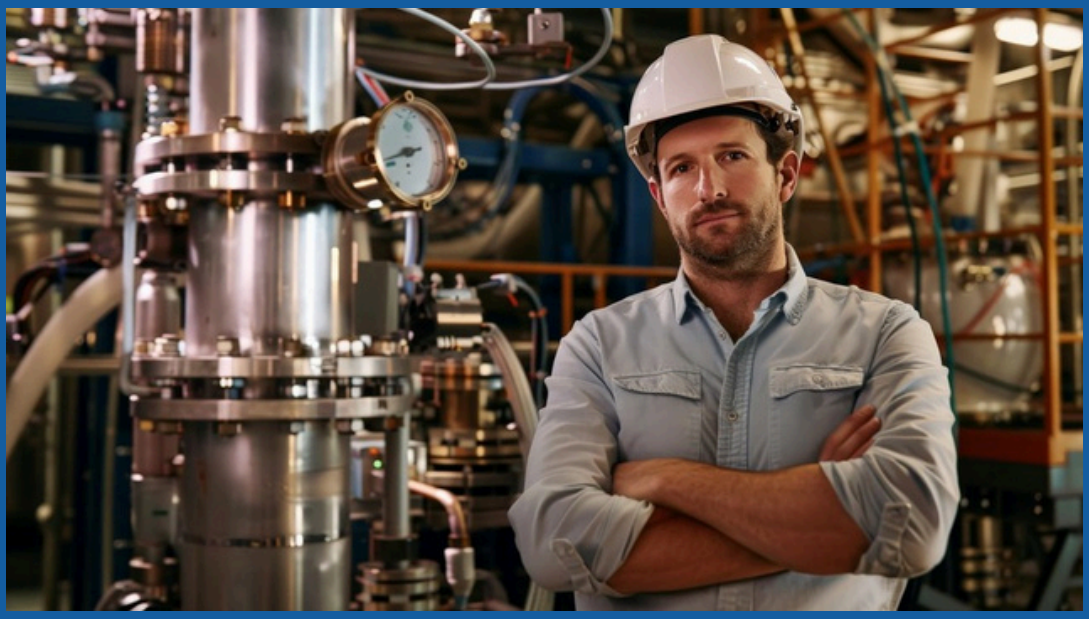
Study Material For Boiler Operation Engineer (BOE) Exams



Theory, Numerical Problems, MCQs and Boiler Drawing Problems from BOE Exams

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PROENGR.IN

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Regn.No._____ **Paper - 1**

Name : _____

(To be written by the candidate)

FIFTH EXAMINATION FOR RECOGNITION OF COMPETENT PERSONS FOR INSPECTION & CERTIFICATION OF BOILERS – DECEMBER 2018

BOILER ACT, INDIAN BOILER REGULATIONS AND THEIR COMPLIANCE AND BOILER DESIGN ENGINEERING

Date : 16/12/2018 **Time : 09:30 – 12:30 Hrs.** **Max. Marks : 150**

GENERAL INSTRUCTIONS :

1. This Question paper contains two parts- Part - A & B.

2. Part - A contains multiple choice questions and use OMR sheet to answer.

3. Part - B contains descriptive questions and use answer paper to answer.

4. All questions in Part-A & B are compulsory.

SEAL

Part-A **(50 X1 = 50 marks)**

(i) Answer all the **50** questions

(ii) Each question carries **one** mark

(iii) Use OMR Sheets to answer

1. As per the Boilers act 1923, which of the following is not a "Boiler Component"?

   a) Superheater b) Economiser

   c) Air preheater d) Reheater

2. As per the Boilers act 1923, Steam Pipe is defined as a pipe through which steam passes if,

   a) Internal Diameter of pipe exceeds 254mm and steam pressure exceeds 1 kg/cm^2 gauge

   b) Internal Diameter of pipe exceeds 254mm and steam pressure less than 1 kg/cm^2 gauge

   c) Internal Diameter of pipe 114.3mm and Steam pressure less than 3.5 kg/cm^2 gauge

   d) All of the above

3. Power to exempt any boiler from the operations of the Boilers Act, is with the _____

a) Central Government
b) Central Boiler Board
c) State Government
d) None of the above

4. Boiler operating at 400^{0}C and above which is subjected for remnant life assessment and if found satisfactory, the life of such boiler is extended for a further period of _____

a) Six years
b) Twelve years
c) Ten years
d) No limit

5. A special class Boiler repairer is eligible to undertake repair of a boiler operating at a pressure up to _____

a) 17.5 kg/cm^2
b) 40.0 kg/cm^2
c) 125.0 kg/cm^2
d) Any boiler pressure

6. Water holding capacity of a shell type Small Industrial Boiler shall not exceed_____

a) 22.75 liters
b) 25.0 liters
c) 150 liters
d) 500 liters

7. A boiler without an integral super heater shall be fitted with a minimum of _____

a) Three safety valves
b) Two safety valves
c) One safety valve
d) Four safety valves

