**
- Material verification program: Procedure used to assess metallic alloy materials.
- PMI Testing: physical evaluation or test of material.

Section A

- Authorized Inspector Duties:
- Determine that the requirements of API 570 on inspection, examination & testing are met.
- Directly involved in the inspection activities.
- All examination results shall be evaluated & accepted by the Authorized Inspection.

Appendix A

INSPECTOR CERTIFICATION:

- Examination shall be based on the current API body of knowledge.
- Education + Experience requirement in addition to exam.
 - BS degree + One year experience = Inspection Exp.
 - 2 years Diploma + 2 years experience = 1 year Inspection Exp.
 - High school + 3 years experience = 1 year Inspection Exp.
 - No Qualification + 5 years experience = 1 year Inspection Exp.
- Certification is valid for 3 years.
- Recertification every 3 years, by written test if inspector is not activity engaged as AI.
- Activity engaged as an AI shall be defined as a minimum 20% of time spent performing or supervising inspection activities during 3 years certification period.

Section 5

- **Risk based Inspection:** Combining the assessment like wood of failure and the consequence of failure are the essential elements of **RBI**.
- **Assessment includes:** Check material, design condition relative operating condition, design codes & standard used, effectiveness of corrosion monitoring, quality of maintenance & **QA/QC** programs, equipment failure data & Information.
- **Consequences includes:** Potential incident that may occur as a result failure like-explosion, fire, toxic exposures, environment impact, health effects.
- **Preparation:** Isolation, **PTW, PPE, NDE** equipment are safe to use, Review history of individual piping system.
- **Injection points:** Considered separate inspection circuits. Injection point circuit is Upstream: **12" or 3 pipe** diameter whichever is greater
Downstream: Second change in flow direction or **25 feet (7.6m)** whichever is less.
- **TML Location**
 - On fittings
 - Impingement location
 - On longest straight pipe
 - At up stream & down stream limit
- Preferred method of inspection is RT or UT
- During periodic inspection extensive inspection
Up stream 12", Down stream 10 pipe diameter
- Dead leg: Hot piping system → high part area more corrosive due to convection current set up in the dead leg.
- CUI: sources of moisture → rain, water leaks, condensation and deluge system
- C.S – localized corrosion, SS → chloride test corrosion crack
- Warmer marine location requires extensive inspection program

- C.S piping normally in-service > than 250°F but intermitted
- SS piping operating between 150°F to 400°F
- C.S piping above 250°F no problems of CUI
- SS piping below 150°F and above 400°F no problem of CUI
- Soil to air interface (S/A): if buried piping uncoated at the grade, consideration should be given to excavating 6" to 12" (150 mm to 350mm) deep.
- Erosion can be characterizes by grooves, rounded holes, waves and valleys in a directional pattern. It usually occurs in areas of turbulent flow → change of flow direction, control valve down stream where vaporization occurs.
- Due to high velocity flowing of solid or liquid will increase erosion danger.
- Velocity sensitive system are hydro sulphide & Sulfuric Acid.
- Environment cracking: polythionic acid SCC of sanitized austenitic alloy steel, caustic in carbon steel amine SCC in piping not PWHT
- Corrosion under lining coating: separation, breaks, holes and blisters and noted, than lining should be remove
 - Bulging or separation in refractory lining is an indication of corrosion.
- Fatigue cracking: due to cyclic stress may be improved pressure, mechanical or thermal means, low cycle fatigue – heat up or cold down, high cycle – vibration
- Creep cracking: It is depended on time, temperature and stress brittle fracture: C.S., low alloy and ferritic steel, are susceptible to brittle failure. It is not an concern with relatively thin wall piping. Special attention to low alloy steel (2¼" CR – 1 Mo material) there are prone to temper embrittlement
- Freeze damage
- Thickness measurement method → pipe larger than PMS 1" – UT is preferred less than 1 PMS preferred When UT is surface 150°F should be careful

Frequency and extends of inspection

- The frequency and extents of inspection depends on the form of degradation. It affect the piping and consequence of the piping failure
- Recommended maximum intervals are given in table 6-1 should not be increase when RBI assessment is made
- Class – 1 piping: Immediate emergency of a leak occurs.
 - Flammable services
 - Pressurized services that may rapidly vaporize
 - Hydrogen sulphide (H₂S) greater than 3% in a gaseous stream
 - Anhydrous hydrogen chloride
 - Hydrofluoric acid
 - Piping through public through ways and over water
- Class – 2: majority of unit process piping and selected off site piping
 - Hydrocarbons that will slowly vaporize
 - Hydrogen, fuel gas and natural gas
 - Strong acid and caustics (on site)

- Hydrogen that will not significantly vaporize
- Distillate and product line
- Offsite acids and caustics.
-

(Table – 6-1)

Max Inspection Intervals

<u>CLASS</u>	<u>THK INSP</u>	<u>EXT VISUAL</u>
1	5	5
2	10	5
3	10	10
Injection Point	3	by class
S/A Interface		by class

CUT Inspection EXTENT

<u>CLASS</u>	NDE Follow up or INSUL Removal at a damaged areas	NDE AT Surface area piping with succceptable temp
1	75%	50%
2	50%	33%
3	20%	10%

Section - 7

Remaining life calculation:

$$RL = \text{tact} - \text{treq} / \text{C.R (mm/year)}$$

$$= \text{Remaining CA} / \text{C.R}$$

$$\text{C.R (LT)} = \text{t initial} - \text{t actual} / \text{Year between ti \& ta}$$

$$\text{C.R (ST)} = \text{t prev} - \text{t actual} / \text{Year between tp – ta}$$

$$\text{C.R} = \text{Metal loss over a period} / \text{Periods in years.}$$

Where

tact = actual thickness at the time of inspection

treq = required thickness computed by the design formula before C.A & Manu fact tolerance adds.

When MAWP is recalculated the max thickness to be considers is : actual thickness minimum twice the estimated corrosion loss before the date of inspection.

Section – 8

- The principles of the ASME B31.3 or code of construction shall be followed for repair & alterations.
- Authorization for alteration work shall be given after consultation & approved by the piping Engineer.
- Inspector will designate hold points required during repair & alternation work.
- Inspector may give general authorization for limited or sportive repair.
- All proposed method of design, execution etc must be approved by Inspector or piping Engineer as appropriate.
- Welding repairs of cracks occurred during in-service should be attempted in consultation with piping Engineer.
- Inspector shall approve all repair & alternation work at designated hold points & after completion.

Temporary repair:

- Longitudinal cracks shall not be repaired using temporary repair methods, such as fuel encirclement welded split sleeves. But with the approved of the Pipe engineer, it can be done.
- If the repair area is localized (pitting or pin holes) & SMYS is not more than 40,000 Psi, repair may be made by fillet welding with split coupling or patch plate.
- Patch plate should not exceed $\frac{1}{2}$ the pipe diameter and 1" (25mm) minimum radius shall be given.
- For minor leaks properly designed enclosure may be welded over the leak while piping systems in-service.
- Temporary repair shall be replaced, but can remain in place for a longer period, if approved by Piping Engineer.

Permanent Repair :

- Corroded areas may be restored with metal deposit.
- Defective area may be removed by cutting a cylindrical section and replacing it with new piece.
- Insert patcher (flush patch) may be used to damaged or corroded area with some condition.
 - Full penetration groove weld
 - Class, 1 x 2 100% RT or UT for welds
 - Patch shall have 1" radius rounded corner
- Non-welding repair for locally thinned sections or circumferential linear defects by bolted leak clamp.
 - Leak sealing fluids (pumping) should be compatible with process piping – accepted by Inspector or piping engineer.
- API publication 2201 - hot tapping procedure and welding "suggested Hot tapping check list" contained in API publication 2201 shall be used.

- Welding, welder qualification, welding procedure shall be as per ASME B31.3 preheating to 300°F may be considered for the alteration and repaired building. This will be applicable only when PWHT is code requirement. This is not applicable if PWHT is a service requirement.
- The above is applicable to P1 and P3 (with explanation of Mn – Mo Steel)
- After welding the joint should immediately be covered with insulation of slow cooling rate.
- Pressure test is normally required after alternation or repair. When it is not necessary of Practical NDE shall be utilized in lieu of pressure test.

Section 9: Buried Piping

- Indications of leaks in Buried piping → change in the surface contour of the ground, discoloration of the soil softening of paving asphalt, poor formation, bubbling water puddle, noticeable odor.
- Above grade visual surveillance - Every 6 months.
- Close – Interval potential survey - Every 5 years
- Lower soil resistivity is more corrosive
- Measurement of soil resistivity → Wenner four pin method as per ASTM - G57, the soild bar (a-c bridges), the soil box.
- API RP 651 for inspecting and maintaining cathodic protection system for buried piping.
- Pigging will give the wall thickness measurement.
- By excavation pipe length 6 feet – 8 feet should be inspected.

Frequency of Inspection of buried piping without effective cathodic protection (by excavation)

Soil Resistivity (ohm-em)	Insp. Intervals (years)
< 2000	5
2000 to 10000	10
> 10000	15

- Leak testing an alterative or supplement to inspection
 - Pressure 10% higher than maximum operating pressure in the above table
 - ½ the length of period interval for piping not cathodically protected
 - Same interval for piping cathodically protected
 - Leak test shall be maintained for 8 hours
 - 4 hours after initial pressurization, the pressure should be noted and if necessary increase up to original test pressure, isolate the line from pressure. During remaining 4 hours period pressure decreases more than 5%, the pipe external visually or internally should be checked further.
- Other alternative leak testing methods are acoustic emission examination, addition of tracer fluids such as helium or sulfur hexafluoride to the pressurized line.

API 570 QUESTIONS
ALL QUESTIONS ARE CLOSED BOOK

- 1) API 570 covers inspection, repair alteration, and re-rating procedures for metallic piping systems that _____.
 - a) Are being fabricated.
 - b) Does not fall under ASTM B31.3
 - c) Have been in-service.**
 - d) Has not been tested.
- 2) API 570 was developed for the petroleum refining and chemical process industries.
 - a) It shall be used for all piping systems.
 - b) It may be used, where practical, for any piping system.**
 - c) It can be used, where necessary, for steam piping.
 - d) It may not be used unless agreed to by all parties.
- 3) API 570 _____ be used as a substitute for the original construction requirements governing a piping system before it is placed in-service.
 - a) Shall not**
 - b) should
 - c) may
 - d) can
- 4) API 570 applies to piping systems for process fluids, hydrocarbons, and similar flammable or toxic fluid services. Which of the following services is not specifically applicable?
 - a) Raw, intermediate, and finished petroleum products
 - b) Water, steam condensate, boiler feed water**
 - c) Raw, intermediate, and finished chemical products
 - d) Hydrogen, natural gas, fuel gas, and flare systems
- 5) Some of the classes of piping systems that are excluded or optional for coverage under API 570 are listed below. Which one is a mandatory included class?
 - a) Water
 - b) Catalyst lines**
 - c) Steam
 - d) Boiler feed water
- 6) The _____ shall be responsible to the owner-user for determining that the requirements of API 570 for inspection, examination, and testing are met.
 - a) Piping Engineer
 - b) Inspector**
 - c) Repair Organization
 - d) Operating Personnel
- 7) Who is responsible for the control of piping system inspection programs, inspection frequencies and maintenance of piping?
 - a) Authorized Piping Inspector
 - b) Owner-user**
 - c) Jurisdiction
 - d) Contractor
- 8) An authorized piping inspector shall have the following qualifications. Pick the one that does not belong in this list:-
 - a) Four years of experience inspecting in-service piping systems**
 - b) High school education plus 3 years of experience in the design, construction, repair, operation, or inspection of piping systems
 - c) Two year certificate in engineering or technology plus 2 years of experience in the design, construction, repair, operation, or inspection of piping systems.
 - d) Degree in engineering plus one year experience in the design, construction, repair, operation, or inspection of piping systems.

- 9) Risk based inspections include which of the following:-
- a) Likelihood assessment
 - b) Consequence analysis
 - c) Operating and inspection histories
 - d) All of the above**
- 10) An RBI assessment can be used to alter the inspection strategy provided:-
- a) The degradation methods are identified
 - b) The RBI is fully documented.
 - c) A third party conducts the RBI
 - d) Both A and B above**
- 11) Which one of the following is not a specific type of an area of deterioration?
- a) Rectifier performance**
 - b) Injection points
 - c) Dead legs
 - d) Environmental cracking
- 12) Injection points subject to accelerated or localized corrosion may be treated as _____
- a) The focal point of an inspection circuit
 - b) Separate inspection circuits
 - c) Piping that must be renewed on a regular schedule
 - d) Locations where corrosion inhibitors must be used
- 13) The recommended upstream limit of inspection of an injection point is a minimum of
- a) 12 feet or 3 pipe lengths whichever is smaller
 - b) 12 inches or 3 pipe diameters whichever is smaller
 - c) 12 inches or 3 pipe diameters whichever is greater**
 - d) 12 feet or 3 pipe lengths which is greater
- 14)** The recommended downstream limit of inspection of an injection point is a minimum of
- a) Second change in flow direction past the injection point, or 25 feet beyond the first change in flow direction whichever is less**
 - b) Second change in flow direction past the injection point, or 25 feet beyond the first change in flow direction whichever is greater
 - c) Second change in flow direction past the injection point, or 25 inches beyond the first change in flow direction whichever is less
 - d) Second change in flow direction past the injection point, or 25 inches beyond the first change in flow direction whichever is greater.
- 15)** Select thickness measurement locations (TMLs) within injection point circuits subjected to localized corrosion according to the following guidelines. Select the one that **does not** belong
- a) Establish TMLs on appropriate fittings within the injection point circuit
 - b) Establish at least one TML at a location at least 25 feet beyond the downstream limit of the injection point**
 - c) Establish TMLs on the pipe wall at location of expected pipe wall impingement or injected fluid
 - d) Establish TMLs at both the upstream and downstream limits of the injection point circuit.

- 16) What are the preferred methods of inspecting injection points?
- a) Radiography and / or ultrasonic's
 - b) Hammer test and / or radiograph
 - c) Ultrasonic's and / or liquid penetrant
 - d) Liquid penetrant and / or eddy current.
- 17) During periodic scheduled inspections, more extensive inspection should be applied to an area beginning _____ upstream of the injection nozzle and continuing for at least _____ pipe diameters downstream of the injection point.
- a) 10 inches, 20
 - b) 12 feet, 10
 - c) 12 inches, 10
 - d) 10 feet, 10
- 18) Why should dead legs in piping be inspected?
- a) API 510 mandates the inspection of dead legs
 - b) Acid products and debris build up in dead legs
 - c) The corrosion rate in dead legs can vary significantly from adjacent active piping.
 - d) Caustic products and debris build up in dead legs.
- 19) Both the stagnant end and the connection to an active line of a dead leg should be monitored. In a hot piping system, why does the high point of a dead leg corrode and need to be inspected?
- a) Corrosion occurs due to directed currents set up in the dead leg
 - b) Erosion occurs due to convective currents set up in the dead leg
 - c) Corrosion occurs due to convective currents set up in the dead leg
 - d) Erosion occurs due to directed currents ET up in the dead leg
- 20) What is the best thing to do with dead legs that are no longer in service?
- a) Ultrasonically inspect often.
 - b) Radiograph often
 - c) Inspect often
 - d) Remove them
- 21) What are the most common forms of corrosion under insulation (CUI)?
- a) Localized corrosion of non-ferrous metals and chloride stress corrosion cracking of carbon steel.
 - b) Localized corrosion of chrome-molly steel and chloride stress corrosion cracking of Ferritic stainless steel.
 - c) Localized corrosion of carbon steel and chloride stress corrosion cracking of austenitic stainless steel
 - d) Localized corrosion of nickel-silicon alloy and caustic stress corrosion of austenitic stainless steel
- 22) What climatic area may require a very active program for corrosion under insulation?
- a) Cooler northern continent locations.
 - b) Cooler direr, mid-continent locations
 - c) Warmer, marine locations
 - d) Warmer drier, desert locations
- 23) Certain areas and types of piping systems are potentially more susceptible to corrosion under insulation. Which of the items listed is not susceptible to CUI?

- a) Areas exposed to mist over-spray from cooling water towers.
 - b) Carbon steel piping systems that normally operate in-service above 250 degrees but are in intermittent service.
 - c) Dead legs and attachments that protrude from insulated piping and operate at a different temperature than the temperature of the active line.
 - d)** Carbon steel piping systems, operating between 250 degrees F and 600 degrees F.
- 24) What location is subject to corrosion under insulation and inspection contributes to it?
- a) Locations where pipe hangers and other supports exist.
 - b) Locations where insulator has been stripped to permit inspection of the piping.
 - c) Locations where insulation plugs have been removed to permit piping thickness measurements.
 - d)** Locations where there is damaged or missing insulation jacketing.
- 25)** Soil-to-air (S/A) interfaces for buried piping are a location where localized corrosion may take place. If the buried part is excavated for inspection, how deep should the excavation be to determine if there is hidden damage?
- A) 12 to 18 inches
 - b)** 6 to 12 inches
 - c) 12 to 24 inches
 - d) 6 to 18 inches
- 26) At concrete-to-air and asphalt-to-air interfaces of buried piping without cathodic protection, the inspector look for evidence that the caulking or seal at the interface has deteriorated and allowed moisture ingress. If such a condition exists on piping systems over _____ years old, it may be necessary to inspect for corrosion beneath the surface before resealing the joint.
- a) 8
 - b)** 5
 - c) 15
 - d) 10
- 27) An example of service-specific and localized corrosion is:-
- a) Corrosion under insulation in areas exposed to steam vents
 - b)** Unanticipated acid or caustic carryover from processes into non-alloyed piping
 - c) Corrosion in dead legs
 - d) Corrosion of underground piping at soil-to-air interface where it ingresses or egresses.
- 28) Erosion can be defined as:-
- a) Galvanic corrosion of a material where uniform losses occur
 - b)** Removal of surface material by action of numerous impacts of solid or liquid particles
 - c) Gradual loss of material by a corrosive medium acting uniformly on the material surface
 - d) Pitting on the surface of a material to the extent that a rough uniform loss occurs
- 29) A combination of corrosion and erosion results in significantly greater metal loss that can be expected from corrosion or erosion alone. This type of loss occurs at
- a)** high-velocity and high-turbulence areas
 - b) Areas where condensation or exposure to wet hydrogen sulphide or carbonates occur
 - c) Surface-to-air interfaces f buried piping
 - d) Areas where gradual loss of material occurs because of a corrosive medium
- 30) Environmental cracking of austenite stainless steels is caused many times by:-
- a) Exposing areas to high-velocity and high-turbulence streams
 - b) Excessive cyclic stresses those are often very low
 - c)** Exposure to chlorides from salt water, wash-up water, etc.

d) Creep of the material by long time exposure to high temperature and stress

- 31) When the inspector suspects or is advised that specific piping circuits may be susceptible to environmental cracking, the inspector should:-
- a) Call in a piping engineer for consultation
 - b) Investigate the history of the piping circuit
 - c) Obtain advice from a Metallurgical Engineer
 - d) Schedule supplemental inspections.**

32) If environmental cracking is detected during internal inspection of pressure vessels, what should the inspector do?

