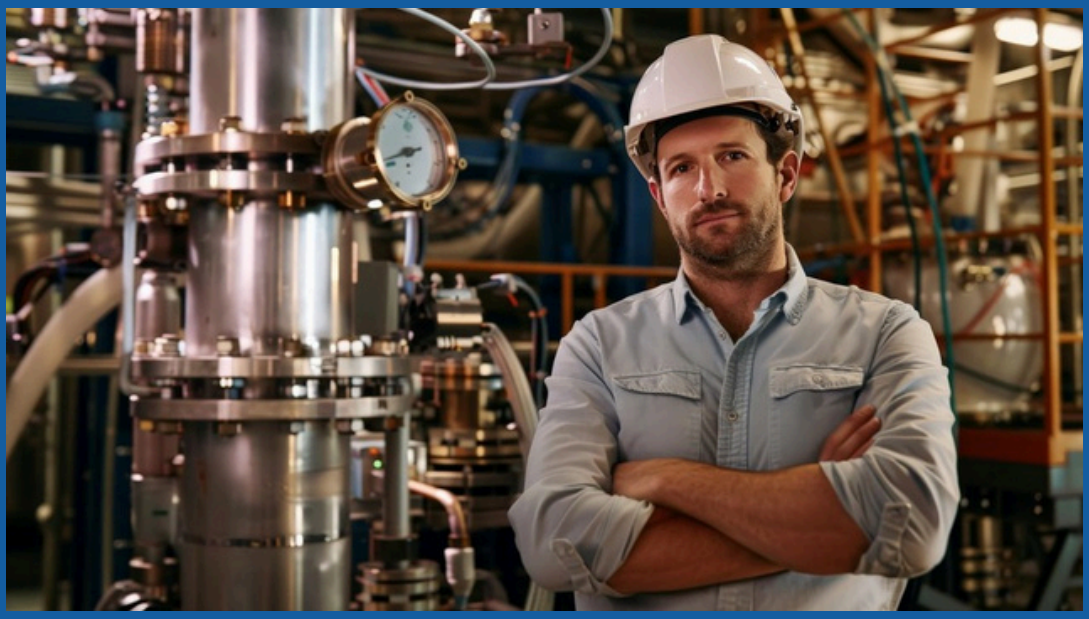
Study Material For Boiler Operation Engineer (BOE) Exams



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

Amazon Flipkart Pothi

PROENGR.IN

SUDESH K JAIN

SYLLABUS

Paper: 1 - Boiler Act,Indian Boiler Regulations and their compliance and Boiler Design Engineering

(Three hours, Open Book (IBR, 1950 & the Boilers Act, 1923), Multiple Choice Question & Descriptive Examination)

Boiler Act and Indian Boiler Regulations:
Salient Features of Boiler Act 1923 (as amended) and Indian Boiler Regulations, 1950 (as amended).

Water tube boilers: Classification of boilers- Natural circulation, Forced circulation, Fluidized Bed Combustor Boiler (FBC), Circulating Fludized Bed Combustor Boiler (CFBC), Waste heat boiler, Chemical recovery boilers, Cycles for Steam Power Plants.

Once through boilers, Supercritical boiler and Ultra-supercritical boiler functions and differences, advantages and disadvantages.

Solar Boilers, unfired boilers including thermic fluid boilers

Water circuit and steam circuit.

Fire tube boiler: Shell type boilers – Horizontal and Vertical boiler, Various types of furnaces, Furnace heat release rates for solid fuel and Oil fired Boilers, Methods of various attachments in Shell and furnaces.

Boiler Design and Engineering :Design calculation methods – factors to be considered in designing a boiler, boiler layout, pressure part arrangement, pressure and temperature drops across the boiler - temperature control methods, High temperature properties (Hot yield, creep) of steel and design criteria for ascertaining permissible stress and maximum temperature for use of each grade of steel - Design calculation to ascertain maximum working pressure of parts, tubes exposed to hot gases connecting pipes, headers, pipes and drums, ligament efficiency, method of compensation for opening, method of attachment of tubes and branch pipes, Longitudinal Stress, bending moment etc., weld coefficient.