8. Any person who uses the boiler without any certificate or order being in force, shall be _____

a) Punishable with fine which may extend to one lakh rupees
b) Punishable with imprisonment which may extend to two years
c) Punishable with fine which may extend to rupees ten lakhs
d) Not punishable

9. The longitudinal weld joint of the internal flue shall be placed at _____

a) Upper portion of the flue
b) Lower portion of the flue
c) At 12 O' clock position of flue
d) Any angle

10. All butt welds of boiler and super heater tubes shall be tested as required under regulation _____ of IBR 1950.

a) 151 (h) b) 360 (d)

c) 265 d) 561

11. The minimum thickness of stay tube of nominal outside diameter of 70mm but not exceeding 76.2mm is _____

a) 3.12mm b) 3.38mm

c) 3.96mm d) 2.81mm

12. The minimum thickness of boiler plate shall not be less than _____

a) 8.0mm b) 12.0mm

c) 10.0mm d) 6.35mm

13. For manufacturing of drum, the bending of shell shall be done by _____

a) Local heating b) Hammering

c) Machine d) Manually

14. If the design pressure of a pipeline exceeds 17.6kg/cm^2, such pipeline is classified as _____

a) Class I Pipe line b) Class II Pipe line

c) Class III Pipe line d) Class IV Pipe line

15. The size of a relief valve to be provided on an economiser should have a minimum diameter of _____

a) 19mm b) 76.2mm

c) 50.8mm d) 25.4mm

16. The length of covered electrode used for metal arc welding shall not exceed_____

a) 18 inch b) 6 inch

c) 12 inch d) 24 inch

17. Boilers shall be inspected at all stages of construction as prescribed in _____

a) Appendix 'B' b) Appendix 'D'

c) Appendix 'J' d) Appendix 'A'

18. Permissible variation in minimum wall thickness at any point under the nominal wall thickness in hot finished and cold finished seamless pipes shall not be more than _____

a) 7.5% b) +1%

c) -7.5% d) -12.5%

19. The minimum length of the visible portion of the water gauge glass shall be _____

a) 200mm b) 175mm

c) 150mm d) 100mm

20. Welding electrodes after initial check tests shall be subjected to periodic check tests after every _____

a) Twelve months b) Six months

c) Three months d) Two months

21. The temperature of water used as a medium of pressure during hydraulic test of a boiler shall not be greater than _____

a) 50^0C b) 20^0C

c) 30^0C d) 10^0C

22. Memorandum of Inspection Book of each boiler shall be in _____ of IBR:1950.

a) Form I b) Form II

c) Form III A d) Form IV

23. Each tube of boiler and super heater shall be tested by the tube manufacturer to a hydraulic pressure of _____

a) 1.0 kg/mm^2 b) 0.7 kg/mm^2

c) 0.4 kg/mm^2 d) 0.5 kg/mm^2

24. Certificate for use of boilers is in _____ of IBR:1950

a) Form III b) Form II

c) Form VI d) Form I

25. Shorter axis of man hole shall be _____

a) Parallel to the longitudinal central line of the boiler

b) Placed in any angle

c) Perpendicular to the longitudinal central line of the boiler

d) Any angle

26. Hydraulic test of a sub-critical boiler during subsequent examination shall be _____

a) From 1¼ to 1½ times the working pressure of the boiler

b) At the maximum working pressure of the boiler

c) From 1¼ to 1½ times the sub-critical outlet pressure

d) None of the above

27. If an owner has applied for renewal of boiler certificate before the expiry of the previous certificate, be entitled to use the boiler at the maximum pressure entered in the former certificate, pending the issue of orders on the application.

a) No

b) Yes

c) Permitted to run at a lower pressure

d) Permitted to run at a higher pressure

28. Which of the following are the prerequisite conditions before manufacturing a boiler component?

I. Person engaged for welding of boiler component holds welder certificate

II. Proper facilities for design and construction

III. Materials used must meet criteria as laid down in IBR 1950

IV. Design and drawing is approved by inspecting authority

a) II & IV only b) IV only

c) I & II only d) I,II,III & IV

29. Boiler component manufacturer shall engage a _____ before start of manufacturing.

a) Competent Authority

b) Quality Inspector

c) Inspecting Authority

d) Not required for well-known Manufacturer

30. An Inspecting Authority is empowered to:

I. Inspect boiler during manufacturing

II. Carry out stage inspection during erection of a boiler for registration

III. To approve design and drawing of boiler and boiler component

a) I only b) III only

c) II only d) I,II & III

31. Boiler registry number is assigned by

a) Boiler manufacturer
b) Chief Inspector of Boilers
c) Inspector of Boilers
d) Boiler owner