- a) The inspector should designate appropriate piping spools upstream and downstream of the vessel to be inspected if piping is susceptible to environmental cracking.**
- b) The inspector should consult with a metallurgical engineer to determine extent of the problems
- c) The inspector should review history of adjacent piping to determine if it has ever been affected.
- d) The inspector should consult with a piping engineer to determine the extent of the problems.

33) If external or internal coatings or refractory liners on a piping circuit are in good condition, what should an inspector do?

- a) After inspection, select a portion of the liner for removal
- b) The entire liner should be removed for inspection
- c) Selected portions of the liner should be removed for inspection
- d) After inspection, if any separation, breaks, holes or blisters are found, it may be necessary to remove portions of the lining to determine the condition under it.**

34) What course of action should be followed if a coating of coke is found on the interior of a large pipe of a reactor on a Fluid Catalytic Cracking Unit?

- a) Determine whether such deposits have active corrosion beneath them. If corrosion is present, thorough inspection in selected areas may be required.
- b) The coke deposits should be removed from the area for inspection.
- c) The coke deposits may be ignored – the deposits will probably protect the line from corrosion.
- d) Consult with a Process Engineer and a Metallurgist on the necessity of removing the coke deposits.

35) Fatigue cracking of piping systems may result from

- a) Embrittlement of the metal due to it operating below its transition temperature
- b) Erosion or corrosion / erosion that thin the piping where it cracks
- c) Excessive cyclic stresses that are often well below the static yield strength of the material**
- d) Environmental cracking caused by stress corrosion due to the presence of caustic, amine, or other substance.

36) Where can fatigue cracking typically be first detected?

- a) At points of low-stress intensification such as reinforced nozzles
- b) At points of high-stress intensification such as branch connections**
- c) At points where cyclic stresses are very low
- d) At points where there are only bending or compressive stresses.

- 37) What are the preferred NDE methods for detecting fatigue cracking?
- Eddy current testing ultrasonic A-scan testing, and / or possibly hammer testing
 - Liquid penetrant testing, magnetic particle testing and / or possibly acoustic emission testing.
 - Visual testing, eddy current testing and / or possibly ultrasonic testing
 - Acoustic emission testing, hydro-testing, and / or possibly ultrasonic testing.
- 38) Creep is dependent on:-
- Time, temperature, and stress
 - Material, product contained, and stress
 - Temperature, corrosive medium, and load
 - time, product contained and load
- 39) An example of where creep cracking has been experienced in the industry is in the problems experienced with cracking of 1.25 % Chrome steels operating at temperatures above _____ degrees F
- 500
 - 900
 - 1000
 - 1200
- 40) Brittle fracture can occur in carbon, low-alloy and other Ferritic steels at or below _____
- 140 degree
 - ambient
 - 100 degree
 - 30 degree
- 41) Water and aqueous solutions in piping systems may freeze and cause failure because of the
- Expansion of these materials;
 - contraction of these materials
 - Construction of these materials;
 - decrease of these materials
- 42) Different types of inspection and surveillance are appropriate depending on the circumstances and the piping system. Pick the one that does not belong in the following list:-
- Internal and external visual inspection
 - Thickness measurement inspection
 - Vibrating piping inspection
 - Chemical analysis inspection
- 43) Internal visual inspections are _____ on piping unless it is a large diameter transfer line, duct, catalyst line or other large diameter piping system.
- The most effective inspection
 - the most useful means of inspection
 - Not normally performed
 - The major means of inspection
- 44) Name an additional opportunity for a normal non-destructive internal inspection of piping
- When the piping fails and the interior is revealed
 - When maintenance asks for an internal inspection
 - When piping flanges are disconnected
 - When a fire occurs and the pipe is in the fire
- 45) Why is thickness measurement inspection performed?
- To satisfy jurisdictional requirements
 - To determine the internal condition and remaining thickness of the piping components
 - To determine the external condition and amount of deposits inside the piping
 - To satisfy heat transfer requirements of the piping

- 46) Who performs a thickness measurement inspection?
- a) The operator or control man
 - b) The inspector or examiner**
 - c) The maintenance workers or supervisor
 - d) The Jurisdiction or OSHA
- 47) When corrosion product build-up is noted during an external visual inspection at a pipe support contact area, lifting of such supports may be required for inspection. When doing this, care should be
- a) Exercised if the piping is in-service**
 - b) Used when determining the course of action
 - C) Practiced so as not to disturb the supports
 - d) Taken that a complete record of the problem is made
- 48) Qualified operating or maintenance personnel also may conduct external visual inspections when:-
- A) Satisfactory to the owner-user
 - b) Acceptable to the inspector**
 - c) Agreeable to the maintenance supervisor
 - d) Permissible to the operation supervisor
- 49) Who would normally report vibrating or swaying piping to engineering or inspection personnel?
- a) Operating personnel**
 - b) Maintenance personnel
 - c) Jurisdictional personnel
 - d) OSHA personnel
- 50) Thermographs are used to check for:-
- a) Vibrating sections of the piping system
 - b) Detecting localized corrosion in the piping system
 - c) Abnormal thermal expansion of piping systems
 - d) Hot spots in refractory lined piping systems**
- 51) Thickness measurement locations (TMLs) are specific _____ along the piping circuit where inspections are to be made
- a) Points
 - b) areas**
 - c) items
 - d) junctures
- 52) The minimum thickness at each TML can be located by
- a) Electromagnetic techniques
 - b) Ultrasonic scanning or radiography**
 - c) Hammer testing
 - d) MT and / or PT
- 53) Where appropriate, thickness measurements should include measurements at each of _____ on pipe and fittings
- a) Two quadrants
 - b) three locations
 - c) Four quadrants**
 - d) six points
- 54) Where should special attention is placed when taking thickness measurements of an elbow?
- a) The outlet end;
 - b) the inlet end
 - c) The inside and outside radius**
 - d) the sides

- 55) TMLs should be marked on inspection drawings and _____ to allow repetitive measurements
- a) On the inspectors notes
 - c) On the piping system**
 - b) on a computer system
 - d) on maintenance department charts
- 56) What is taken into account by an experienced inspector when selecting TMLs?
- a) The amount of corrosion expected
 - b) The patterns of corrosion that would be expected**
 - c) The number and the cost of reading the TMLs
 - d) Whether the TMLs are easily accessed
- 57) In theory, a piping circuit subject to perfectly uniform corrosion could be adequately monitored with _____ TMLs
- a) 1**
 - b) 2
 - c) 3
 - d) 4
- 58) More TMLs should be selected for piping systems with any of the following characteristics:-
- a) Low potential for creating a safety or environmental emergency in the event of a leak.
 - b) More complexity in terms of fittings, branches, dead legs, injection points, etc.**
 - c) Relatively non-corrosive piping systems
 - d) Long, straight-run piping systems
- 59) Fewer TMLs can be selected for piping systems with any of the following characteristics:-
- a) More complexity in terms of fittings, branches, dead legs, injection points, etc.
 - b) Higher expected or experienced corrosion rates
 - c) Long, straight-run piping systems**
 - d) Higher potential for localized corrosion
- 60) TMLs can be eliminated for piping systems with the following characteristics
- a) Higher potential for creating a safety or environmental emergency in the event of a leak.
 - b) Low potential for creating a safety or environmental emergency in the event of a leak.
 - c) Extremely low potential for creating a safety of environmental emergency in the event of a leak.**
 - d) More complexity in terms of fittings, branches, dead legs, injection points, etc.
- 61) What is usually the most accurate means for obtaining thickness measurements on installed pipe larger than NPS 1?
- a) MT
 - b) UT**
 - c) PT
 - d) ET
- 62) What thickness measuring technique does not require the removal of some external piping insulation?
- a) AE
 - b) UT
 - c) ET
 - d) RT**
- 63) When ultrasonic thickness measurements are taken above _____ degrees F, instruments couplant, and procedures should be used that will result in accurate measurements at the higher temperature
- a) 150**
 - b) 175
 - c) 200
 - d) 250

- 64) Typical digital thickness gages may have trouble measuring thickness less than _____ inches
a) 0.2188 b) 0.1875 c) 0.1562 **d) 0.1250**
- 65) When pressure testing of piping systems is conducted, they shall be performed in accordance with the requirements of:-
a) ASME B31.3 b) ASME B&PV Code, Section VIII
c) SA B16.5 d) API 510
- 66) If a lower pressure test (lower than prescribed by code) is used only for tightness of piping systems, the _____ may designate the pressure
a) owner-user b) inspector c) jurisdiction d) contractor
- 67) The preferred medium for a pressure test is _____
a) Steam b) air **c) water** d) hydrocarbon
- 68) If a non-toxic hydrocarbon (flammable) is used as the test medium, the liquid flash point shall be at least _____ degrees F or greater
a) 95 b) 100 c) 110 **d) 120**
- 69) Piping fabricated of or having components of 300 series stainless steel should be tested with _____
a) Water with a pH of 4
b) Water with a pH of 6
c) Water with a chloride content of less than 400 ppmw chlorides
d) Steam condensate
- 70) For sensitized austenitic stainless steel, piping subject to polythionic stress corrosion cracking, consideration should be given to using _____ for pressure testing
a) An acidic-water solution **b) an alkaline-water solution**
c) A water with a pH of 5 d) a water with a pH of 4
- 71) When a pipe requires post weld heat treatment, when should the pressure test be performed?
a) During heat treatment b) Before any heat treatment
c) After any heat treatment d) No test is required
- 72) During a pressure test, where test pressure will exceed the set pressure of the safety relieve valve or valves on a piping system, the safety relief valve or valves should be _____ when carrying out the test
a) Altered by screwing down the adjusting screw
b) Reset to exceed the test pressure
c) Checked or tested
d) Removed or blanked
- 73) When using block valves to isolate a piping system for pressure test, what precaution should be taken?
a) Do not use a globe valve during a test

- b) Make sure the packing gland of the valve is tight
 - c)** Do not exceed the permissible seat pressure of the valve
 - d) Check the bonnet bolts to make sure they are tight
- 74) Several methods may be used to verify that the correct alloy piping is in a system. Pick the incorrect method from the list below:-
- a)** Holography
 - b) optical spectrographic analyzer
 - c) X-ray fluorescent analyzer
 - d) chemical spot checking
- 75) Name a part of a piping system that thickness measurements are not normally routinely taken
- a) Elbows
 - b) expansion loops
 - c) tees
 - d)** valves
- 76) If environmental cracking is found during in-service inspection of welds, who assesses the problem?
- a) Owner-user
 - b) Inspector
 - c)** Piping Engineer
 - d) Metallurgist
- 77) If an inspector finds an imperfection in an original fabrication weld and analysis is required to assess the impact of the weld quality on piping integrity, which of the following may perform the analysis?
- a) An API 510 inspector, WPS inspector, A Pressure Vessel Engineer
 - b)** An API 570 inspector, a CWI inspector, a piping engineer
 - c) An owner-user, a B31.3 inspector, an industrial engineer
 - d) A Jurisdictional representative, a API 574 inspector, a Chemical Engineer
- 78) According to API 570, some welds in a piping system that has been subjected to radiography according to ASME B31.3:-
- a) Will meet random radiograph requirements and will perform satisfactorily in-service without a hydrotest
 - b) Will not meet random radiograph requirements, and will not perform satisfactorily in-service even though hydro tested.
 - c) Will meet random radiograph requirements, and will not perform satisfactorily in-service after a hydrotest
 - d)** Will not meet random radiograph requirements, but will still perform satisfactorily in-service after being hydro tested.
- 79) How should fasteners and gaskets is examined to determine whether they meet the material specifications
- a) All fasteners and gaskets should be checked to see if their markings are correct according to ASME and ASTM standards
 - b)** A representative sample of the fasteners and gaskets should be checked to see if their markings are correct according to ASME and ASTM standards
 - c) Purchase records of all fasteners and gaskets should be checked to see if the fasteners and gaskets meet ASME and ASTM standards
 - d) A representative sample of the purchase records of fasteners and gaskets should be checked to see if the fasteners and gaskets meet ASME and ASTM standards.
- 80) When checking flange and valve bonnet bolts for corrosion, what type of NDT is usually used?
- a) RT
 - b) UT
 - c)** VT
 - d) AE

- 81) What course of action is called for when an inspector finds a flange joint that has been clamped and pumped with sealant?
- Disassemble the flange joint; renew the fasteners and gaskets. The flanges may also require renewal or repair.
 - Renew all the fasteners and renew the gasket if leakage is still apparent.
 - Check for leakage at the bolts; if re-pumping is contemplated, affected fasteners should be renewed.**
 - No action is required since the joint has been pumped with a sealant.
- 82) All process piping systems must be categorized into different classes. On what are the classifications selection based?
- Requirements of jurisdiction and the proximity of population areas
 - Potential safety and environmental effects should a leak occur**
 - Liability to the owner-user and the requirements of the jurisdiction
 - Access to the systems for inspection and closeness to population areas
- 82) (1) Inspection strategy based on likelihood and consequence of failure is called
- RBI**
 - FFS
 - BIR
 - MSOS
- 82) (2) An RBI assessment can be used to _____ the inspection interval limits in Table 1 of API 570 **or** the extent of the inspection conducted
- Increase
 - decrease
 - Either a or b above**
 - none of the above
- 82) (3) when an RBI assessment is used to increase or decrease inspection intervals, the assessment **shall** be conducted on Class 1 systems at a maximum interval of _____ years
- 5**
 - 10
 - 15
 - 3
- 83) Listed below are several examples of a CLASS 1 piping system. Which one does not belong?
- Anhydrous hydrogen chloride;
 - Hydrofluoric acid
 - Piping over or adjacent to water and piping over public thoroughways
 - Distillate and product lines to and from storage and loading**
- 84) Of the three classification of piping systems, which includes the majority of unit processes and selected off-site piping?
- Class 3
 - Combination of classes 1 and 2
 - Class 1
 - Class 2**
- 85) Class 3 piping is described as being in services
- With the highest potential of resulting in an immediate emergency if a leak occurs
 - That are flammable but do not significantly vaporize when they leak and are not located in high-activity areas**
 - That is not flammable and pose no significant risk to populated areas
 - that is not in classes 1 and 2.
- 86) Who establishes inspection interval for thickness measurements, external visual inspections and for internal and supplemental inspections?

- a) Piping engineer;
- b) Owner-user or the inspector
- c) Chemical Engineer
- d) Piping engineer and the jurisdiction

- 87) Thickness measurement inspection should be scheduled based on the calculation of not more than
- a) One half the remaining life determined from corrosion rates or the maximum interval of 5 years whichever is shorter.
 - b) One half the remaining life determined from corrosion rates or the maximum interval allowed by API 570 in Table 1, whichever is shorter
 - c) one fourth the remaining life determined from corrosion rates or the maximum interval of 10 years whichever is shorter.
 - d) one quarter the remaining life determined from corrosion rates or the maximum interval allowed by API 570 in Table 1, whichever is shorter.
- 88) For external inspections for potential corrosion under insulation (CUI) on Class 1 systems, the examination should include at least _____ percent of all suspect areas and _____ percent of all areas of damaged insulation
- a) 50, 75
 - b) 50, 33
 - c) 75, 50
 - d) 25, 10
- 89) Piping systems that are known to have a remaining life of over _____ years or that are protected against external corrosion need not have insulation removed for the periodic external inspection
- a) 10
 - b) 15
 - c) 5
 - d) 20
- 90) For Class 3 piping systems, the examination for corrosion under insulation (CUI) should include at least _____ percent of all suspect areas
- a) 50
 - b) 30
 - c) 10
 - d) 0
- 91) For Class 2 piping, the extent of CUI inspections on a system operating at – 45°F will be
- a) 75 % of damaged areas, 50 % of suspect areas
 - b) 50 % of suspect areas, 33 % of damaged areas
 - c) 33 % of damaged areas, 50 % of suspect areas
 - d) None of the above
- 92) Small bore piping (SBP) that is Class I shall be inspected
- a) Where corrosion has been experienced
 - b) At the option of the inspector
 - c) To the same requirements as primary process piping
 - d) Only if it has dead legs
- 93) Inspection of small bore piping (SBP) that is secondary and auxiliary (associated with instruments and machinery) is
- a) Only required where corrosion has been experienced
 - b) Optional
 - c) Only if it has dead legs
 - d) Only if it is threaded
- 94) If an inspector finds threaded small bore piping (SBP) associated with machinery and subject to fatigue damage, he should :-

- a) Plan periodically to assess it and consider it for possible renewal with a thicker wall or upgrade it to welded components.
 - b) Inspect it only if it is corroded and the class of service requires an inspection.
 - c) Call for dismantling the threaded joints for close inspection to determine if any cracks are in the roots of the threads.
 - d) Have all the threaded piping renewed at each inspection period.
- 95) An eight-inch diameter piping system is installed in December 1979. The installed thickness is measured as 0.34". The minimum thickness of the pipe is 0.20". It is inspected 12/83 and the thickness is found to be 0.32". An inspection 12/87 reveals a loss of 0.01" from the 12/85 inspection. During 12/89 the thickness was found to be 0.29". The last inspection was during 12/95 and the thickness was found to be 0.26". What is the long-term corrosion rate of this system?
- a) 0.005"/year
 - b) 0.0075"/year
 - c) 0.00375"/year
 - d) 0.0025"/year
- 96) Using the information in question 95, calculate the short-term corrosion rate
- a) 0.005"/year
 - b) 0.0075"/year
 - c) 0.00375"/year
 - d) 0.0025"/year
- 97) Using the information in questions 95 and 96, determine the remaining life of the system
- a) 18 years
 - b) 15 years
 - c) 12 years
 - d) 6 years
- 98) You have a new piping system that has just been installed. It is completely new and no information exists to establish a corrosion rate. Also, information is not available on a similar system. You decide to put the system in service and NDT it later to determine the corrosion rate. How long do you allow the system to stay in service before you take your first thickness readings?
- A) 1 month
 - b) 3 months
 - c) 6 months
 - d) 12 months
- 99) After an inspection interval is completed and if calculations indicate that an inaccurate rate of corrosion has been assumed in a piping system, how do you determine the corrosion rate for the next inspection period?
- a) Check the original calculations to find out what the error is in the original assumption.
 - b) Unless the corrosion rate is higher, the initial rates shall be used.
 - c) The corrosion rate shall be adjusted to agree with the actual rate found.
 - d) If the corrosion rate is higher than originally assumed, call in a corrosion specialist.
- 100) If a piping system is made up of unknown materials and computations must be made to determine the minimum thickness of the pipe, what can the inspector or the piping engineer do to establish the minimum thickness?
- a) The lowest grade material and joint efficiency in the applicable code may be assumed for calculations.
 - b) Samples must be taken from the piping and testing for maximum tensile stress and yield strength will determine the allowable stress to be used.
 - c) The piping made of the unknown material must be removed from service and current piping of known material must be installed.
 - d) The piping of unknown material may be subjected to a hydrostatic stress test while having strain gages on it to determine its yield strength and thus allowable stress.