Elements of feed water heaters –Design and construction including tube expansion methods.

Design & working pressure calculations for shell type boilers, ligament efficiency, end plates / tube plates, tube design, furnace design, method of compensation for openings, stay rods, gussets, stiffeners, pressure circle calculations etc.

Various boiler mountings and auxiliaries like fusible plugs, safety valves, safety valve selection criteria and capacity calculation, electromatic safety valves, drum level indicators, selection of feed water pumps etc.

Boiler components, piping, fitting, steam receivers, valves, steam traps, new materials.

Criteria for adopting Pressure reducing and desuperheating stations (PRDS), Feed water control system, Tees, elbows, bends and fittings.

Metal temperature calculations for various sections of boiler.

Paper – 2 - Boiler Design, Manufacturing, Materials, Erection, Commissioning, Operation and Maintenance, Inspection & Certification during manufacture or operations and High Pressure Welding Inspection

(Three hours, Open Book (IBR, 1950 & the Boilers Act, 1923), Multiple Choice Question & Descriptive Examination)

Boiler Design

All aspects of boiler design included**.**

Materials

Classification of materials, Classification of steels, boiler materials, basic metallurgy, weldability of materials, plates , pipes, tubes, casting and forgings of boiler quality and welding electrodes, process of steel manufacturing, chemical composition, mechanical properties, tolerances, knowledge on equivalent international materials used in boiler manufacture ,well known steel /forge/foundry/ pipe / tube maker etc requirements, procedures, inspection and testing to be done in the absence of well-known recognitions, new materials.

Construction and workmanship

Welding- Welding procedure, Welders Qualification, Initial Qualification & renewal for welders, Conditions under which requalification test is required, tests to be done on plate/Pipe & Tube for Initial and requalification, Essential variables.

Welding processes : SMAW, GTAW, SAW, FCAW, GMAW, Combination welding, Plasma, Flash butt welding, Induction Pressure welding, etc., welding consumables and their classification, welding engineering (joint design, fit-up, weld & welding symbols), reinforcement requirements, weld defects unique to each weld-fit-up process and their acceptance norms, methods & norms for weld repairs.

Welding Consumables - initial/periodic check tests on consumables as per IBR.

Preheating, Post heating and Post weld heat treatment, Criteria for application of PWHT for Shells, Drums, Headers, piping, Tubular products, method of loading, calibration of furnaces and measuring instruments, soaking temperature / time, Rate of heating / cooling .

Different process adopted in welding of tubes, pipes, Shells, Visual Inspection of welds, reinforcement requirements, acceptance norms for weld defects, norms & method for weld repairs.

Non-destructive Testing: Mandatory NDT requirements for various welds on tubes, pipes, headers and drums, Qualification of NDE personnel.

PT- Liquid Penetrant Testing
Principles of liquid penetrant process, Lighting for liquid penetrant testing Materials for liquid penetrant testing, Testing of materials, Interpretation/Evaluation, Factor affecting indications, Indications from discontinuities, Procedures, Codes/Standards/Specifications. Non relevant indications.

MT- Magnetic Particle Testing

Characteristics of magnetic fields and equipments, Technique/Calibrations, Selecting the proper

method of magnetization, Magnetic particle test indications and interpretations, Procedures, Codes/Standards/Specifications. Non relevant indications.

RT-Radiographic Testing

Principles Radiographic imaging, Sources for radiation, Techniques / Calibration, Imaging considerations, Image Quality Indicator (IQI), Density of material, Viewing of radiographs, Judging radiographic quality, Interpretation and Evaluation: Radiographic appearance of discontinuities, Non-relevant indications, Film artifacts, Film identification and correlation of the weld, Procedures, Codes/Standards/Specifications.

UT-Ultrasonic Testing

Principles, Equipment/Materials, Pulse/echo instrumentation, Calibration blocks, Techniques/Calibrations, Use of all types of probes, Calibration(electronic and functional), Interpretation and Evaluations: Evaluation of base metal, product forms, Evaluation of weldments, Variables affecting test results, Procedures, Codes/Standards/Specifications.

