

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.

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°C	b) 650°C
c) 730°C	d) 100°C

6. During the bend test of a Steel plate having a tensile strength of 54 kg/mm² and thickness as T, the test piece shall withstand without fracture and bent cold through 180° 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
- Vertical position only
 - Both Horizontal and Vertical positions
 - Flat, Horizontal and Vertical positions
 - 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?
- The joint shall be volumetrically examined
 - The joint shall be stress relieved
 - Both a & b
 - None of the above
28. What is the minimum length of skirt to be provided on a hemispherical dished end?
- 25mm
 - 38mm
 - 50mm
 - 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
- Waiting time
 - Soak time (drain time)
 - Penetration time (dwell time)
 - Bleed-in time
30. The balanced draft furnace is one which is using
- Induced draft fan and chimney
 - Induced draft fan and forced draft fan
 - Forced draft fan and chimney
 - None of the above
31. Radiography is best suited for the identification of
- Volumetric defects
 - Tight linear cracks
 - Material lamination
 - None of the above
32. The tendency of an alternating current to flow only along the surface of the conductor is due to
- Compton effect
 - Super conductivity
 - Skin effect
 - 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) $1\frac{1}{4}$ times the maximum working pressure at the super heater outlet
 - b) $1\frac{1}{2}$ 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) 1/4th of the pressure
 - c) 3/4th 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°F
 - b) not less than 200°F
 - c) not less than 150°F
 - d) not less than 50°F
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

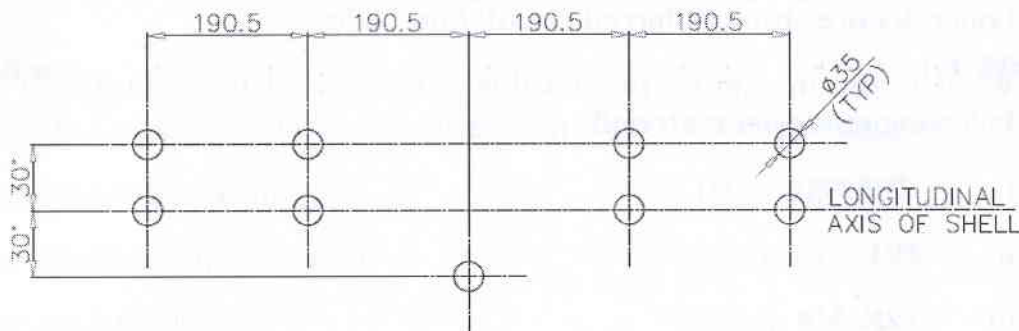
Question No: 1

(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/cm²(g)
- e. Shell design temperature : 479°C
- f. Allowable stress : 1022.7 kg/cm²

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



Determine the following,

- a) Efficiency of ligament. The circumferential distance for 30° 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°C
 - f. Allowable stress : 1298.5 kg/cm²
 - g. Dish material : SA234WPC
 - h. Dish Allowable stress : 1298.5 kg/cm²
 - i. Flat end material : SA105
 - j. Flat end Allowable stress : 1214 kg/cm²

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 °C for the following grades of material? **(8 Marks)**
 - i. TP347H
 - ii. T91
 - iii. 12X1Mφ
 - iv. TP316L
- d. For an economizer tube, the maximum water temperature is 380°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/cm²(g)

Saturation temperature : 211°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 °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

- Check whether provided thickness of circular reversal chamber is adequate.
- 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/cm²

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/cm²

Tensile strength of nozzle material : 4218 kg/cm²

Area of nozzle welds that can be taken for compensation : 300 mm²

- 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

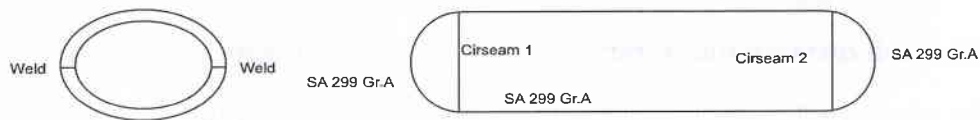
(4 X 5 = 20 Marks)

- (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)**

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