- 101) A piping engineer is designing a piping service with high potential consequences if a failure occurs, i.e. a 350 psi natural gas line adjacent to a high density population area. What should he consider doing for unanticipated situations?
- a) Have all his calculations checked twice.
 - b) Increase the required minimum thickness.**
 - c) Notify the owner-user and the jurisdiction.
 - d) Set up an emergency evacuation procedure.
- 102) when evaluating locally thinned areas, the surface of the weld includes _____ on either side of the weld or _____ times the minimum measured thickness on either side of the weld, whichever is greater.
- A) 0.5", 3 **b) 1", 2** c) 2", 1 d) 1.5", 1.5
- 103) an inspector finds a thin area in a fabricated 24" diameter pipe. The thin area includes a longitudinal weld in the pipe and is 10 feet long and 2 foot circumferentially. Calculations show that with 0.85 joint factor, the pipe must be repaired, renewed, etc. or the pressure in the pipe must be lowered. The owner does not want to do any hot work on the pipe and he does not wish to lower the pressure. What other course could you follow?
- a) Write the results of the inspection up and leave it with the owner.
 - b) Radiograph the weld 100 % and increase the joint factor to one.**
 - c) Insist that the weld be repaired or renewed or that the pressure be lowered.
 - d) Call in a regulator agency to force the owner to repair, renew, etc. the line.
- 104) Piping stress analysis is done during the system's original design. How can the inspector make use of stress analysis information?
- a) An inspector cannot use this information. It is only meaningful to a piping engineer.
 - b) It can be used to make sure the piping system was originally evaluated and designed correctly.
 - c) It can be used to concentrate inspection efforts at locations most prone to fatigue or creep damage, and to solve vibration problems.**
 - d) The inspector should use this information to evaluate the need for conducting additional piping stress analysis.
- 105) you are inspecting a piping system. You find a significant loss of material (a major increase of corrosion rate) in gas oil piping (used as reboiler oil, temperature 500 degrees F) on a Fluid Catalytic Cracking Unit. What is the best course of action for you to take?
- a) The losses may be reported to your supervisor for corrective response
 - b) The losses should be recorded and reported in your final report after the unit has started.
 - c) It shall be reported to the owner-user for appropriate action.**
 - d) Replace excessively thin piping and note replacement in the final report after unit start-up.
- 106) the _____ shall maintain appropriate permanent and progressive records of each piping system covered by API 570.
- a) Inspector **b) owner-user** c) jurisdiction d) examiner

- 107) When making repairs and alterations to piping systems, the principles of _____ or the code to which the piping system was built shall be followed:-
- a) ASME B31.3
 - b) API 570
 - c) API 574
 - d) ASME B&PV code
- 108) Repair and alteration work must be done by a repair organization as defined in API 570 and must be authorized by the _____ prior to its commencement
- a) Jurisdiction
 - b) inspector**
 - c) owner-user
 - d) examiner
- 109) Authorization for alteration work to a piping system may be given by the inspector after:-
- a) Notifying the jurisdiction and getting their approval
 - b) Consulting API 570 and getting the approval of the owner-user
 - c) Consultation with and approval by a piping engineer**
 - d) Discussing with and consent by an examiner
- 110) a repair procedure involving welding requires that the root pass of the weld be inspected before continuing the weld. A "hold" on the repair is required at this point. Who designates this "hold?"
- a) A metallurgist
 - b) The owner-user
 - c) An API 570 inspector**
 - d) the welder supervisor
- 111) what type of repairs and procedures may the inspector give prior general authorization to continue (provided the inspector is satisfied with the competency of the repair organization)?
- a) Major repairs and minor procedures
 - b) Limited or routine repairs and procedures**
 - c) Alterations and re-ratings
 - d) Minor re-ratings and alterations
- 112) Who approves all proposed methods of design, execution, materials, welding procedures, examination and testing of in-service piping ?
- a) The jurisdiction or the piping engineer as appropriate
 - b) The analyst and the operator as appropriate
 - c) The examiner and the piping programmer as appropriate
 - d) The inspector or the piping engineer as appropriate**
- 113) who must give approval for any on-stream welding?
- a) owner-user**
 - b) jurisdiction
 - c) examiner
 - d) analyst
- 114) an inspector finds a crack in the parent metal of a pipe adjacent to a support lug. The pipe was being inspected after a 5 year run. Before repairing, he should:-
- a) Notify the jurisdiction prior to the start of any repairs
 - b) Write a detailed procedure for the repair organizations use in repairing the crack
 - c) Consult with the piping engineer to identify and correct the cause of the crack.**
 - d) Consult with a metallurgist prior to writing a procedure to repair the crack.
- 115) a full encirclement welded split sleeve designed by a piping engineer may be applied over a damaged or corroded area of a pipe. This is considered a temporary repair. When should a permanent repair be made?

- a) If the owner-user designates the welded split sleeve as permanent, it may remain.
 - b) A full encirclement welded split sleeve is permanent if Okayed by the inspector.
 - c) A full encirclement welded split sleeve is considered a permanent repair.
 - d)** A permanent repair must be made at the next available maintenance opportunity.
- 116) what type of defect, corrosion, pitting and / or discontinuity should not be repaired by a full encirclement welded split sleeve?
- a)** A longitudinal check
 - b) A circumferential crack
 - c) Pits that are one half through wall
 - d) General corrosion in the longitudinal direction.
- 117) If a repair area is localized (for example, pitting or pin-holes) and the specified minimum yield strength (SMYS) of the pipe is not more than _____ psi, a temporary repair may be made by fillet welding a properly designed plate patch over the pitted area :-
- a) 30,000 psi b) 55,000 psi **c)** 40,000 psi d) 36,000 psi
- 118) Insert patches (flush patches may be used to repair damaged or corroded areas of pipe if several requirements are met. One of these is that an insert patch (flush patch) may be of any shape but it shall have rounded corners with _____ minimum radii.
- a) 0.375" b) 0.50" c) 0.75" **d)** 1"
- 119) an inspector finds a pin-hole leak in a weld during an on-stream inspection of a piping system. A permissible temporary repair is:-
- a) The use of plastic steel to seal off the leak
 - b) Driving a wooden plug into the hole
 - c) Screwing a self tapping screw into the hole
 - d)** The installation of a properly designed and fabricated bolted leak clamp
- 120) Temporary leak sealing and leak dissipating devices shall be removed and the pipe restored to original integrity:-
- A) As soon as the piping system can be safely removed from service
 - b)** At a turnaround or other appropriate time
 - c) When the leak seal and leak dissipating device ceases to work
 - d) As soon as possible – must be done on a safe, emergency shut-down basis
- 121) which of the following is **NOT** an item for consideration by an inspector when a leak sealing fluid ("pumping") is used for a temporary leak seal repair:-
- a) Consider the compatibility of the sealant with the leaking material
 - b) Consider the pumping pressure on the clamp (especially when re-pumping)
 - c)** Consider the pressure testing of the piping in question
 - d) Consider the number of times the seal area is re-pumped
- 122) any welding conducted on piping components in operation must be done in accordance with
- a) NFPA 704 b) API Standard 510
 - c) ASME B31.3 **d)** API Publication 2201

- 123) all repair and alteration welding to piping systems shall be done in accordance with the:-
 - a) Exact procedures of ASME B31.3 or to the code to which it was built
 - b) Standards of ASME B31.1 or the code to which it was built
 - c) Principles of ASME B31.3 or the code to which it was built**
 - d) Ideals of ASME, NBIC, or API standards
- 124) Welders and welding procedures used in making piping repairs, etc. shall be qualified in accordance with:-
 - a) ASME B31.3 or the code to which the piping was built**
 - b) NBIC or the system to which the piping was built
 - c) NACE or the method to which the piping was built
 - d) ASTM or the law to which the piping was built
- 125) the repair organization responsible for welding shall maintain records of welding procedures and welder performance qualifications. These records shall be available to the inspector:-
 - a) At the end of the job
 - b) After the start of welding
 - c) Following the start of welding
 - d) Before the start of welding**
- 126) Preheating to not less than _____ degrees F may be considered as an alternative to post weld heat treatment for alterations or repairs of P-1, piping initially post weld heat treated as a code requirement (may not be used if the piping was post weld heat treated due to environmental cracking prevention).
 - a) 150
 - b) 200
 - c) 300**
 - d) 350
- 127) When using local PWHT as a substitute for 360-degree banding on local repairs of PWHT'd piping, which of the following items is **NOT** considered
 - a) The application is reviewed, and a procedure is developed by the piping engineer
 - b) The locally PWHT'd area of the pipe must be RT'd or UT'd**
 - c) A preheats of 300°F or higher is maintained while welding
 - d) The PWHT is performed for code compliance and not for environmental cracking
- 128) piping butt joints shall be:-
 - a) Double spiral fillet welds
 - b) single fillet lap welds
 - c) Double fillet lap welds
 - d) full-penetration groove welds**
- 129) When should piping components that need repair be replaced?
 - a) When enough time remains on a turnaround to allow replacement
 - b) When repair is likely to be inadequate**
 - c) When the cost of repair is as high as renewal
 - d) When replacement is preferred by maintenance personnel
- 130) Fillet welded patches (lap patches) shall be designed by
 - a) An engineer
 - b) the inspector
 - c) The piping engineer**
 - d) the repair organization

- 131) Fillet welded lap patches (overlay patches) shall leave:-
a) No membrane stresses b) right-angle corners
c) Rounded corners d) burnished corners
- 132) Materials used in making welding repairs or alterations _____ be of known weldable quality:-
a) May **b)** shall c) should d) can
- 133) Acceptance of a welded repair or alteration shall include _____ in accordance with the applicable code and the owner-user's specification, unless otherwise specified in API 570
a) Nominal Pragmatic Sizing (NPS) b) NBE
c) Safeguards **d)** Non-destructive examination
- 134) after welding is completed on a repair or alteration, _____ in accordance with API 570 shall be performed if practical and deemed necessary by the inspector
a) NPS b) safety sanctions
c) NBE **d)** a pressure test
- 135) when are pressure tests normally required?
a) Pressure tests are normally required after alterations and any repair
b) Pressure tests are normally required after alterations and major repairs
c) Pressure tests are normally required after major and minor repairs
d) Pressure tests are normally required only as specified by the owner-user
- 136) When a pressure test is not necessary or practical, what shall be utilised in lieu of a pressure test?
a) NPS **b)** Non-destructive examination
c) Vacuum visual examination d) NBE
- 137) Special procedure in place of a pressure test after an alteration or repair may be done only after consultation with:-
a) The operations and the repair organization
b) The inspector and the piping engineer
c) The jurisdiction
d) The examiner and the inspector
- 137) Special procedure in place of a pressure test after an alteration or repair may be done only after consultation with:-
a) The operators and the repair organization
b) The inspector and the piping engineer
c) The jurisdiction
d) The examiner and the inspector
- 138) when it is not practical to perform a pressure test of a final closure weld that joins a new or replacement section of piping to an existing system, several requirements shall be satisfied. Which of the following is **NOT** one of the requirements:-
a) The closure weld is a full-penetration fillet weld between a weld neck flange and standard piping component or straight sections of pipe of equal diameter and thickness, axially aligned, and or equivalent materials. For design cases up to Class 150 and 500°F, slip-on flanges are acceptable alternates.

- b) MT or PT shall be performed on the root pass and the completed butt weld. Fillet welds must have PT / MT on the completed weld.
 - c) The new or replacement piping is pressure tested.
 - d) Any final closure butt weld shall be of 100 % radiographic quality; or angle-beam UT may be used, provide the appropriate acceptance criteria is established.
- 139) which of the following is **NOT** a requirement for re-rating a piping system by changing the temperature or the MAWP:-
- a) The existing pressure relieving devices are still in place and set as they were originally
 - b) Calculations are performed by the piping engineer or the inspector
 - c) Piping flexibility is adequate for design temperature changes
 - d) A decrease in minimum operating temperature is justified by impact test results, if required by the applicable code.
- 140) Why is the inspector of buried process piping (not regulated by DOT) different from other process piping inspection?
- a) The insulating effect of the soil increases the possibility of more internal combustion
 - b) Internal corrosion has to be controlled by cathodic protection
 - c) Significant external deterioration can be caused by corrosive soil conditions
 - d) Internal corrosion must be controlled by internal coatings.
- 141) Indications of leaks in buried piping may include several indications. Which of the ones listed below is **NOT** one of the indications?
- a) A change in the surface contour of the ground.
 - b) Water standing on the pipeline right-of-way
 - c) Discoloration of the soil
 - d) Notice odour
- 142) Corrosion cells can form on both bare and coated pipe where bare steel contacts the soil. How can these cells be detected?
- a) Run an acoustic emission test on the piping
 - b) Visually survey the route of buried piping
 - c) The potential at the area of corrosion will be measurable different than other areas and a close-interval potential survey can detect the location of corrosion
 - d) Run an internal survey of the piping using a video camera
- 143) a pipe coating holiday survey is used to locate coating defects on coated pipes. It can be used on newly constructed pipe systems to ensure that the coating is intact and holiday-free. More often, it is used on buried pipe to:-
- a) Show the measurable differences in electrical potential in corroded areas
 - b) Evaluate coating serviceability for buried piping that has been in-service for along time.
 - c) Determine the depth of the piping for resistivity testing
 - d) Evaluate the cathodic protection components of the under-ground pipe
- 144) cathodically protected buried piping should be monitored _____ to assure adequate levels of protection
- a) Regularly
 - b) intermittently
 - c) Erratically
 - d) frequently

- 145) If an "intelligent pigging" system is used to inspect buried piping, what type of bends is usually required in the piping system?
- a) Five diameter bends
 - b) 90 degree pipe ells
 - c) Ten diameter bends
 - d) three diameter bends
- 146) how often should above-grade visual surveillance of a buried pipeline right-of-way be made?
- a) Once a month
 - b) Approximately 6 month intervals
 - c) Once a year
 - d) Once every 3 months
- 147) how often should poorly coated pipes with inconsistent cathodic protection potentials have a pipe-to-soil potential survey made?
- a) Yearly
 - b) Every 2 years
 - c) Every 5 years
 - d) Every 7 years
- 148) on buried piping, what is the frequency of pipe coating holiday surveys?
- a) The frequency is governed by the leak test interval of the pipe
 - b) It is usually based on indications that other forms of corrosion control are ineffective.
 - c) Surveys are normally made every 5 years
 - d) Pipe coating holiday surveys are made when the pipe is excavated.
- 149) for a piping buried in lengths greater than _____ feet and not cathodically protected, evaluation of soil corrosivity should be performed at 5-year intervals.
- a) 50
 - b) 75
 - c) 100
 - d) 150
- 150) If buried piping is cathodically protected, the system should be monitored at intervals in accordance with Section 10 of NACE RP0169 or Section 90 of API RP 651. API RP 651 specifies _____ interval.
- a) Annual
 - b) biannual
 - c) Biennial
 - d) triennial
- 151) Buried piping inspected periodically by excavation shall be inspected in lengths of _____ feet at one or more locations judged to be most susceptible to corrosion
- a) 2 to 4
 - b) 4 to 6
 - c) 6 to 8
 - d) 8 to 10
- 152) after excavation of buried piping, if inspection reveals damaged coating or corroded piping:
- a) The condition should be noted in the records and the inspection interval shortened
 - b) The complete piping system must be day-lighted (excavated) for repair or replacement.
 - c) The damaged coating or corroded piping must be repaired or replaced
 - d) Additional piping shall be excavated until the extent of the condition is identified.
- 153) If buried piping is contained inside a casing pipe, the casing should be:-
- a) capable of carrying the same pressure as the product pipe
 - b) checked to see if its protective coating is intact and serviceable
 - c) pressure tested to make sure it is serviceable
 - d) inspected to determine if water and / or soil has entered the casing

- 154) An alternative or supplement to inspection of buried piping is leak testing with liquid at a pressure at least _____ % greater than the maximum operating pressure at intervals ½ the length of those shown in Table 9-1 of API 570 for piping **NOT** cathodically protected and at the same intervals as shown in Table 9-1 for cathodically protected piping
- a) 5 **b) 10** c) 25 d) 50
- 155) the leak test for buried piping should be for a period of _____ hours.
- a) 4 **b) 8** c) 12 d) 24
- 156) the leak test for an 8" diameter buried piping system is 300 psi. After 7 hours, the pressure reacts 273 psi. What should the inspector do?
- a) Nothing is required. The loss of pressure is negligible and will not affect the test. The loss can be disregarded.
- b) The system should be re-pressurized to the original leak test pressure and the test should begin again.
- c) The test charts and the temperature should be reviewed to determine if any change in temperature caused the pressure drop.
- d) The piping should be visually inspected externally and / or inspected internally to find the leak and assess the extent of corrosion.**
- 157) a buried piping system that is not cathodically protected has to have an inspection interval set. The soil resistivity is checked and found to be 3400 ohm/cm. As the inspector, what interval would you set?
- a) 2.5 years b) 7.5 years c) 5 years **d) 10 years**
- 158) Buried piping also may be surveyed for integrity by removing the line from service and performing a leak test. This inspection method typically involves pressurizing the line with a _____, allowing time for the _____ to diffuse to the surface and surveying the buried line with a gas-specific detector to detect the _____
- a) Tracer gas (such as helium or sulphur hexafluoride)**
- b) Light hydrocarbon (such as butane)
- c) Smoke type material (such as chemical smoke)
- d) Water vapor (such as steam)
- 159) Repairs to coating on buried piping may be tested using
- a) A low-voltage holiday detector
- b) Light taps with an inspection hammer
- c) A flaw indicator fluid
- d) A high-voltage holiday detector**
- 160) If buried piping leaks are clamped and reburied:-
- a) No further action is required unless the piping leaks again
- b) The date of installation shall be marked on the clamp for future identification
- c) A record of the location and the date of installation shall be maintained**
- d) The clamped line shall be leak tested.