32. Use of the boiler is prohibited under the following condition(s):

I. At a pressure higher than the maximum pressure recorded in certificate or provisional order
II. Boiler certificate is not in force
III. When boiler is not in charge of qualified persons holding certificate of proficiency or competency as required by rules
IV. Without registration as required by the Boilers Act 1923

a) I only
b) IV only
c) I,III & IV
d) I,II,III & IV

33. A firm has fraudulently marked a registry number which is not assigned to their boiler, then the firm_____

a) is punishable for imprisonment up to 24 months
b) is punishable for fine up to one lakh rupees
c) is punishable for fine up to one lakh rupees and imprisonment up to 24 months
d) Any of the above

34. Alteration, addition or renewal of steam pipe is to be carried out by a/ an_____.

a) Approved repairer
b) Boiler component manufacturer
c) a or b
d) None of the above

35. Penalty for use of boiler at a higher pressure than the certified in the boiler certificate is,

a) Imprisonment up to two years
b) Fine of two lakh rupees
c) Fine up to One lakh rupees
d) Imprisonment up to two years and fine up to one lakh rupees

36. Validity of provisional order is for

a) Three months
b) Six months
c) Twelve months
d) Nine months

37. An owner of boiler is bound to produce current boiler certificate to following authority(ies),

a) Commissioner of Police
b) District Magistrate
c) Chief Inspector of Factories
d) All of the above

38. Which of the following heat treatment(s) can be applied to cold drawn carbon steel tubes?

a) Sub-critical annealing
b) Full annealing
c) Normalising
d) Any one of the above

39. What is the minimum tempering temperature of SA 335 grade P91 cold drawn pipes in the final heat treatment?

a) 1040°C
b) 650°C
c) 730°C
d) 675°C

40. In which of the following conditions Post Bend Heat Treatment is required for T91 tube bends?

a) % Thinning is more than 25%
b) OD ≤ 141.3 mm & R/D ≤ 1.5
c) OD > 141.3 mm & R/D ≤ 2.5
d) As specified in material specification

41. Remnant Life Assessment shall be carried out of Heat recovery steam generator operated at a temperature of 480°C

a) after 100,000 Hours of operation
b) after 25 years
c) after 10,000 Hours of operation
d) None of the above

42. In which of the following conditions post weld heat treatment is not required for 1 Cr ½ Mo Pipe butt joints?

a) Outside Diameter less than 127mm
b) Thickness less than 13mm
c) Preheated to 125°C
d) All of the above

43. Maximum and minimum permitted thickness for plain furnace in a shell type boiler is

a) 22mm & 7mm
b) 16mm & 6mm
c) 10mm & 6mm
d) 22mm & 10mm

44. Stress relieving is required for Class I boilers if

a) Carbon content of the steel plate is more than 0.25 %

b) Plate thickness is 20mm

c) Alloy steel is used in manufacturing of boiler

d) All of the above

45. A welder qualified for groove welding for plates is

a) also considered to be qualified for fillet welds in plates

b) also considered to be qualified for branch welding

c) also considered to be qualified for tube butt joint welding

d) None of above

46. Minimum diameter of safety valve to be used for Small Industrial Boiler is

a) 12.7mm b) 12.0mm

c) 10.5mm d) 10.0mm

47. A water tube boiler is operated at a pressure < 50 kg/cm^2 and main steam outlet temp < 400^{0}C; which of the following tests is/are necessary for the purpose of remnant life assessment?

a) Ultrasonic testing b) Magnetic particle testing

c) Dye penetrant testing d) All of the above

48. The space between the coils when the valve is lifted to ¼th of its diameter shall be not less than _____ for full lift valves.

a) 1.6mm b) 1.8mm

c) 2mm d) 1.4mm

49. In shell type boiler the reduction in working pressure is considered when,

a) Age of the boiler exceeding 25 years

b) Age of the boiler exceeding 15 years

c) Working hours of the boiler exceeds 1,00,000 hours at which the boiler operating at 400^{0}C and above

d) None of the above

50. For Small Industrial Boilerwhich of the following statements is true?

a) The fee for inspection is not required

b) The certificate of manufacture of the boiler is not required

c) Operator for these boilers is not required

d) Operator for these boilers shall be a pass in class X or equivalent

Part-B

(i) Answer all the **six** questions

Question No: I **(8 X 2 = 16 Marks)**

1) What is the formula for the portion of the branch available for compensation?

2) Whether tube holes in a header/drum are allowed in welded seams and if yes, explain.

3) Why the syphonic arrangement is provided in the Pressure Gauges of the High pressure steam pipe lines?

4) What is the minimum included angle of bevel ('V' type edge preparation) in fusion welded longitudinal seams?

5) Calculate the working metal temperature for Radiant super heater tube having maximum steam outlet temperature of 440^0C.

6) Calculate the working metal temperature for Integral economiser tubes having maximum water outlet temperature of 210^0C.