Radioscopy Test (Fluoroscopy).

Field installation and registration

Review of document of boiler parts as received and correlation to the corresponding part - Verifying the qualification of welders, NDE personnel etc, review and remedial action, Inspection during field installation w.r.t parts identification, Weld setups, Welding and non destructive examination. Evaluation of field welds by RT, UT, HT or PT or by combination.

Heat Treatment where applicable method for local HT and controls - Witnessing final Hydraulic test before thermal insulation, water quality and temperature, Safety Valve set / reset pressure, discharge capacity, Safety valve set pressure and discharge capacity for waste Heat Boiler with auxiliary firing, Water level indicator and use of remote Water level indicator, Steam pipe lines cold / hot condition flexibility and hanger settings, Verification of instruments to measure metal temperature, Steam temperature and pressure, Protection of boilers through burner management system (Fuel cut off systems, flame scanner and trips , interlocks etc.).

Documentation for registration of boilers.

Inspection & Certification:

Stages of Inspection during manufacture of Boiler/Boiler Components, erection and use of different IBR forms and their applicability, Memorandum of Inspection or registration Book (Form I) and its salient features.

Requirements for Registration of boilers.

Repair and Renewal of Certificate for use of Boilers:

Procedure for Inspection and repair of Installed Boilers & Steam pipes.

Boiler Operation and Maintenance

Chemical requirements of feed water, Boiler water, steam quality for low, medium pressure, high and super-critical Boilers, sampling methods, test method, Carryover, scale and sludge, scaling of fireside of heating surfaces, steam contamination and its control, prevention of

deposit formation in boiler units, corrosion of heating surfaces, Start & stop sequence, operation procedure, critical boiler parameters, alarms and annunciations, contingency action plan, safety precautions.

Boiler emergencies – How to handle

Boiler explosions – Reasons and Preventions

Boiler repairs – Methods and procedure, Failure analysis

Thick walled component repair at site – Precautions and limitations, Preheating and post heating, Post Weld Heat Treatment

Maintenance schedule – shutdown maintenance, procedure, safety precautions, work permit system, restarting procedure , acid cleaning, hydraulic test, light up of boiler, commissioning

Data acquisition and analysis – Broad idea, importance

Boiler inspection periodicity, methods, procedure

In service periodic inspection

Review mandatory requirements of operating boilers, Procedures for conducting periodic hydraulic test of operating boilers, Elements of mode of failures of metals, Assessment of condition of boilers: - Review past record of boilers w.r.t. failures, outages, repairs / replacements of pressure parts, Visual inspection of external & internal surfaces for visible damages, loss of metal by erosion/corrosion, condition of tube supports, spacers etc., fire side scaling, ash/slag fouling, Boilers with record of frequent failures may require detailed investigation by conducting NDE using Dye penetrant / magnetic particle test for detecting cracks or UT to determine thickness of tubes or cracks in dissimilar welds / fillet / butt weld cracking or RT insitu metallurgical examination, Conducting laboratory examination on tube samples for erosion / corrosion, creep damage, hydrogen embrittlement, Stress Corrosion Cracking, Oxygen pitting, Oxidation, fire side fouling, water side deposits and need for chemical cleaning etc., Authorization for repairs & replacement, Verifying the condition of safety valves, water level gauges and other mounting, instruments for measuring temperature and pressure and fire protection systems and interlocks, Isolation of steam and water circuits in battery of boilers and other safety measures.

Remnant Life Assessment (RLA) of boilers

Criteria for R L A – Tests required for various boiler components, Evaluation methods for remaining life.

Fuel – Air – Gas system

Basics knowledge in the areas like Primary fuels, principles of combustion, chemistry of combustion, pulverized coal fired furnaces, fuel oil and gas fired furnaces, controls and instrumentation and their effect on boiler functioning. Isolation of Fuel/Flue Gas during inspection.

Layout and Sketches

Layout and Sketches of boilers & boiler components, steam & feed water circuits and their parameters.