- 161) A 10" diameter piping system with 4" diameter and 6" diameter reinforced branch connections is to have changes made to it. Which of the following is considered an alteration?
- a) A new 1" diameter un-reinforced nipple is installed
 - b)** A new 8" diameter reinforced branch connection is installed
 - c) A new 4" diameter reinforced branch connection is installed
 - d) A new 3" diameter reinforced branch connection is installed
- 162) which of the following **would not** be classified as an applicable code to which a piping system was built?
- a) ASME B31.3
 - b) ASME B31.1
 - c) ASA B31.1-1955, Section 3
 - d)** ASTM A-20
- 163) which of the inspection agencies listed below is **NOT** an *Authorized Inspection Agency* as defined in API 570.
- a) Jurisdictional inspection organization
 - b) Owner-user inspection organization
 - c)** ASTM inspection organization
 - d) Independent inspection organization
- 164) an *authorized piping inspector* is an employee of an authorized inspection agency who is qualified to perform the functions specified in API 570. Which individual listed below is **not** usually an *authorized piping inspector*.
- a) An owner-user inspector.
 - b) A jurisdictional inspector
 - c)** An NDE examiner
 - d) an insurance inspector
- 165) which of the following qualifies as *auxiliary piping*?
- a) Control valve manifolds
 - b) bypass lines around exchangers
 - c)** Pump seal oil lines
 - d) orifice runs
- 166) CUI stands for:-
- a) Control unit inspector
 - b)** corrosion under insulation
 - c) Corrected unobtrusive inserts
 - d) corroded underground installation
- 167) Dead legs of a piping system are:-
- a) The upstream piping of control valve manifolds
 - b) Supports attached to a pipeline that has no product in them
 - c) The upstream part of an orifice runs
 - d)** Sections that normally have no significant flow
- 168) a defect is an imperfection of a type or magnitude exceeding the _____ criteria.
- a) Non-specific
 - b) imprecise
 - c) general
 - d)** acceptable
- 169) the design temperature of a piping system component is the temperature at which, under the coincident pressure, the _____ is required.
- a) Smallest thickness or highest component rating
 - b)** Greatest thickness or highest component rating
 - c) Maximum thickness or lowest component rating
 - d) Minimum thickness or minimum component rating

- 170) an examiner is a person who _____ the inspector
A) Supplants **b)** assists  c) supervises d) directs
- 171) Hold point is a point in the repair or alteration process beyond which work may not proceed until the _____ has been performed and documented
a) PWHT required **b)** required inspection
c) RT required d) ultrasonic testing
- 172) what is an imperfection?
a) It is a flaw or discontinuity noted during inspection that may be subject to acceptance.
b) It is a defect noted during inspection that is unacceptable.
c) It is a weld flaw noted during an inspection that may be subject to repair
d) It is a blemish that is only cosmetic and acceptable under all conditions
- 173) _____: is a response or evidence resulting from the application of a non-destructive evaluation technique
a) Indication b) imperfection c) breach d) division
- 174) what are points where chlorine is introduced in reformers, water is added in overhead systems, etc. called
a) Primary process points b) level bridle points
c) Injection points d) test points
- 175) what is the loss of ductility and notch toughness in susceptible low-alloy steels such as 1.25 and 2.5 Cr., due to prolonged exposure to high-temperature service called?
a) Creep **b)** temper embrittlement
c) Incipient melting d) graphitization
- 176) Secondary process piping is small-bore (less than or equal to _____) process piping downstream of normally closed block valves
a) NPS 3/4 b) NPS 1 **c)** NPS 2 d) NPS 3
- 177) A test point is an area defined by a circle having a diameter not greater than _____ inches for a line diameter not exceeding 10 inches or not greater than _____ inches for larger lines.
a) 3, 4 **b)** 2, 3 c) 1, 2 d) 3/4, 1
- 178) when making a repair utilizing a welded full encirclement repair sleeve and the sleeve material is different from the pipe material, you should
a) Consult the piping engineer
b) Use a weld rod matching the higher strength material
c) Use a weld rod matching the lower strength material
d) Use an alloy weld rod such as Inco-A
- 179) what type of electrode should be used when welding a full encirclement repair sleeve?
a) low-hydrogen electrode b) low-phosphorous electrode
c) low-chrome electrode d) low-nitrogen electrode
- 180) which of the following welding electrodes is low-hydrogen?
a) E6010 **b)** E7016 c) E7011 d) E7014

181) when welding a small repair patch, the diameter of electrodes used should not exceed

a)	1/8"	b)	3/16"	c)	5/32"	d)	1/4"
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ANSWER KEY

- | | | | | | |
|-----|---|------------------|-------|---|----------------|
| 1. | c | API 570, 1.1.1 | 49. | a | API 570, 5.4.3 |
| 2. | b | API 570, 1.1.2 | 50. | d | API 570, 5.4.5 |
| 3. | a | API 570, 1.1.3 | 51. | b | API 570, 5.5.1 |
| 4. | b | API 570, 1.2.1 | 52. | b | API 570, 5.5.2 |
| 5. | b | API 570, 1.2.1 | 53. | c | API 570, 5.5.2 |
| 6. | b | API 570, 4.3.4 | 54. | c | API 570, 5.5.2 |
| 7. | b | API 570, 4.1 | 55. | c | API 570, 5.5.2 |
| 8. | a | API 570, A.2.1 | 56. | b | API 570, 5.5.3 |
| 9. | d | API 570, 5.1 | 57. | a | API 570, 5.5.3 |
| 10. | d | API 570, 5.1 | 58. | b | API 570, 5.5.3 |
| 11. | a | API 570, 5.3 | 59. | c | API 570, 5.5.3 |
| 12. | b | API 570, 5.3.1 | 60. | c | API 570, 5.5.3 |
| 13. | c | API 570, 5.3.1 | 61. | b | API 570, 5.6 |
| 14. | a | API 570, 5.3.1 | 62. | d | API 570, 5.6 |
| 15. | b | API 570, 5.3.1 | 63. | a | API 570, 5.6 |
| 16. | a | API 570, 5.3.1 | 64. | d | API 570, 5.6 |
| 17. | c | API 570, 5.3.1 | 65. | a | API 570, 5.7 |
| 18. | c | API 570, 5.3.2 | 66. | a | API 570, 5.7 |
| 19. | c | API 570, 5.3.2 | 67. | c | API 570, 5.7 |
| 20. | d | API 570, 5.3.2 | 68. | d | API 570, 5.7 |
| 21. | c | API 570, 5.3.3 | 69. | d | API 570, 5.7 |
| 22. | c | API 570, 5.3.3 | 70. | b | API 570, 5.7 |
| 23. | d | API 570, 5.3.3.1 | 71. | c | API 570, 5.7 |
| 24. | c | API 570, 5.3.3.2 | 72. | d | API 570, 5.7 |
| 25. | b | API 570, 5.3.4 | 73. | c | API 570, 5.7 |
| 26. | d | API 570, 5.3.4 | 74. | a | API 570, 5.8 |
| 27. | b | API 570, 5.3.5 | 75. | d | API 570, 5.9 |
| 28. | b | API 570, 5.3.6 | 76. | c | API 570, 5.10 |
| 29. | a | API 570, 5.3.6 | 77. | b | API 570, 5.10 |
| 30. | c | API 570, 5.3.7 | 78. | d | API 570, 5.10 |
| 31. | d | API 570, 5.3.7 | 79. | b | API 570, 5.11 |
| 32. | a | API 570, 5.3 | 80. | c | API 570, 5.11 |
| 33. | d | API 570, 5.3.8 | 81. | c | API 570, 5.11 |
| 34. | a | API 570, 5.3.8 | 82. | b | API 570, 6.2 |
| 35. | c | API 570, 5.3.9 | 82(1) | a | API 570, 6.1 |
| 36. | b | API 570, 5.3.9 | 82(2) | c | API 570, 6.1 |
| 37. | b | API 570, 5.3.9 | 82(3) | a | API 570, 6.1 |
| 38. | a | API 570, 5.3.10 | 83. | d | API 570, 6.1.1 |
| 39. | b | API 570, 5.3.10 | 84. | d | API 570, 6.1.2 |
| 40. | b | API 570, 5.3.11 | 85. | b | API 570, 6.2.3 |
| 41. | a | API 570, 5.3.12 | 86. | b | API 570, 6.2 |
| 42. | d | API 570, 5.4 | 87. | b | API 570, 6.2 |
| 43. | c | API 570, 5.4.1 | 88. | a | API 570, 6.4 |
| 44. | c | API 570, 5.4.1 | 89. | a | API 570, 6.3 |
| 45. | b | API 570, 5.4.2 | 90. | c | API 570, 6.3 |
| 46. | b | API 570, 5.4.2 | 91. | d | API 570, 6.4 |

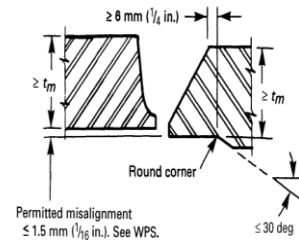
47.	a	API 570, 5.4.3	92.	c	API 570, 6.5.1
48.	b	API 570, 5.4.3	93.	b	API 570, 6.5.2
94.	a	API 570, 6.6.3	143.	b	API 570, 9.1.3
95.	a	API 570, 7.1.1	144.	a	API 570, 9.1.5
96.	a	API 570, 7.1.1	145.	a	API 570, 9.1.6
97.	c	API 570, 7.1.1	146.	b	API 570, 9.2.1
98.	b	API 570, 7.1.2	147.	c	API 570, 9.2.2
99.	c	API 570, 7.1.3	148.	b	API 570, 9.2.3
100.	a	API 570, 7.2	149.	c	API 570, 9.2.4
101.	b	API 570, 7.3	150.	a	API 570, 9.2.5
102.	b	API 570, 7.4	151.	c	API 570, 9.2.6
103.	b	API 570, 7.4	152.	d	API 570, 9.2.6
104.	c	API 570, 7.5	153.	d	API 570, 9.2.6
105.	c	API 570, 7.6	154.	b	API 570, 9.2.7
106.	b	API 570, 7.6	155.	b	API 570, 9.2.7
107.	a	API 570, 8.1	156.	d	API 570, 9.2.7
108.	b	API 570, 8.1.1	157.	d	API 570, 9.2.7
109.	c	API 570, 8.1.1	158.	a	API 570, 9.2.7
110.	c	API 570, 8.1.1	159.	d	API 570, 9.3.1
111.	b	API 570, 8.1.1	160.	c	API 570, 9.3.2 & 9.4
112.	d	API 570, 8.1.2	161.	b	API 570, 3.1
113.	a	API 570, 8.1.2	162.	d	API 570, 3.3
114.	c	API 570, 8.1.2	163.	c	API 570, 3.4
115.	d	API 570, 8.1.3.1	164.	c	API 570, 3.5
116.	a	API 570, 8.1.3.1	165.	c	API 570, 3.6
117.	c	API 570, 8.1.3.1	166.	b	API 570, 3.8
118.	d	API 570, 8.1.3.2	167.	d	API 570, 3.9
119.	d	API 570, 8.1.4	168.	d	API 570, 3.10
120.	b	API 570, 8.1.4	169.	b	API 570, 3.11
121.	c	API 570, 8.1.4	170.	b	API 570, 3.12
122.	d	API 570, 8.2	171.	b	API 570, 3.13
123.	c	API 570, 8.2	172.	a	API 570, 3.14
124.	a	API 570, 8.2.1	173.	a	API 570, 3.15
125.	d	API 570, 8.2.1	174.	c	API 570, 3.16
126.	c	API 570, 8.2.2.1	175.	b	API 570, 3.44
127.	b	API 570, 8.2.2.1	176.	c	API 570, 340
128.	d	API 570, 8.2.3	177.	b	API 570, 3.46
129.	b	API 570, 8.2.3	178.	a	API 570, Appendix C
130.	c	API 570, 8.2.3	179.	a	API 570, Appendix C
131.	c	API 570, 8.2.3	180.	b	API 570, Appendix C
132.	b	API 570, 8.2.4	181.	c	API 570, Appendix C
133.	d	API 570, 8.2.5	141.	b	API 570, 9.1.1
134.	d	API 570, 8.2.6	142.	c	API 570, 9.1.2
135.	b	API 570, 8.2.6			
136.	b	API 570, 8.2.6			
137.	b	API 570, 8.2.6			
138.	a	API 570, 8.2.6			
139.	a	API 570, 8.3			
140.	c	API 570, Section 9			

Piping CBT Latest Notes

- 1- A carbon steel ASTM A 53 Grade B material is being impact tested. What is the minimum energy requirement for this material (average for 3 specimens-fully deoxidized steel)?
- 7 ft-lbs
 - 10 ft-lbs
 - 13 ft-lbs
 - 15 ft-lbs

Answer: C, ASME B31.3, 323.3.5, Table 323.3.5

- 2- Two different thickness to be welded, say 10mm and 6 mm, What is the permitted angle and misalignment?
- 30° and 1.5 mm
 - 37.5° and 1.5 mm
 - 30° and 2.4 mm
 - 37.5° and 2.4 mm



Answer: A, ASME B31.3, Fig. K328.4.3

- 3- When two different materials (say P1 and P3) are joined by welding, Which preheating temperature will be dominant:
- P1
 - P3
 - Average of P1 and P3
 - P1 and P3 can't be welded

Answer: B, ASME B31.3, 330.2.1 (When welding two different P-No. materials, the preheat temperature shall be the higher temperature for the material being welded)

- 4- The joint factor can be increased by additional examination on which of the following pipe joint:
- Electric fusion weld
 - ERW
 - Furnace butt weld
 - Casting

Answer: A, ASME B31.3, Table 302.3.4

- 5- ASME B31.3 covers:
- Fired heaters
 - Refineries and Process piping
 - Cross country pipeline
 - Gas Plants

Answer: B, ASME B31.3, 300.1

- 6- For Pneumatic Leak Test, The test pressure shall not exceed:
- a. 1.1 design pressure
 - b. 1.33 design pressure and 0.9 yield strength
 - c. 1.5 design pressure

Answer: B, ASME B31.3, 345.5.4

- 7- For welding 8 mm base metal, what is the maximum allowable weld height is:
- a. 1.5 mm
 - b. 4.5 mm
 - c. 2.0 mm
 - d. 3.0 mm



Answer: D, ASME B31.3, Table 341.3.2 Criterion Value Notes

- 8- impact testing is not required for design minimum temperature–thickness combination when it's:
- a. On Curve
 - b. Below Curve
 - c. Above Curve
 - d. On or Above Curve

Answer: D, ASME B31.3, 323.2.2 b (b)

- 9- For pneumatic test, the pressure shall be gradually increased until a gage pressure that is the lesser of ----- test pressure or 170 kPa (25 psi) is attained
- a. 25%
 - b. 10%
 - c. 50%
 - d. 5%

Answer: C, ASME B31.3, 345.5.5

- 10- Unless otherwise specified by the engineering design, the following records shall be retained for at least 5 years after the record is generated for the project:
- a. examination procedures
 - b. examination personnel qualifications
 - c. examination reports
 - d. All of the above

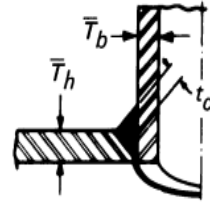
Answer: D, ASME B31.3, 346.3

- 11- For impact testing, each set of impact test specimens shall consist of ---- specimen bars:
- a. 3
 - b. 2
 - c. 4
 - d. 1

Answer: A, ASME B31.3, 323.3.3

12- NPS 2 schedule 80 (0.218" wall) is welded into a NPS 6 Schedule 40 (0.0.280" wall) header. What size cover fillet weld is required around the fully penetrated groove weld of the branch into the header? (Express answer to nearest hundredth)

- a. 0.15"
- b. 0.20"
- c. 0.22"
- d. 0.25"



Answer: A, ASME B31.3, Fig 328.5.4D ($t_c = \text{lesser of } 0.7 T_b \text{ or } \frac{1}{4}"$)

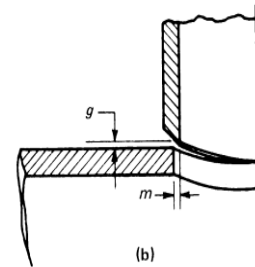
13- Pneumatic test pressure shall be not less than ----- the design pressure

- a. 140%
- b. 133%
- c. 110%
- d. 150%

Answer: C, ASME B31.3, 345.5.5

14- Branch lateral to pipe offset is:

- a. 1.5 mm
- b. 3 mm
- c. 4.5 mm
- d. 2.5 mm



Answer: B, ASME B31.3, Fig 328.4.4 ($m = \text{lesser of } 3.2 \text{ mm or } \frac{1}{2} \text{ branch thickness}$)

15- At the owner's option, a piping system, which Category may be subjected to an initial service leak test

- a. Category M
- b. Lethal
- c. Normal Category
- d. Category D

Answer: D, ASME B31.3, 345.5.5



16- Flange bolt holes shall be aligned within ----- maximum offset

- a. 3 mm
- b. 1.5 mm
- c. 0.8 mm
- d. 2 mm

Answer: A, ASME B31.3, 335.1 (3)

17- PWHT could be checked by using

- a. UT
- b. PT
- c. RT
- d. Hardness Survey

Answer: D, ASME B31.3, 331.1.7 (2010 edition), and API 577, 9.10.1

18- Which has the highest thermal expansion?