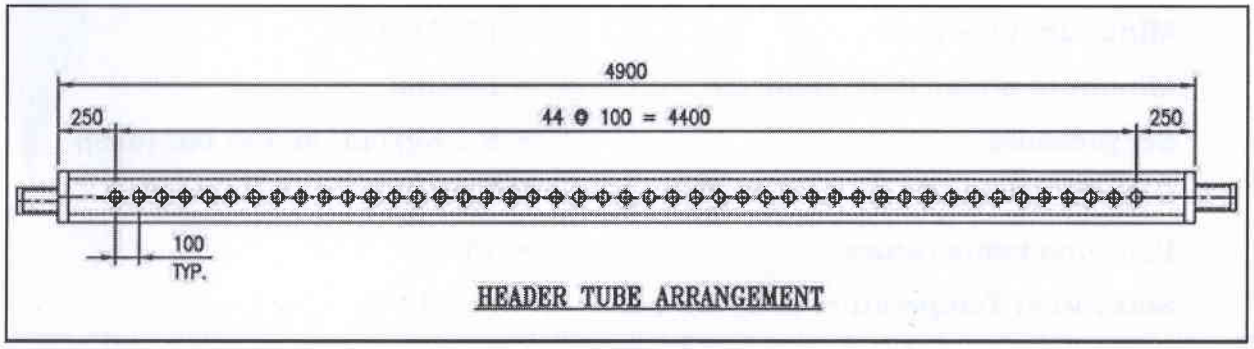
7) Calculate the heat treatment cycle (Soaking temperature and soaking time) for the following component.
   a. Component – Header
   b. Material – SA335 P22 (2¼ Cr-1 Moly)
   c. Pipe schedule – 219.1 X 32 thk
   d. Flat End plate butt welded with thickness 45mm

8) What is the minimum temperature required to perform stress relieving heat treatment of a fabricated carbon steel pipe line?

Question No: II **(4 Marks)**

Calculate the Ligament efficiency for the following header application as per IBR requirement.

Header diameter	:	219.1mm
Header tube hole diameter	:	50mm
Pitch of the hole	:	100mm



HEADER TUBE ARRANGEMENT

Question No: III **(25 Marks)**

Design a Boiler Drum with the following parameters:

Design pressure	- 190 kg/cm^2
Design temperature	- 368.6^{0}C
Thickness of the drum	- 190mm
OD of the drum	- 2118mm
Longitudinal efficiency	- 0.85
Diagonal efficiency	- 0.87
Circumferential efficiency	- 1.572
Material of the drum	- SA 299
R value at room temperature	- 5368.09 Kg/cm^2

Permissible working stress shall be calculated as Per IBR, since E_t value is not available.

a) Calculate the working pressure of the drum and its suitability for this particular application?

b) Calculate the maximum diameter of opening without any compensation?

Question No: IV **(2 X10 = 20 Marks)**

a) Find the thickness of the casting for the safety valve with the following parameters:

Working pressure	- 12 Kg/cm^2
Maximum internal diameter of the chest	- 288 mm
Working temperature	- 343^{0}C
Material for casting	- ASTM 216 Gr.WCB
Maximum Allowable Stress @ 343^{0}C	- 1252 Kg/cm^2

b) What is the discharge capacity of the safety valve having the following parameters:

Minimum bore area	= 18941mm^2
Minimum nozzle bore diameter	= 156mm
Set pressure	= 5.5 Kg/cm^2 (6.405 bar (abs))
Constant value	= 0.48
Relieving temperature	= 330^{0}C
Saturation Temperature @ 6.405 bar	= 161.18^{0}C

Question No: V **(20 Marks)**

Find out (a) tube metal temperature (b) select a suitable tube material and (c) calculate minimum thickness required as per IBR for the following:

Application : Radiant superheater coil

Steam temperature : 450°C

Working pressure : 115 Kg/cm²

Superheater tube diameter (OD) : 44.5mm

Allowable stress value (in Kg/cm²):

Material	400°C	450°C	500°C	550°C
SA-210 Gr.A1	906.53	639.39	322.23	129.50
SA-213 T11	1040.1	988.11	782.12	374.24
SA-213 T22	1162.48	1162.48	824.95	486.4

Question No: VI **(15 Marks)**

Find out the minimum plain tubes thickness for a shell type boiler and check the suitability of thickness provided.

External diameter of the tube = 63.5mm

Nominal thickness of the tube = 3.66mm

Negative tolerance = 12.5 %

Material specification = BS 3059 part I ERW Gr. 320

Max. Permissible stress = 877 kg/cm²

✓ Working Pressure = 10.54 Kg/cm².