- a. Stainless steel
- b. Cu
- c. CS
- d. Low Alloy Steel

Answer: B, ASME B31.3, Appendix C, Table C-1 (Sequence of material from highest to lowest : Aluminum, Brass, Bronze, Copper, SS, Monel, Nickel, low alloy steels, carbon steel, Titanium)

19- According to ASME B16.5, Flange shell test value shall be

- a. 1.1 Design pressure
- b. 1.5 times pressure rating
- c. 1.33 pressure rating
- d. Flanges are not required to be pressure tested

Answer: D, ASME B16.5, 8.1

20- Material for components that meet the requirements for more than one specification or grade, The multiple marking shall be in accordance with the guidelines set out in:

- a. ASME B16.5
- b. AMSE B16.47
- c. ASME ASME BPVC Section II, Part D
- d. ASME B31.3

Answer: C, ASME B16.5, 4.2.8

21- Material flanged fittings in accordance to ASME B16.5 cover sizes:

- a. NPS 1/2 through NPS 24
- b. NPS 2 through NPS 24
- c. NPS 1 through NPS 26
- d. NPS 1/2 through NPS 48

Answer: A, ASME B16.5, 1.1 (a)

22- Maximum size for flanges in accordance to ASME B16.5:

- a. NPS 26
- b. NPS 24
- c. NPS 48
- d. NPS 12

Answer: B, ASME B16.5, 1.1 (a)

23- Either a serrated concentric or serrated spiral finish having a resultant surface finish from ----- average roughness shall be furnished

- a. 125 μ in to 250 μ in
- b. 150 μ in to 250 μ in
- c. 125 μ mm to 250 μ mm
- d. 63 μ in

Answer: A, ASME B16.5, 6.4.5.3

24- Ring Joint side wall surface finish shall not exceed ----- roughness

- a. 125 μ in
- b. 63 μ in
- c. 250 μ mm
- d. 1.6 μ in

Answer: B, ASME B16.5, 6.4.5.2

25- Class 150 flanged joints may develop leakage problems above temperature:

- a. 750° F
- b. 300° F
- c. 400° F
- d. 600° F

Answer: C, ASME B16.5, 2.5.2

26- Which of the following is considered as high strength bolting:

- a. ASTM A193 Gr B7
- b. ASTM A193 Gr B5
- c. ASTM A320 Gr B8 CL2
- d. ASTM A193 Gr B7M

Answer: A, ASME B16.5, 5.3.2, table 1B

27- Fitting local areas having less than minimum wall thickness could be accepted if:

- a. 0.50 $\sqrt{dt_m}$, 1.25 $\sqrt{dt_m}$
- b. 0.30 $\sqrt{dt_m}$, 1.95 $\sqrt{dt_m}$
- c. 0.35 $\sqrt{dt_m}$, 1.75 $\sqrt{dt_m}$
- d. 0.35 $\sqrt{dt_m}$, 0.75 $\sqrt{dt_m}$

Answer: C, ASME B16.5, 6.1.2

28- For B16.5 scope, which of the following class rating is not covered?

- a. 150
- b. 300
- c. 1500
- d. None of the above

Answer: D, ASME B16.5, 1.9.1

29- The test duration of 8" flanged fitting is

- a. 1 minuet.
- b. 2 minuets
- c. 3 minuets
- d. Flanged fitting not required to be pressure tested

Answer: B, ASME B16.5, 8.2.4

30- Fitting shell pressure rating shall be rounded off to the next higher:

- a. 1 bar
- b. 25 PSI
- c. A & B
- d. None of the above

Answer: C, ASME B16.5, 8.2.2

31- Flanged joints and flanged fittings may be subjected to system hydrostatic tests at :

- a. 1.1 design test pressure
- b. 1.5 Operating pressure
- c. 1.5 times the 38°C (100°F) rating.
- d. Not required

Answer: C, ASME B16.5, 2.6

32- Pipe flanges and flanged fittings are covered in:

- a. ASME B16.5
- b. ASME B31.3
- c. ASME BPVC VIII Div 1
- d. ASME B31.4

Answer: A, ASME B16.5, Title.

33- Flanged fitting (A105N Class 150 material) will be subjected to fluid of 370°C temp, what should be the pressure testing value?

- a. 220 PSI
- b. 430 PSI
- c. 450 PSI
- d. 600 PSI

Answer: C, ASME B16.5, 2.6, Table II-2-1.1 ($1.5 \times 285 = 427.5$ (rounded to next 25 psi) → 450 PSI)

34- An item that is not in accordance with specified codes, standards or other requirements

- a. Non-conformance
- b. Non-standard
- c. Non applicable item
- d. Non compatible

Answer: A, API 570, 3.1.61

35- Which NDT method is very often technique of choice on NPS 8 and under when localized corrosion is suspected?

- a. UT
- b. PAUT
- c. PRT
- d. ACFM

Answer: C, API 570, 5.7.1 (Bonus: UT scanning is preferred for larger than NPS 12)

36- All of the following are examples of Supplemental Inspection except:

- a. Radiography and/or thermography to check for fouling
- b. Acoustic emission
- c. Scanning of the areas with UT
- d. Visual survey to check for pipe movement

Answer: D, API 570, 5.5.7

37- API 570 covers:

- a. inspection, rating, repair, and alteration procedures for in-service piping
- b. Design and inspection of power piping
- c. Construction of process piping
- d. Pressure vessels inspection and fabrication

Answer: A, API 570, 1.1.1

38- Which of the following is not considered as dead leg:

- a. Lines with one end blanked
- b. Control valve bypass piping
- c. pressure relieving device inlet and outlet header piping
- d. Sample points, drains, bleeders, and instrument connections.

Answer: B, API 570, 3.1.21 (stagnant control valve bypass piping)

39- As part of Piping Stress Analysis, what is not required to verify Piping is supported and guided:

- a. Its weight is carried safely
- b. It does not vibrate excessively
- c. Accounts for other loads (e.g. those included in the original code of construction)
- d. Pressure loads and other applicable loads

Answer: D, API 570, 7.8

40- Soil-to-air interface generally is considered to be at least ----- below to 6 in. (150 mm) above the soil surface:

- a. 3"
- b. 12"
- c. 10"
- d. 3D

Answer: B, API 570, 3.1.97

- 41- Any type of deterioration encountered (e.g. corrosion; cracking; erosion; dents) is called:
- a. Damage Mechanism
 - b. Damage type
 - c. Defect
 - d. Inclusion

Answer: A, API 570, 3.1.19

- 42- Components of a piping system that normally have little or no significant flow
- a. Dummy leg
 - b. Blanked branches
 - c. Auxiliary piping
 - d. Dead-legs

Answer: D, API 570, 3.1.21

- 43- Considerations for corrosion under insulation includes:
- a. Low points of sagging lines
 - b. Evidence of fluid leakage
 - c. Condition/age of the external coating
 - d. All of the above

Answer: D, API 570, 5.8

- 44- As per API 570, Hydrotesting temperature need not exceed
- a. 48 °C
 - b. 60 °C
 - c. 50 °C
 - d. 52 °C

Answer: C, API 570, 5.11.4 (Note: in ASME B31.3 max testing temp is 49 °C)

- 45- Decrease in the design temperature, design pressure or both to provide increased corrosion allowance:
- a. Rerating
 - b. Alteration
 - c. Derating
 - d. Major repair

Answer: C, API 570, 3.1.91

- 46- Minimum allowed pipe wall thickness needed to hold the design pressure at the design temperature:
- a. Pressure design thickness
 - b. Structural thickness
 - c. Nominal thickness
 - d. Mill Thickness

Answer: A, API 570, 3.1.81

- 47- The holiday pipe coating survey can be used to:
- a. Relative classification of the soil corrosivity
 - b. Locate external coating defects on buried coated pipes
 - c. Girth welds surface defects
 - d. Joint leakage

Answer: B, API 574, 11.7.2.3

- 48- Which NDE method used to check for fouling and internal plugging:
- a. ACFM
 - b. PT
 - c. UT
 - d. RT

Answer: D, API 570, 5.5.7

- 49- As per API 570, Flange fasteners should be fully engaged, Any fastener failing to do so is considered acceptably engaged if:
- a. Nut and fastener end are flushed
 - b. lack of engagement is one thread
 - c. lack of engagement is two threads
 - d. Two threads appearing outside nut surface

Answer: B, API 570, 5.15 (if ASME B31.3 used, then A is correct answer , check 335.2.3)

- 50- Bodies of valves that operate in severe cyclic temperature service shall be checked for:
- a. Fouling and corrosion build-ups
 - b. Erosion
 - c. Local corrosion
 - d. Internally for cracks

Answer: D, API 574, 10.3.4

- 51- Water may not be suitable as a test fluid in some piping systems, such as:
- a. Oil-transfer lines
 - b. Hot or volatile oil lines
 - c. Toxic and lethal service
 - d. Acid lines, cryogenic systems, and air-drier systems

Answer: D, API 574, 11.2

- 52- The ACFM technique is an electromagnetic non-contacting technique that is able to
- a. Detect and size surface breaking defects
 - b. Subsurface defects
 - c. Lack of fusion
 - d. Internal cracks

Answer: A, API 577, 9.5

53- Most factors affects MIC:

- a. Aqueous environments
- b. Hardness of material
- c. Stagnant flow
- d. A & C

Answer: D, API 571, 3.45.3

54- Material in Amine DEA environment should be checked for:

- a. Check cracking by WFMT
- b. Check hardness for PWHT areas
- c. Check for fouling
- d. Check for local corrosion using UT scanning

Answer: D, API 571, 3.3.7.a (Amine Stress Corrosion Cracking)

55- Valve Inspection and Testing requirements are covered in?

- a. ASME B16.36
- b. API 600
- c. API 598
- d. ASME B31.3

Answer: C, API 598: Valve Inspection and Testing

56- Pipe surface imperfections considered defects if it penetrate more than?

- a. 5% of nominal wall thickness
- b. 12½ % of nominal wall thickness
- c. 10% of nominal wall thickness
- d. 1% of nominal wall thickness

Answer: B, ASTM A-106, 18.2

57- Surface As an alternative to the hydrostatic test, it is permissible for the full body of pipe to be tested with:

- a. Nondestructive Electric Test
- b. UT
- c. RT
- d. Pipe must be hydrotested.

Answer: A, ASTM A-106, 13.2

58- The mass of any length of pipe shall not vary

- a. 8%, 3%
- b. 10%, 2%
- c. 5%, 2.5%
- d. 10%, 3.5%

Answer: D, ASTM A-106, 16.1

- 59- For gasket surfaces, if there is imperfection of 3mm was observed, which code would be used to evaluate this imperfection?
- a. ASME B16.5
 - b. ASME B31.3
 - c. ASME B16.47
 - d. None of the above

Answer: D, ASME PCC-1, APPENDIX D

- 60- Procedure is a specified way to carry out an activity or process, it includes all of the following except:
- a. Materials to be used
 - b. Personnel qualifications
 - c. Equipment used
 - d. Documents and records

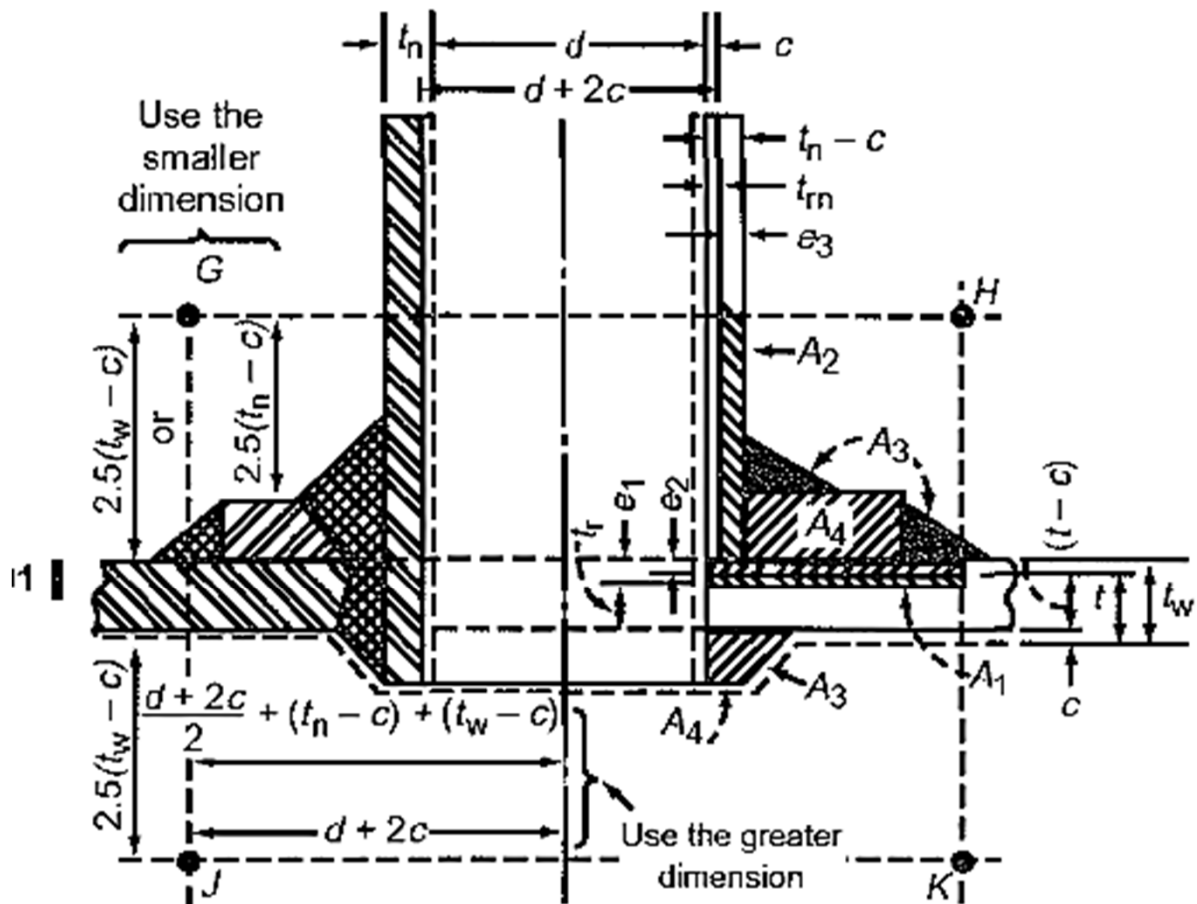
Answer: B, ISO 10005, 3.5 Note 7

api 570 3.1.83 A procedure may include methods to be employed, equipment or materials to be used, qualifications of personnel involved, and sequence of work.

Additional Notes:

- Check API 570 for Terms, Definitions, Acronyms, and Abbreviations
- Check ASME B 16.5
- Check ASTM A-106 (focus on tolerances and ranges)

Reinforcement of Single Openings



t_r = Required thickness of a seamless wall (or solid plate); if the opening passes through a welded joint whose direction is parallel to the cross section under consideration, t_r shall be given a value that allows for the difference, if any, between the specified efficiency of 100 percent.

t_m = Required thickness of the nozzle neck, allowing for the efficiency of longitudinal joints, if any, in the nozzle neck.

e_1 = Excess thickness if the opening is in solid plate.

e_2 = Excess thickness if the opening passes through a welded joint that has an efficiency of less than 100 percent and whose direction is parallel to the cross section under consideration.

e_3 = Thickness of the nozzle neck available for reinforcement of the opening.

A_1 = Area in excess thickness of the tank wall that is available for reinforcement.

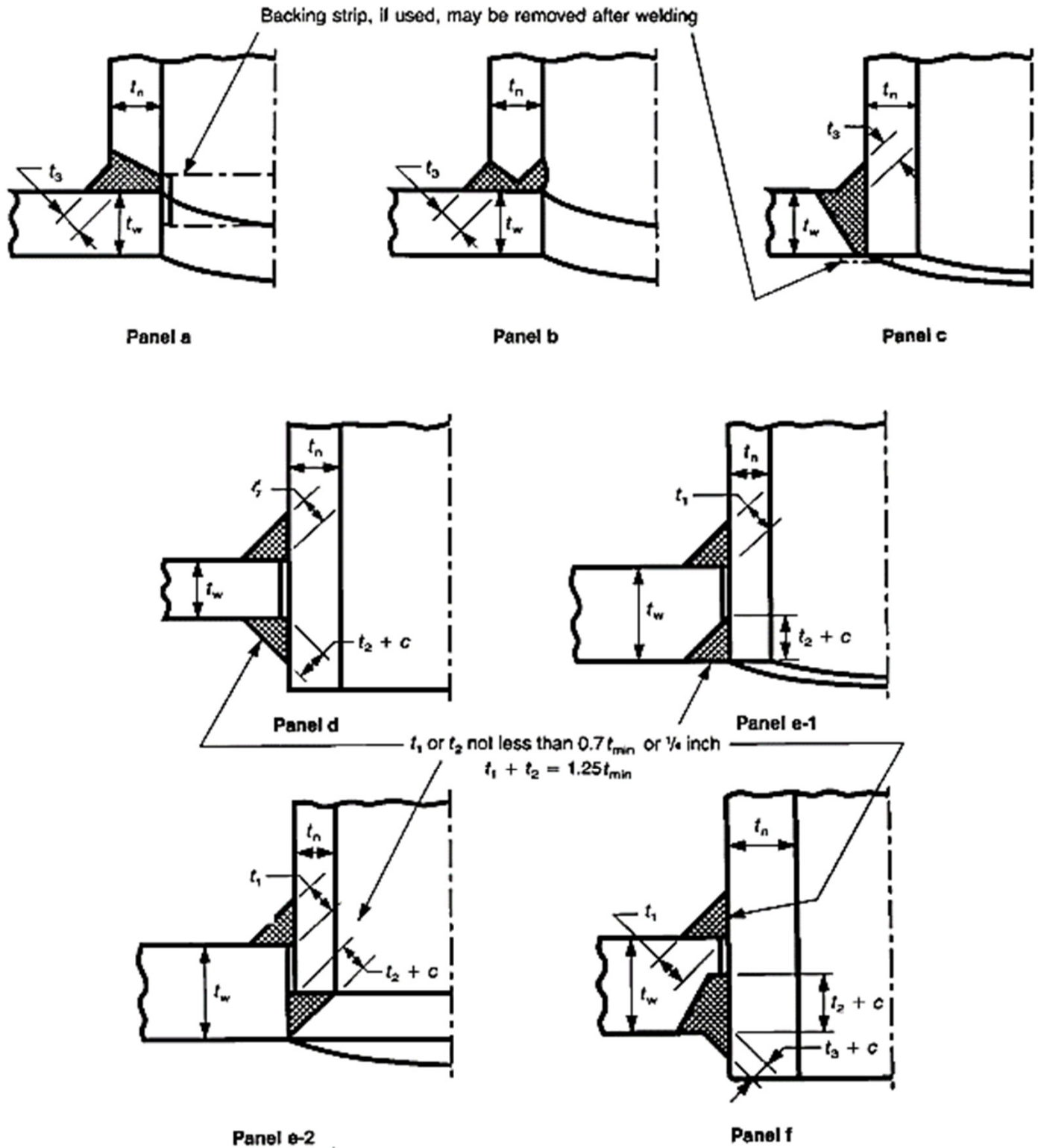
A_2 = Area in excess thickness of the nozzle neck that is available for reinforcement.

A_3 = Cross-sectional area of welds available for reinforcement.

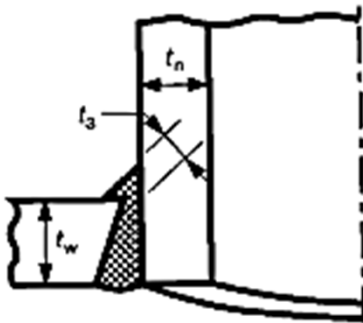
A_4 = Cross-sectional area of material added as reinforcement.

Note: See 5.16.5.1 and Figure 5-8 for definitions of other variables.

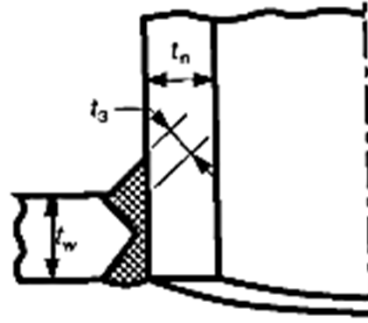
Acceptable Types of Welded Nozzles and Other Connections



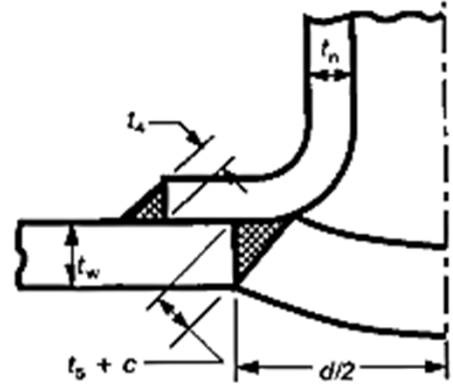
Acceptable Types of Welded Nozzles and Other Connections



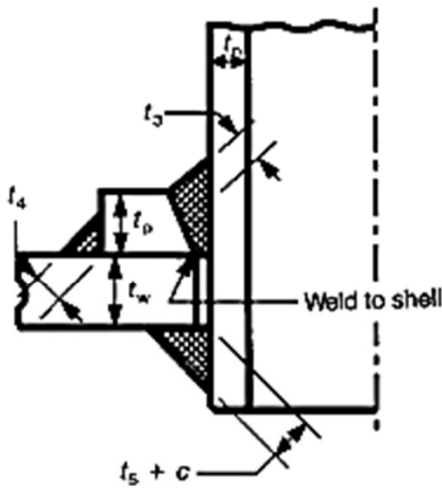
Panel g



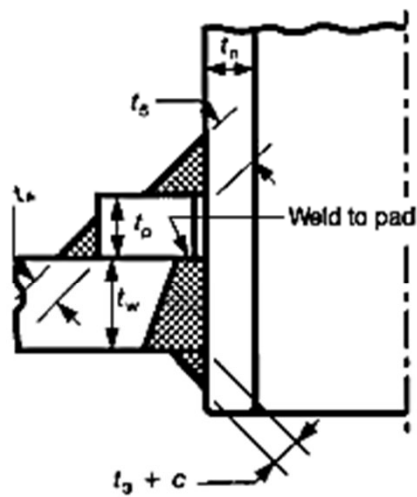
Panel h



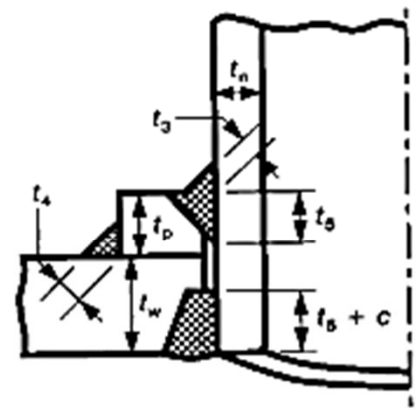
Panel i



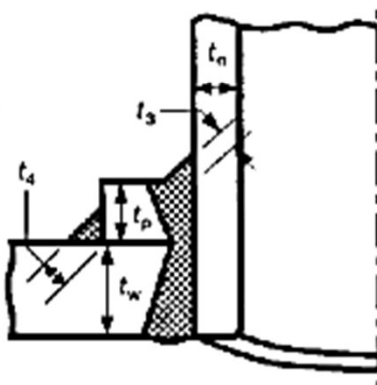
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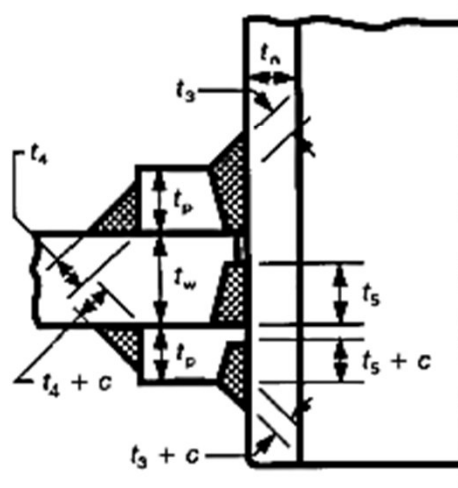
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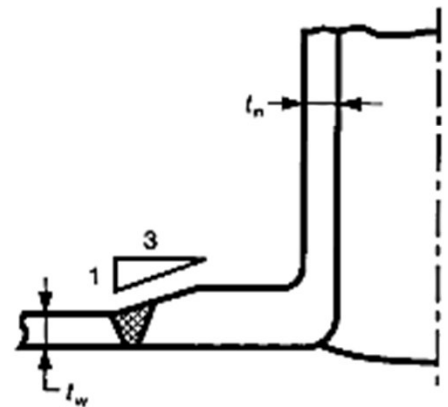
Panel l



Panel m

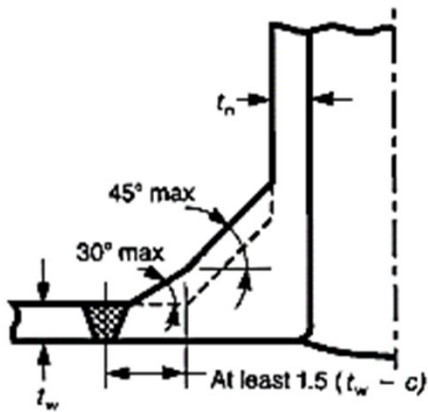


Panel n

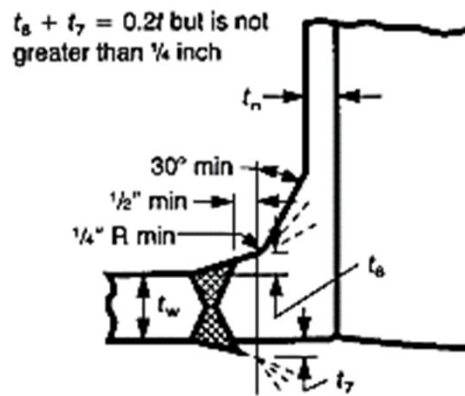


Panel o-1

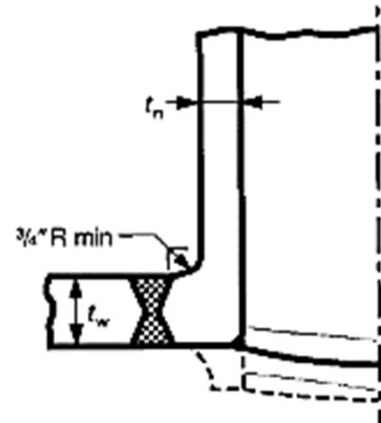
Acceptable Types of Welded Nozzles and Other Connections



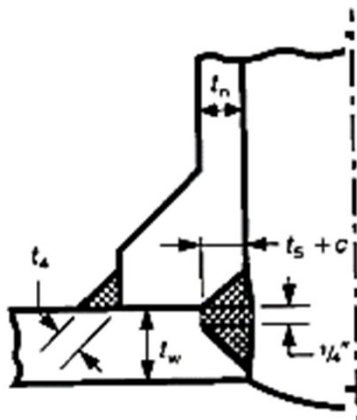
Panel o-2



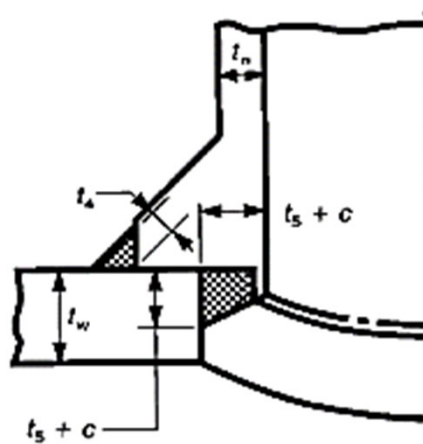
Panel o-3



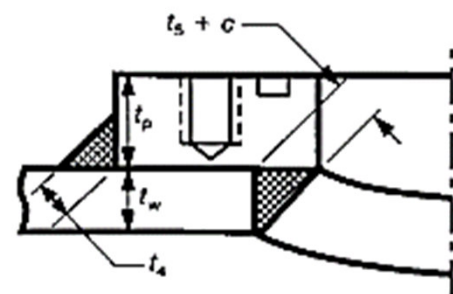
Panel o-4



Panel p

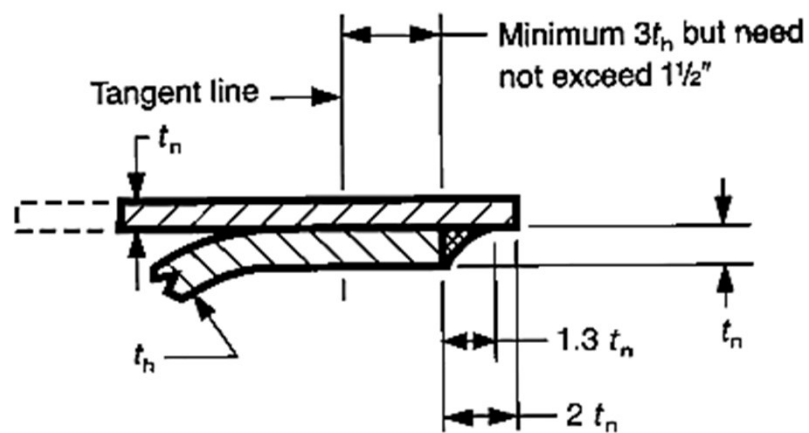
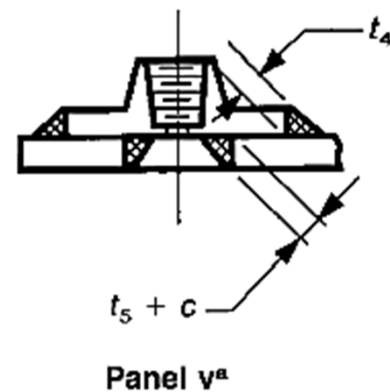
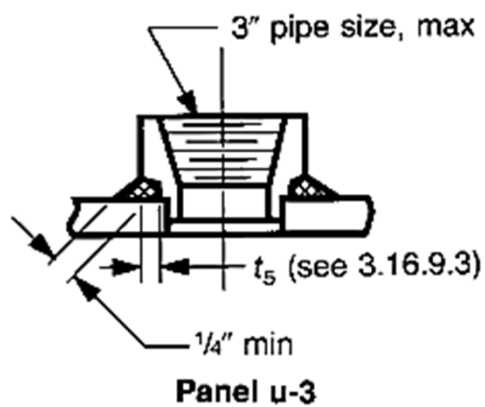
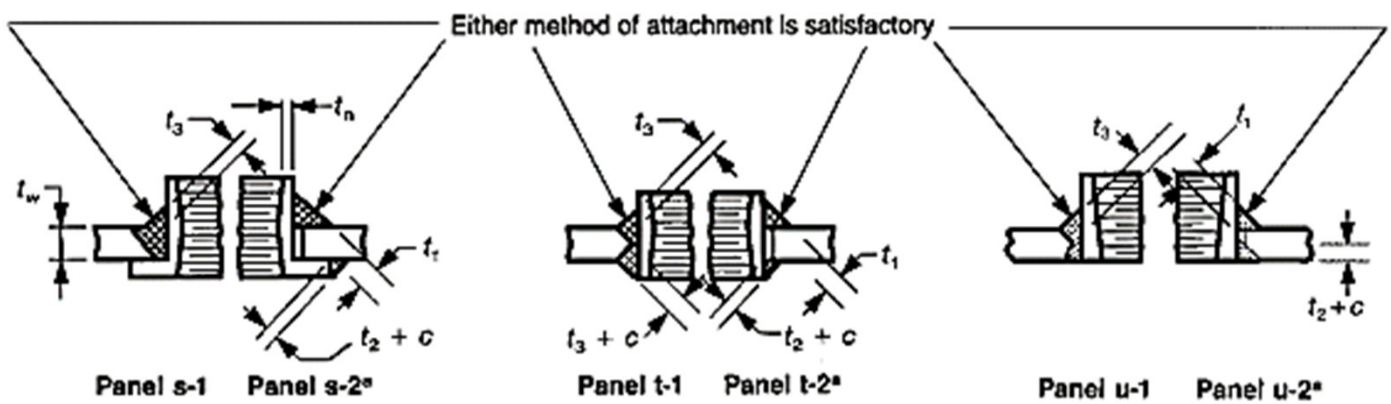


Panel q



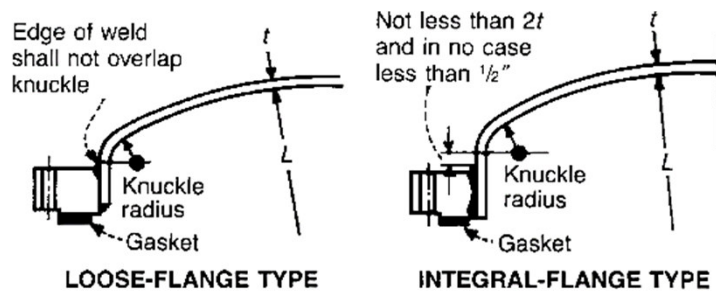
Panel r

Acceptable Types of Welded Nozzles and Other Connections

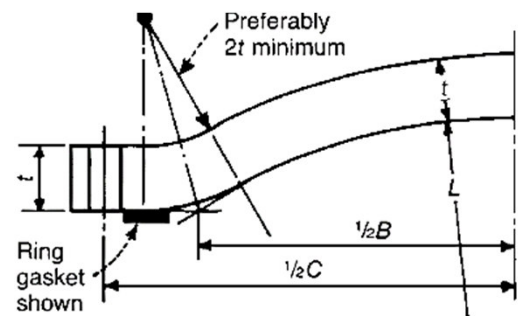


Single-fillet lap weld for heads convex to pressure
Panel w

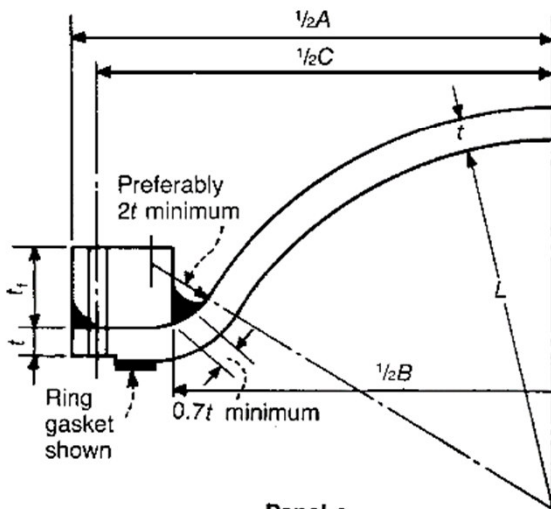
Spherically Dished Steel Plate Covers with Bolting Flanges



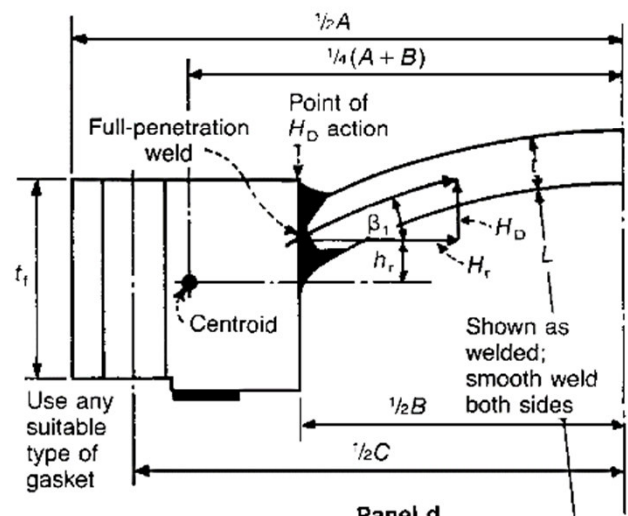
Panel a (See Note 1)