********** **End of the question Paper** **********

SEAL

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Regn.No._____ **Paper - 2**

Name: _____

(To be written by the candidate)

FIFTH EXAMINATION FOR RECOGNITION OF COMPETENT PERSONS FOR INSPECTION & CERTIFICATION OF BOILERS – DECEMBER 2018

BOILER DESIGN, MANUFACTURING, MATERIALS, ERECTION, COMMISSIONING, OPERATION AND MAINTENANCE, INSPECTION & CERTIFICATION DURING MANUFACTURE OR OPERATIONS AND HIGH PRESSURE WELDING INSPECTION

Date : 16/12/2018 **Time : 14:00 – 17:00 Hrs.** **Max. Marks : 150**

GENERAL INSTRUCTIONS:

1. This Question paper contains two parts- Part-A & B.

2. Part - A contains multiple choice questions and use OMR sheet to answer.

3. Part-B contains descriptive questions and use answer paper to answer.

SEAL

Part-A **(50 X1 = 50 marks)**

(i) Answer all the **50** questions

(ii) Each question carries **one** mark

(iii) Use OMR Sheets to answer

1. What is the limit of Sulphur and Phosphorus in steel for boiler applications?

a) Not more than 0.05% b) Not more than 0.5%

c) Not more than 0.06% d) Not more than 0.6%

2. What is the width of reduced tensile section specimen?

a) At least 25mm b) At least 20mm

c) At least 30mm d) At least 12mm

3. Which impurity in water requires critical attention in a high pressure boiler used for generation of power?

a) Hydrogen b) Ammonia

c) Silica d) None of the above

4. Continuous increase of flue gas temperature at inlet to chimney for given steam outputs is an indication of

a) Higher effectiveness of boiler

b) High calorific value of coal being burnt

c) Fouling of heat transfer surfaces

d) None of the above

5. What is the minimum temperature of tempering for T11 tubes in a normalized & tempered condition?

a) 675^0C b) 650^0C

c) 730^0C d) 100^0C

6. During the bend test of a Steel plate having a tensile strength of 54 kg/mm^2 and thickness as T, the test piece shall withstand without fracture and bent cold through 180^0 around a mandrel of radius_____

a) 0.5T b) 1.5T

c) 2T d) 3T

7. Minimum required size of man hole to be provided in the upper part of boiler having a shell diameter of 1150mm is

a) 9 Inches x 7 Inches b) 14 Inches x 10 Inches

c) 15 Inches x 11 Inches d) 12 Inches x 9 Inches

8. What is/are the criteria for selection of material for super-heater tube?

a) It should be oxidation resistant

b) It should be high creep resistant

c) It should be cost effective

d) All of the above

9. Which impurity in water requires critical attention in a high pressure boiler used for generation of power?

a) Hydrogen b) Ammonia

c) Silica d) None of the above

10. Continuous increase of flue gas temperature at inlet to chimney for given steam outputs is an indication of

a) Higher effectiveness of boiler

b) High calorific value of coal being burnt

c) Fouling of heat transfer surfaces

d) None of the above

11. The minimum thickness of plate used for welder's initial qualification test is

a) 25mm b) 20mm

c) 16mm d) 13mm

12. Maximum number of longitudinal seam/seams allowed in each section of internal flues used in a shell type boiler is

a) Two b) One

c) Four d) Three

13. Which part of the sub critical boiler requires mandatory hydraulic test to be done at the Manufacturer's Works?

a) All components b) Boiler drum

c) Boilers drums and headers d) All components except piping

14. Intermediate stress relieving is required for shells of Drum when D/T is less than_____, where D is inside Diameter and T is shell plate thickness.

a) 10 b) 15

c) 20 d) 25

15. What is the maximum permissible working pressure percentage for a 70 year old shell type boiler?

a) 95% b) 60%

c) 40% d) 85%

16. Incomplete penetration in single V butt joint could be caused by

a) Large root face b) Less root gap Low

c) Included Angle d) Any of the above

17. The term "heating surface" in boiler means

a) Area of the grate

b) Volume of the furnace

c) Surface area of pressure parts which is in contact with the flue gases

d) None of the above

18. The function of superheater in a boiler is to

a) Increase the temperature of air

b) Increase the rate of combustion of fuel

c) Increase the temperature of steam above the saturation temperature

d) None of the above

19. What is the most important feature of visual inspection?

a) It can detect any surface discontinuities

b) It is able to prevent many discontinuities before the weld is complete

c) a & b

d) None of the above

20. A main steam stop valve body is to be made of F91 material. If the manufacturer wants to use an equivalent casting material for this body, which material should he use?

a) WC6 b) WC9

c) WC91 d) C12A

21. What is the maximum temperature for which cast iron valves are permitted to be used as per IBR?

a) 220°C b) 427°C

c) 454°C d) None of the above

22. Which of the following is not a destructive testing?

a) Tensile testing b) Bend testing

c) Hardness testing d) None of the above

23. Which of the following tests is not suitable for non-magnetic materials?

a) LPI b) ECT

c) MPI d) All of the above

24. The ratio of heat utilised to produce steam and the heat generated in furnace is known as

a) Boiler effectiveness b) Boiler evaporative capacity

c) Boiler efficiency d) None of the above

25. The superheater safety valve set pressure as compared to drum safety valve set pressure must be at

a) A higher value b) A lower value

c) The same value d) None of the above

26. A welder qualified in Vertical position is automatically qualified for welding in

a) Vertical position only

b) Both Horizontal and Vertical positions

c) Flat, Horizontal and Vertical positions

d) Any Position

27. A nozzle opening in a P91 header falls exactly on a butt joint. What are the pre-requisites for making this opening?

a) The joint shall be volumetrically examined

b) The joint shall be stress relieved

c) Both a & b

d) None of the above

28. What is the minimum length of skirt to be provided on a hemispherical dished end?

a) 25mm b) 38mm

c) 50mm d) Minimum skirt is not mandatory

29. The term used to define the period of time in which the test part is covered with penetrant in LPI is

a) Waiting time b) Soak time (drain time)