Panel b



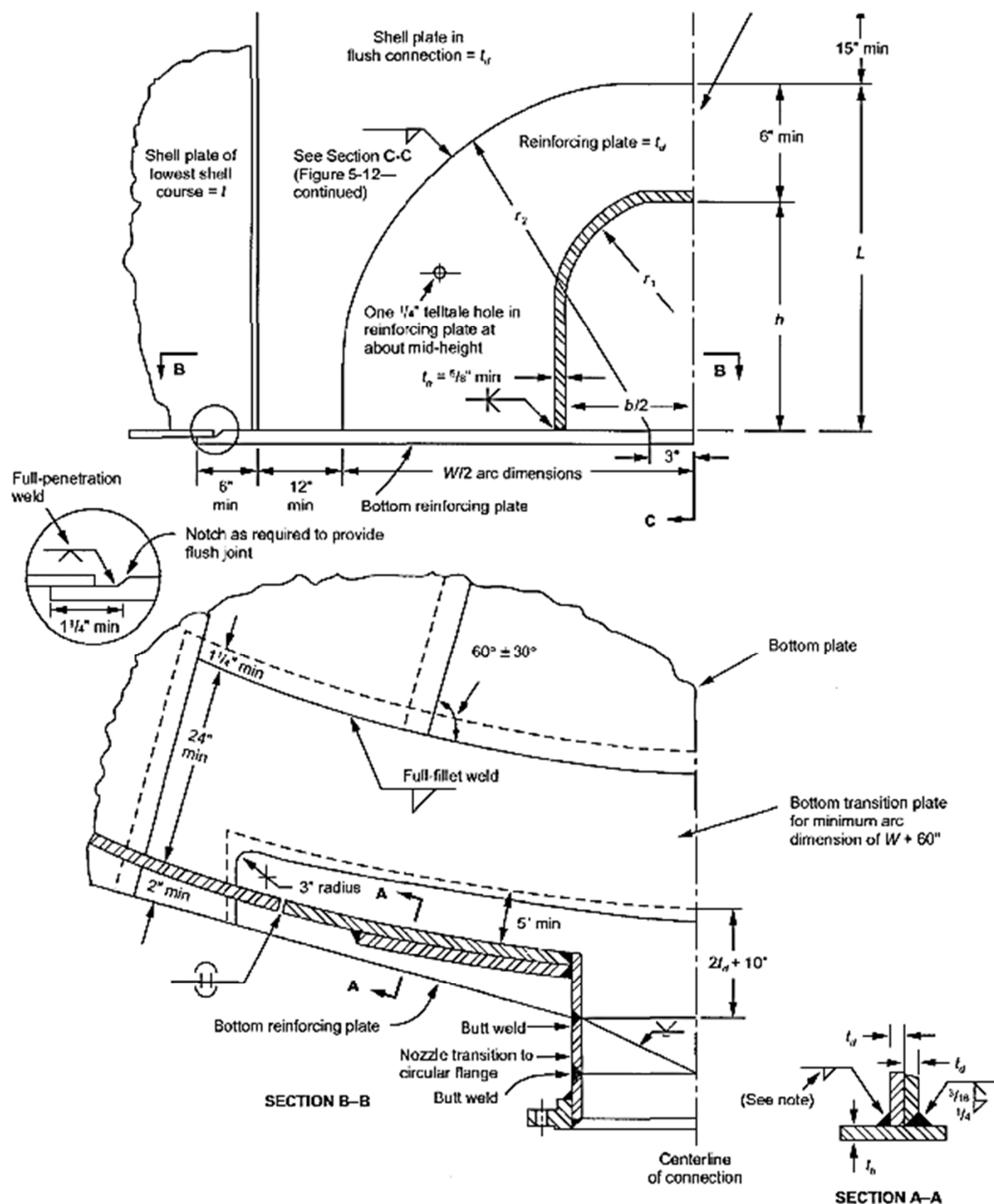
Panel c



Panel d

Notes:

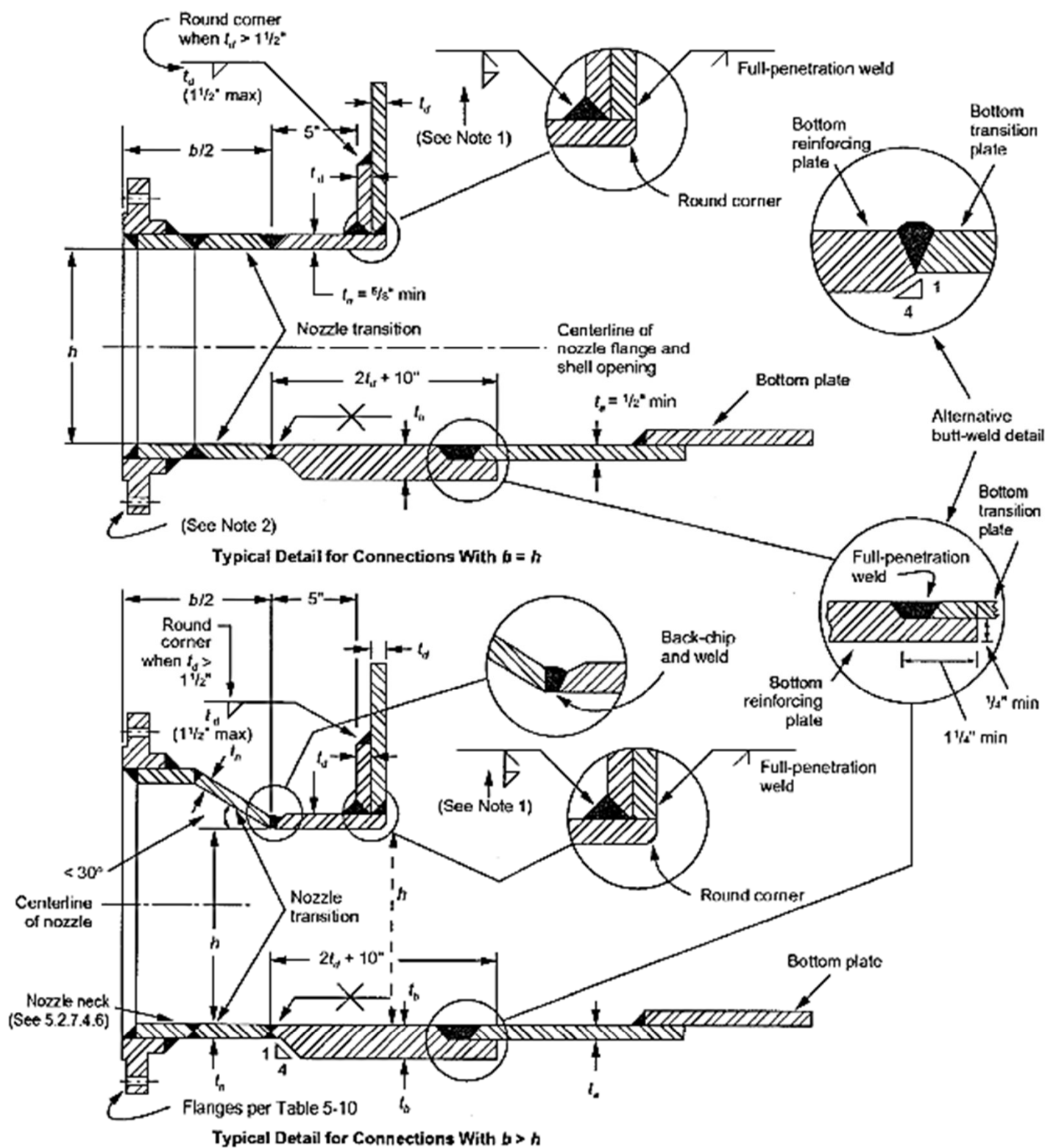
1. Ellipsoidal or hemispherical heads may also be used in the above type of cover plate.
2. In no case shall the radius of dish, L , be greater than the inside of the cover-plate bolting flange (Dimension B).



Note:

1. The thickness of the thinner plate joined with a maximum of $1/2$ inch.

Figure 5-12-Part 1—Flush-Type Sidewall Connection



SECTION C-C

Notes:

1. The thickness of the thinner plate joined with a maximum of $\frac{1}{2}$ inch.
2. Flanges in sizes $1\frac{1}{2}$ - 24 inches shall conform to ASME B16.5. Flanges in sizes larger than 24 inches shall conform to ASME B16.47.

Figure 5-12-Part 2—Flush-Type Sidewall Connection

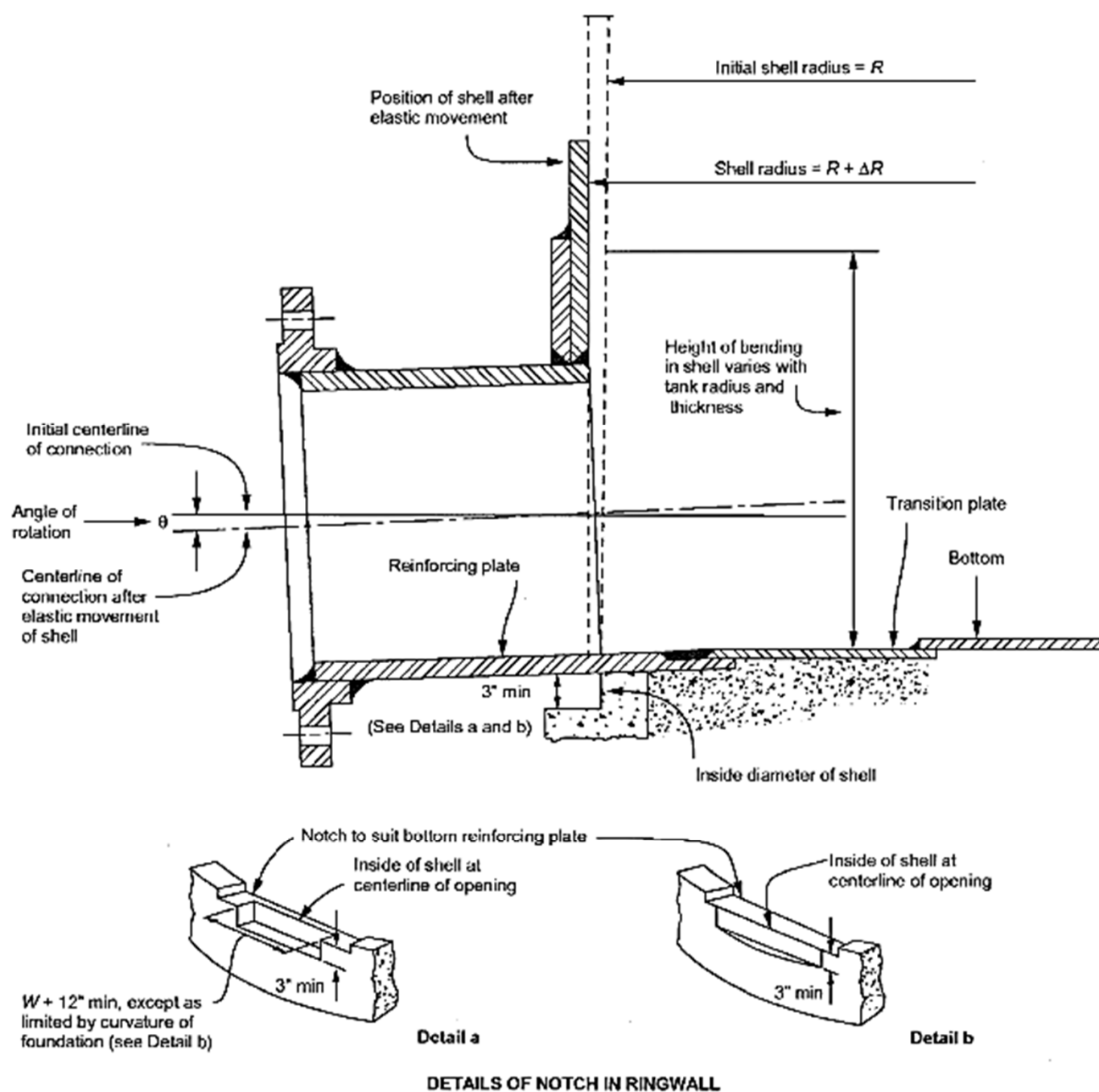


Figure 5-14—Rotation of Sidewall Connection

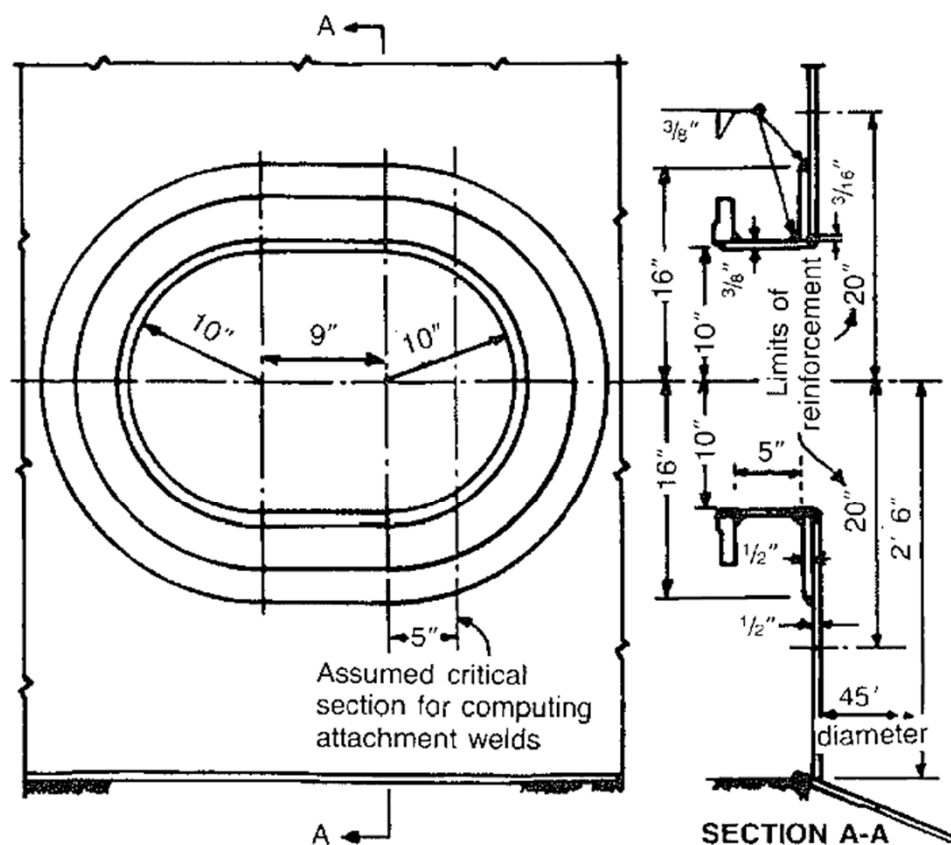
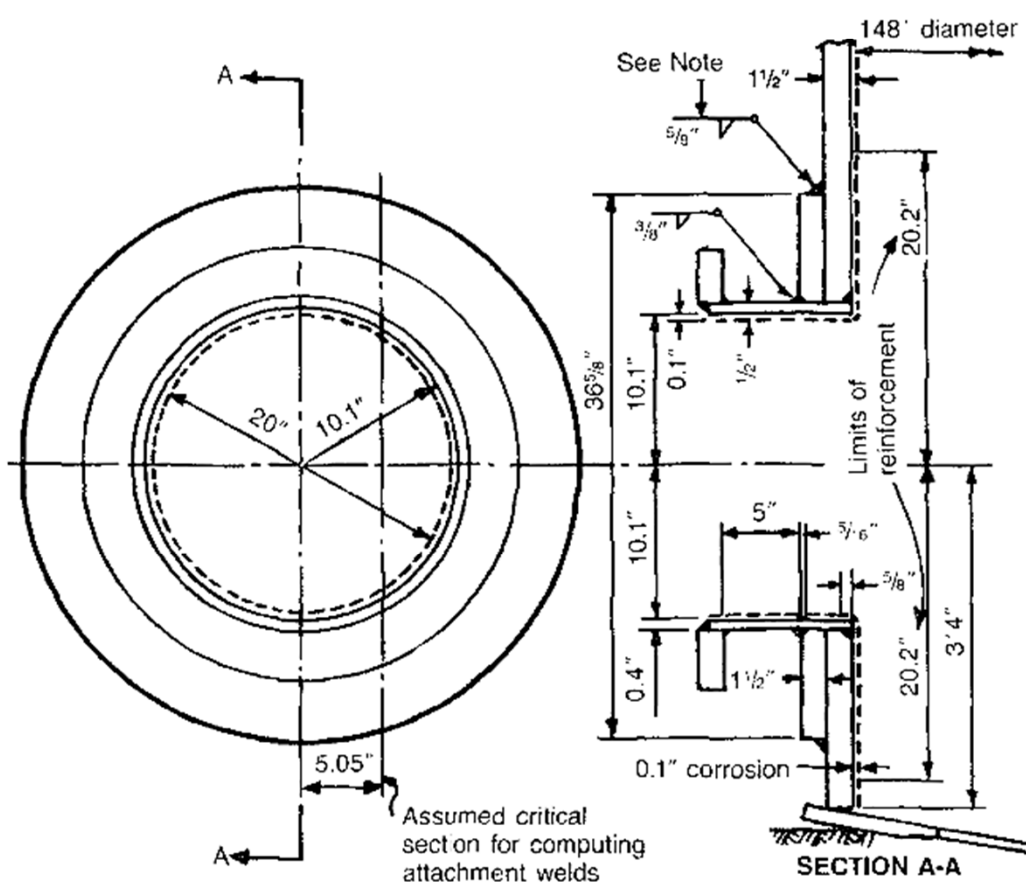


Figure F-5—Example of a Reinforced Opening (See F.5.1)



Note: Upon computation, a $\frac{5}{8}$ -inch outer fillet weld was found to be inadequate for strength requirements. The outer weld should be a 1-inch fillet weld.