c) Penetration time (dwell time) d) Bleed-in time

30. The balanced draft furnace is one which is using

a) Induced draft fan and chimney

b) Induced draft fan and forced draft fan

c) Forced draft fan and chimney

d) None of the above

31. Radiography is best suited for the identification of

a) Volumetric defects b) Tight linear cracks

c) Material lamination d) None of the above

32. The tendency of an alternating current to flow only along the surface of the conductor is due to

a) Compton effect b) Super conductivity

c) Skin effect d) Hall effect

33. What is the permissible shape of manhole openings in a shell type boiler?

a) Circular
b) Elliptical
c) Circular or Elliptical
d) None of the above

34. What are the documents the owner must provide to the State's Chief Inspector of Boilers to register a completed boiler?

a) An approved plan showing the general arrangement of the boiler
b) Details of the principal components and methods of manufacture, inspection and testing
c) A certificate issued by the Inspecting Authority certifying that the materials were tested and the boiler built under their supervision
d) All of the above

35. The welders engaged in welding of boilers, boiler components, economisers, feed pipes, steam pipes and super heaters shall possess certificate in

a) Form X
b) Form XI
c) Form XIII
d) None of the above

36. During hydraulic test of components, the test pressure shall be raised gradually under proper control at all times so that it never exceeds

a) by more than 2% of the required pressure
b) by more than 4% of the required pressure
c) by more than 6% of the required pressure
d) None of the above

37. Every super-critical boiler shall be hydraulically tested after erection at site in the presence of a Competent Person to

a) 1¼ times the maximum working pressure at the super heater outlet
b) 1½ times the maximum working pressure at the super heater outlet
c) 2 times the maximum working pressure at the super heater outlet
d) None of the above

38. Butt welds are

a) Permitted within bends
b) Not permitted within bends
c) Permitted within bends with certain conditions
d) None of the above

39. The design metal temperature should not exceed _____ for seamless carbon steel pipe as per IBR

a) 425°C b) 454°C

c) 425°F d) 454°F

40. A boiler is said to be of water tube type if

a) Water passes through tubes & hot product of combustion surrounds the tubes

b) The hot product of combustion passes through the tubes & water surrounds it

c) Forced circulations takes place

d) None of the above

41. The essential elements of a material used in high temperature steel tubes are

a) Zinc & Niobium b) Chromium & Molybdenum

c) Titanium & Vanadium d) Cobalt & Zirconium

42. The loss of energy as sound moves through a specimen is called

a) Absorption b) Reflection

c) Propagation d) Attenuation

43. Static marks which are black tree-like or circular marks on a radiograph are often caused by

a) Film being bent when inserted in a cassette or holder

b) Foreign material or dirt imbedded in screens

c) Scratches on lead foil screens

d) Improper film handling techniques

44. What is the maximum allowable working pressure of blow down pipe, which cannot be subjected to full boiler pressure?

a) 1/2 of the pressure b) $1/4^{th}$ of the pressure

c) $3/4^{th}$ of the pressure d) full pressure

45. The main function of the attemperator in a boiler is to :

a) Control the boiler pressure

b) Increase the generation of steam

c) Control the steam temperature

d) All of the above

46. What is the NDE requirement for a Class 1 piping butt joint where the pipe OD is 159mm and thickness is 18mm and the completed pipe line is subjected to hydraulic test after erection?

a) 2% RT per welder

b) 5% RT per welder

c) 10% RT per welder

d) 100% RT

47. Automatic firing controls of a Boiler shall shut off the fuel supply to the burners when

a) There is Flame failure or pilot flame failure in the cases of gas, oil or pulverized fuel fired boilers

b) There is Failure to ignite the fuel at the burner within a pre-determined time

c) The water level in a boiler with a perceptible water level falls below a pre-determined safe level

d) Any of the above

48. For small industrial horizontal fire tube boiler, the lowest visible part of the water gauge shall be located at a distance of _____ above the lowest permissible water level.

a) At least 100mm b) At least 25mm

c) At least 80mm d) At least 75mm

49. The fusible metal used in a fusible plug shall be an alloy melting readily at a temperature _____ in excess of the saturated steam temperature at the maximum permissible working pressure of the boiler.

a) not less than 300^0F

b) not less than 200^0F

c) not less than 150^0F

d) not less than 50^0F

50. Who is authorized to issue IBR certificates under Form II?

a) Maker

b) Maker's Representative

c) Competent Person

d) Inspecting Authority

Part-B

(i) Answer only any **five** questions.