Figure F-6—Example of a Reinforced Opening (See F.5.2)

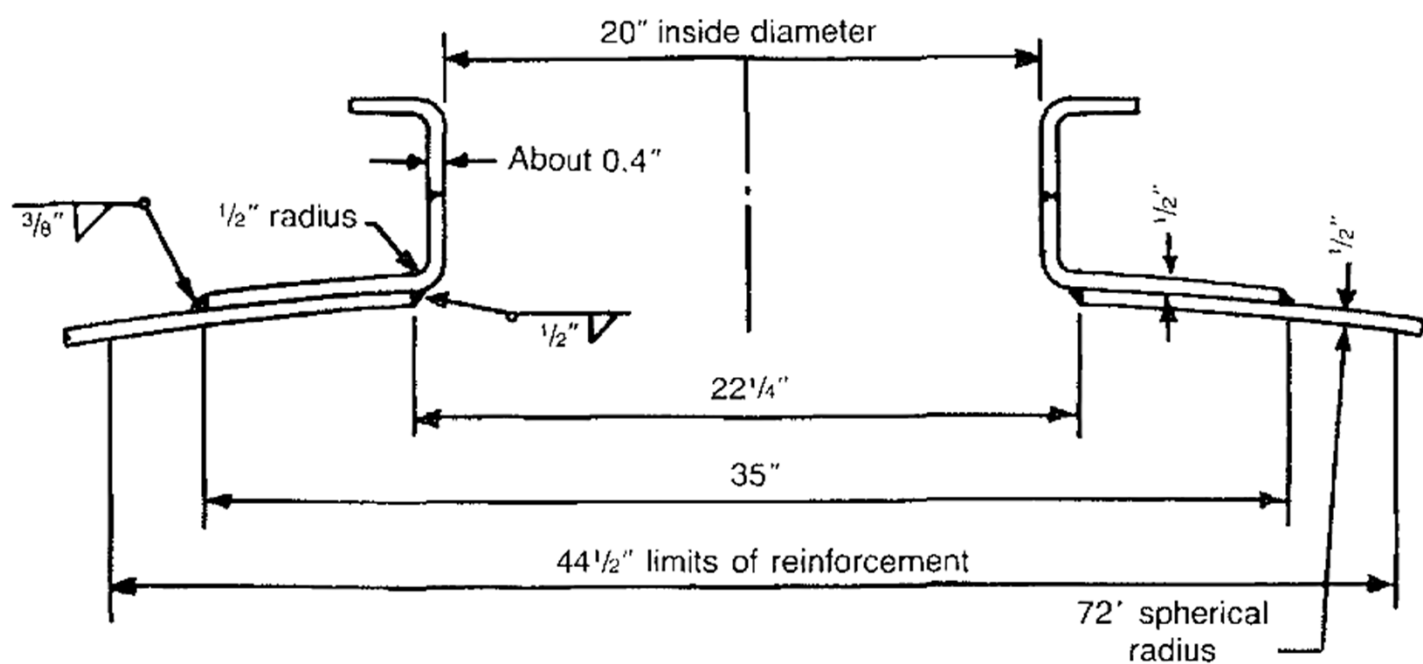


Figure F-8—Example of a Reinforced Opening (See F5.4)

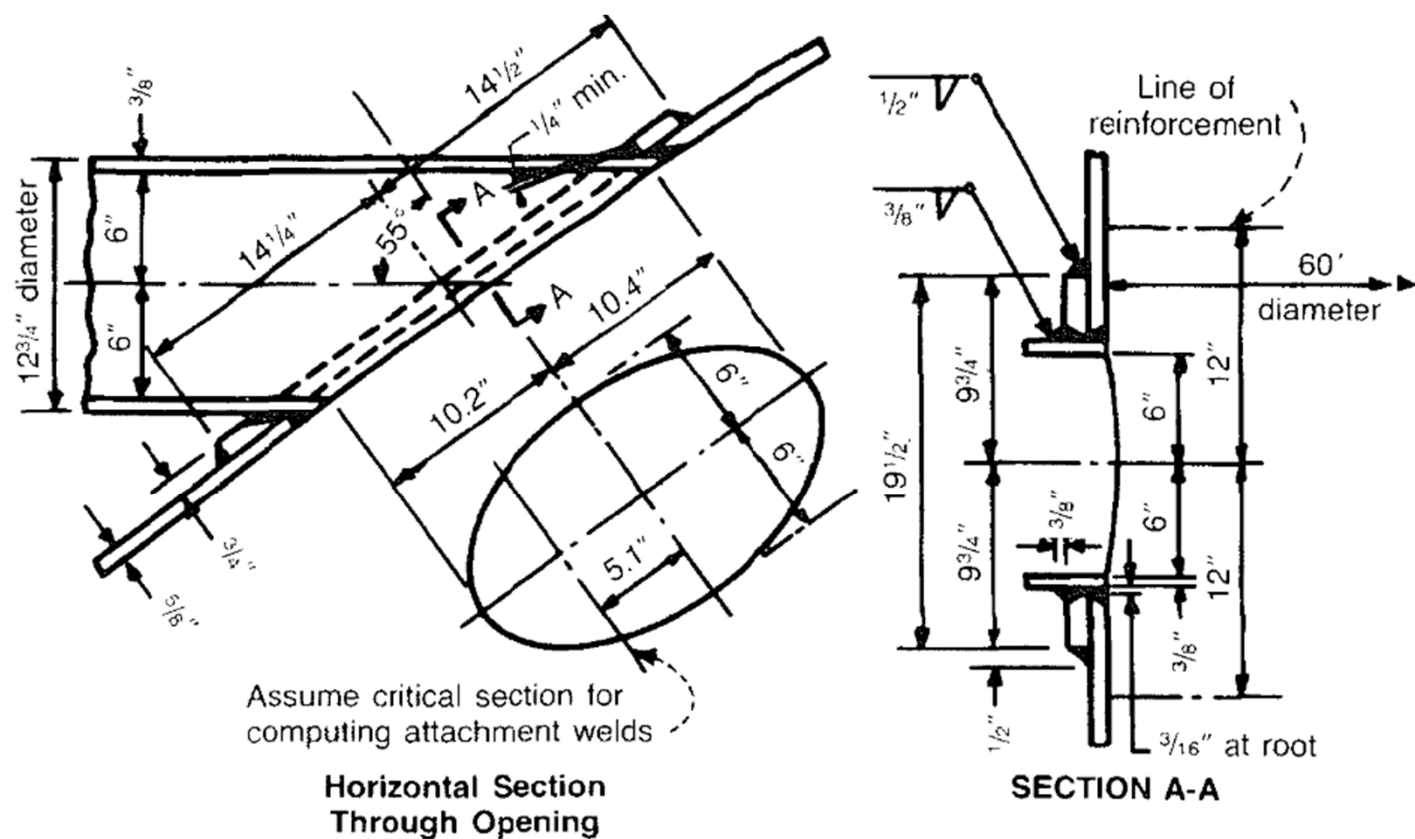


Figure F-7—Example of a Reinforced Opening (See F.5.3)

APPENDIX P—NDE AND TESTING REQUIREMENTS SUMMARY

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Process	Welds for which the Inspection and Testing is Required	Reference Section
Air Test	Through tell-tale holes, all welds of nozzles with single thickness reinforcing plates, saddle flanges, or integral reinforcing pads. Does not include nozzles on the underside of tank bottoms or reinforcements that are too narrow.	5.16.10, 7.18.2.3
Air Test	Completed tank	7.18.2.6
Air Test	Roofs of tanks not designed for liquid loading.	7.18.3.1
Air Test	Appendix R tanks: Shell-to-bottom welds which are not complete penetration.	R8.2.3
Air Test	Appendix R tanks: Completed tank.	R.8.4
Air Test	Appendix R tanks: Outer tank of a double wall refrigerated tank.	R.9
Air Test	Appendix Q: The shell-to-bottom welds that are not full penetration.	Q.8.2.2
Air Test	Appendix Q: Vapor space above hydrostatic test level when the tank is subjected to pneumatic pressure.	Q.8.5.1 & Q.8.5.4
Hydro	Shell only if the roof is not designed for liquid loading.	7.18.3.1
Hydro	Complete tank including the roof if so designed.	7.18.4.1
Hydro	Appendix R tanks.	R.8
Hydro	Appendix Q:	Q.8.1.1
MT	Flush type shell connections: Nozzle-to-tank shell, Repad welds, shell-to-bottom reinforcing pad welds on the root pass, every 1/2 in. of deposited weld, and completed weld.	5.27.11
MT	Welds attaching nozzles, manways, and clean out openings unless given a liquid penetrant test.	7.18.2.2
MT	Appendix R carbon steel tanks: all butt welds not completely radiographed, cylindrical wall to bottom annular plate weld, all welds of openings that are not completely radiographed (includes progressive MT) attachment welds to primary components, and the second layer of weld on joints with permanent backing strips.	R.7.5
MT	Permanent and temporary attachments if not examined by PT.	7.16.3, R.7.8
PT	Appendix R stainless steel tanks: all butt welds not completely radiographed, cylinder wall to bottom annular plate weld, all welds of openings that are not completely radiographed (includes progressive PT) attachment welds to primary components, and the second layer of weld on joints with permanent backing strips.	R.7.5
PT	Welds attaching nozzles, manways, and clean out openings instead of MT if approved. Not for Appendix Q tanks.	7.16.4
PT	Appendix Q: All longitudinal and circumferential butt-welds not completely radiographed.	Q.7.5.a
PT	Appendix Q: Cylindrical wall-to-annular plate welds.	Q.7.5.b
PT	Appendix Q: Opening welds that are not radiographed. PT the root pass and every 1/2 in. of deposited weld metal.	Q.7.5.c
PT	Appendix Q: Attachment welds of non-pressure parts to primary components.	Q.7.5.d
PT	Appendix Q: The second pass of joints on which backing strips are to remain.	Q.7.5.e
PT	Appendix Q: Base metal repairs for erection lug removal areas on primary components.	Q.7.9

Process	Welds for which the Inspection and Testing is Required	Reference Section
RT	100% butt welds of joints with plate thicker than 1.25 in. and tension stress greater than 0.1 times the specified minimum tensile stress of the material and where required by joint efficiency.	5.26.2, 5.26.3
RT	Spot examination for all butt-welded main joints that are not 100% radiographed except for roof joints exempted by Table 5-2, tank bottoms fully supported, and components designed for compressive stress only (5.26.4).	7.17.2.1
RT	Flush-type shell connections.	5.27.11
RT	Appendix Q: 100% of butt-welds with operating stress greater than 0.1 times plate tensile strength.	Q.7.6.1
RT	Appendix Q: Spot RT butt-welds with operating stress less than or equal to 0.1 times the plate tensile strength.	Q.7.6.2
RT	Appendix Q: 100% of butt-welds around thickened insert plates.	Q.7.6.3
RT	Appendix Q: All three plate butt joints except flat bottoms uniformly supported.	Q.7.6.4
RT	Appendix Q: 25% of butt-welded annular plate radial joints shall have 6-in. radiographs taken at the outside of the selected joints.	Q.7.6.5
RT	Appendix Q: 25% of butt-welded compression bar radial joints shall have 6-in. radiographs except as required by 5.26.3.3.	Q.7.6.6
RT	Appendix Q: 100% of longitudinal butt welds in pipes and pipe fittings containing liquids within the limitations of 1.3.2 except for pipe 12 in. diameter or less that has been welded without filler metal and has been hydrotested.	Q.7.7.2
RT	Appendix Q: 100% of longitudinal butt welds in pipes and pipe fittings containing vapor within the limitations of 1.3.2 except for pipe 18 in. diameter or less that has been welded without filler metal and has been hydrotested.	Q.7.7.3
RT	Appendix Q: 30% of all circumferential welded pipe joints.	Q.7.7.4
RT	Appendix Q: 100% of butt-welded joints used to fabricate tank fittings.	Q.7.7.5
RT	Appendix R tanks: Primary-component butt welds.	R.7.6
RT	Appendix R tanks: Butt welds in piping.	R.7.7
VB	Bottom Welds unless tested by tracer gas.	7.18.2.4
VB	Appendix R tanks: all bottom welds, full penetration shell-to-bottom welds, and fillet welds around bottom openings that do not receive repad pressure test.	R.8.2.1, R.8.2.2, R.8.2.5
VB	Appendix Q: All bottom welds and full penetration joints between the shell and bottom.	Q.8.2.1
VB	Appendix Q: Welds above hydro test level when the inner tank pneumatic pressure is equalized on both sides.	Q.8.2.4
VB	Appendix Q: Attachment fillets around bottom openings that cannot be tested by air pressure behind the repads.	Q.8.2.5
VE	Tack welds left in place.	6.9.1.4
VE	All welds.	7.15.5
VE	Shell-plate butt welds.	7.16.1
VE	Appendix Q: Base metal repairs for erection lug removal areas on secondary components.	7.16.1
VE	Welds attaching nozzles, manways, and clean out openings.	7.16.4

Process	Welds for which the Inspection and Testing is Required	Reference Section
Definitions:		
	MT= Magnetic Particle Examination PT = Liquid Penetrant Examination Pen Oil = Penetrating Oil Test RT = Radiographic Testing VB = Vacuum Box Testing VE = Visual Examination	
Acceptance Standard:		
	MT: ASME Section VIII, Appendix 6, Paragraphs 6-3, 6-4, and 6-5 PT: ASME Section VIII, Appendix 8, Paragraphs 8-3, 8-4, and 8-5 VE: API 620, Sections 7.15.5.2 and 7.15.5.3 RT: ASME Section VIII, Paragraph UW-51(b)	
Examiner Qualifications:		
	MT: API 620, Section 7.15.2.3 PT: API 620, Section 7.15.4.3 VE: none VB: none RT: ASNT Level II or III	
Procedure Requirements:		
	MT: ASME Section V, Article 1, T-150 PT: ASME Section V, Article 6 VE: none VB: none RT: A procedure is not required. However, the examination method must comply with ASME Section V, Article 2.	

Table Q-4A—Minimum Thickness for the Annular Bottom Plate: Steel Tanks

Nominal Thickness of First Shell Course (in.)	Design Stress ^a in First Shell Course (lb/in. ²)					
	≤ 19,000	22,000	25,000	28,000	31,000	34,000
≤ 0.75	1/4	1/4	1/4	9/32	11/32	13/32
> 0.75 – 1.00	1/4	1/4	9/32	11/32	7/16	17/32
> 1.00 – 1.25	1/4	1/4	11/32	7/16	17/32	21/32
> 1.25 – 1.50	—	9/32	13/32	17/32	21/32	25/32

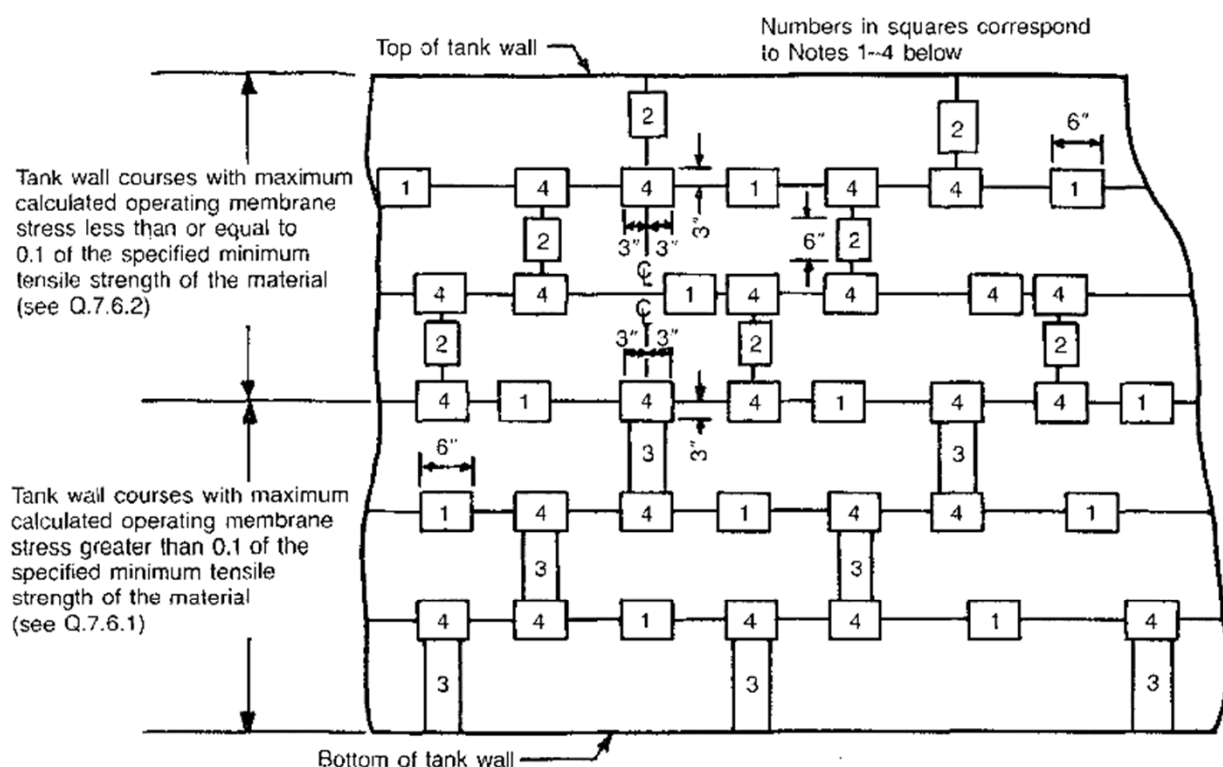
Notes:

The thicknesses and widths (see Q.3.4.1) in this table are based on the foundation providing a uniform support under the full width of the annular plate. Unless the foundation is properly compacted, particularly at the inside of a concrete ringwall, settlement will produce additional stresses in the annular plate. The thickness of the annular bottom plates need not exceed the thickness of the first shell course. The minimum thicknesses for annular bottom plates were derived based on a fatigue cycle life of 1000 cycles for aluminum tanks.

^aThe stress shall be calculated using the formula $[(2.6D) \times (HG)]/t$, where D = nominal diameter of the tank, in ft; H = maximum filling height of the tank for design, in ft; G = design specific gravity; and t = design thickness of the first shell course, excluding corrosion allowance, in in.

Q-14

API STANDARD 620



Notes:

1. One circumferential spot radiograph shall be taken in the first 10 ft. for each welding operator of each type and thickness. After the first 10 ft., without regard to the number of welders, one circumferential spot radiograph shall be taken between each longitudinal joint on the course below.
2. One longitudinal spot radiograph shall be taken in the first 10 ft. for each welder or welding operator of each type and thickness. After the first 10 ft., without regard to the number of welders, one longitudinal spot radiograph shall be taken in each longitudinal joint.
3. Longitudinal joints shall be 100% radiographed.
4. All intersections of joints shall be radiographed.

Figure Q-2—Radiographic Requirements for Butt-Welded Shell Joints in Cylindrical Flat-Bottom Tanks