(ii) Each Question may have many sub-sections. Write the Question number and sub-section number clearly against each answer.

(iii) Total number of answered question should not exceed five. If answered more than five questions only first five answered question will be evaluated. Choose wisely and answer only any five questions.

(iv) Each question carries **Twenty** marks

Question No: 1 **(20 Marks)**

The design parameters of a seamless shell in a water tube boiler are as follows:

a. Shell ID : 301.4mm

b. Shell minimum thickness : 52.5mm

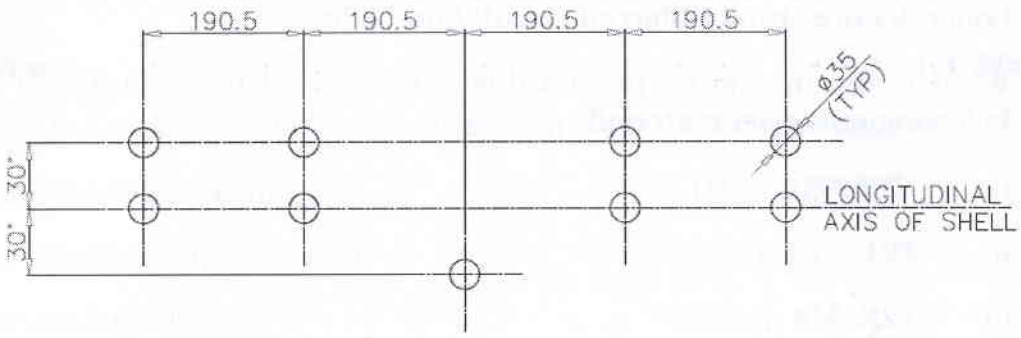
c. Shell material : SA335P12

d. Shell design pressure : 197.4 kg/cm^2(g)

e. Shell design temperature : 479^{0}C

f. Allowable stress : 1022.7 kg/cm^2

The drilling in the shell is as per the enclosed drilling plan.



Determine the following,

a) Efficiency of ligament. The circumferential distance for 30^0 shall be taken as 90.7mm. Evaluation of diagonal efficiency shall be as per the formula specified in Regulation 215.

b) For the least ligament determine whether the thickness of the shell provided is sufficient?

Question No: 2 **(20 Marks)**

Considering the following design conditions in a header of a water tube boiler:

Find the minimum thickness required for

(i) Hemispherical dished end cover with no hole drilled.

(ii) Flat end cover. (The flat end cover is butt welded with the shell).

a.	Header ID	: 185.5mm
b.	Header minimum thickness	: 43.8mm
c.	Header material	: SA106GRC
d.	Header design pressure	: 209 kg/cm2(g)
e.	Header design temperature	: 368^{0}C
f.	Allowable stress	: 1298.5 kg/cm^2
g.	Dish material	: SA234WPC
h.	Dish Allowable stress	: 1298.5 kg/cm^2
i.	Flat end material	: SA105
j.	Flat end Allowable stress	: 1214 kg/cm^2

Question No: 3

a. Define - Calculation pressure **(2 Marks)**

b. Define - Design pressure with respect to a natural or assisted circulation boiler & once through forced circulation boiler **(2 Marks)**

c. What is the maximum permissible design metal temperature in ^{0}C for the following grades of material? **(8 Marks)**

i. TP347H

ii. T91

iii. 12X1M¢

iv. TP316L

d. For an economizer tube, the maximum water temperature is 380^{0}C. What is the working metal temperature? **(2 Marks)**

e. What is the minimum thickness permitted for a dished end? **(2 Marks)**

f. Explain the hydraulic test for tubes done at manufacturer works and how to calculate maximum permitted test pressure, under what condition the hydraulic test for tubes can be dispensed? **(4 Marks)**

Question No: 4 **(20 Marks)**

Given below are the details of a circular reversal chamber used in Class I shell type Boiler:

Boiler Design pressure : 20.25 kg/cm^2(g)

Saturation temperature : 211^{0}C

Circular reversal chamber outside diameter : 2500mm

Length of circular reversal chamber between effective points of support 950mm

Commercially available plate thicknesses are 28mm, 32mm, 36mm, 40mm, 45mm

Designer has used circular reversal chamber thickness as 32mm

Material properties are given in table below:

Temperature in ^{0}C	Upto 250	275	300	325
Elevated temperature yield stress in Kgf/cm^2	2160	2143	2083	2024
Modulus Of Elasticity in Kgf/cm^2	1982000	1967000	194700	1921500

a) Check whether provided thickness of circular reversal chamber is adequate.

b) If not, what are the avenues to make the design safe? Provide basis of calculations provided for the avenues opted. Changing the diameter and Length of circular reversal chamber between effective points of support is not possible. Plate material having higher strength is not available.

Question No: 5 **(20 Marks)**

Given below are the details of a nozzle fitted to a class I shell type boiler:

Boiler Working pressure : 10.54 kg/cm^2

Boiler Shell outside diameter : 3200mm

Boiler shell thickness : 16mm

Outside diameter of nozzle seamless pipe : 219.1mm

Diameter of opening in shell : 222mm

Nozzle pipe thickness : 12.7mm

Nozzle projection inside shell : 78mm

Nozzle projection outside shell : 200mm

Tensile strength of Shell material : 4921 kg/cm^2

Tensile strength of nozzle material : 4218 kg/cm^2

Area of nozzle welds that can be taken for compensation : 300 mm^2

a) Establish whether compensation is required or not for this nozzle to shell attachment.

b) If yes, calculate compensation pad width. Compensation pad is made out of 10mm thickness plate. Same material is used for shell and compensation pad.

Question No: 6 **(4 X 5 = 20 Marks)**

(i) Explain the functions of the Flux used in Submerged Arc Welding (SAW) process.

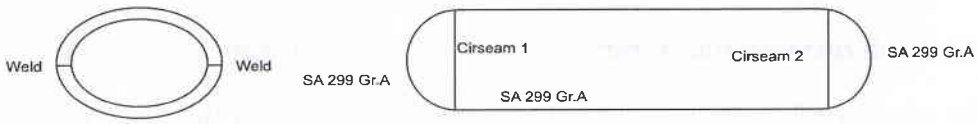
(ii) Explain the reasons for Tungsten Inclusion in Gas Tungsten Arc Welding (GTAW) process.

(iii) Explain the meaning of all the characters used in classification of Electrode E7018. Why low hydrogen electrodes are preferred in Shielded Metal Arc Welding (SMAW) process?

(iv) List down a minimum of four possible weld defects in SMAW process and ways to eliminate each defect.

Question No: 7 **(20 Marks)**

A Manufacturer has to manufacture a Boiler Drum as below. Prepare a checklist with reference to the applicable IBR regulations and brief the requirements stated there-in w.r.t raw materials, manufacturing, examination, inspection, testing and certification.



Raw material : Plate SA 299 Gr. A

Shell Plate Thickness : 185mm; Inside Radius : 874mm;

Hemispherical EC – Thickness : 150mm; Radius: 874mm.

Question No: 8

a) What is the purpose of Post Weld Heat treatment in fabrication of boiler & boiler components? Explain Normalizing & Solution Annealing Heat treatments and also elucidate the differences between Stress Relieving and Tempering. **(10 Marks)**

b) Is it advisable to perform Normalizing heat treatment in a local spot in a component? Give reasons for your answer with metallurgical explanation. **(5 Marks)**

c) What is meant by a Design proof test? Name any three proof tests and explain one proof test permitted by IBR. **(5 Marks)**

Question No: 9

a) Explain the effect of the following alloying elements in Steel: **(10 Marks)**

(i) Chromium

(ii) Molybdenum

(iii) Vanadium

(iv) Tungsten

b) What are the factors that affect weld distortion? Explain each one of them. **(5 Marks)**

c) Explain "Soak band", "Heated band" and "Gradient control band" w.r.t. local heat treatment of steel. **(5 Marks)**

Question No: 10 **(20 Marks)**

Mention any five Weld discontinuities observed on a Radiograph & briefly explain about their characteristic appearance on a Radiograph with sketches

Question No: 11 **(4 X 5 = 20 Marks)**

1) What is departure from nucleate boiling? Why it is to be avoided?

2) What is once through boiler? How it is different from drum type boiler?

3) What is the function of an economiser? What is steaming economiser?

4) Differentiate between a supercritical and subcritical boiler.

Question No: 12 **(4 X 5 = 20 Marks)**

1) Explain the situations warranting immediate shut down of boilers

2) Why and how boiler internal inspection is carried out during annual inspection?

3) What is boiler purging and explain its purpose?

4) What is soot blower and why it is required?

Question No: 13 **(4 X 5 = 20 Marks)**

1) What is attemperator?

2) What is the purpose of a reheater in a boiler?

3) Why, when and how boiler preservation is carried out?

4) What is acid cleaning and alkali boil out in a boiler?

Question No: 14 **(20 Marks)**

Explain the criticality of the following boiler water chemistry parameters and the methods for controlling the same

a) Dissolved solids

b) pH

c) Dissolved oxygen

d) Silica

Question No: 15

1) What is conductivity of feed water and how it is controlled? **(5 Marks)**

2) What is the allowable pH value of feed water and why it is to be maintained? **(5 Marks)**

3) What is the purpose of High Pressure heaters and Low Pressure heaters? Explain with the help of Rankine cycle. **(10 Marks)**

********** **End of the question Paper** **********