Syllabus for Online Examination for Recruitment of Assistant Director (Technical) in Bureau of Energy Efficiency.

Duration of Online Examination: 120 Minutes.

Details of Marks.

S.No	Name of the Test	No. of Questions	Maximum marks	Version
01	a) General aspects of Energy Management and Energy Audit. b) Energy Efficiency in Thermal Utilities. c) Energy Efficiency in Electrical Utilities. d) Energy Performance Assessment for Equipment & Utilities.	120	120	Bilingual i.e Hindi & English.
02	Reasoning & General Awareness (Energy & Climate change).	30	30	Bilingual i.e Hindi & English

PAPER-1: GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT

1.1 Energy Scenario:

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future.

1.2 **Energy Conservation Act 2001 and related policies**:

Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, Electricity Act 2003, Integrated energy policy, National action plan on climate change.

1.3 **Basics of Energy and its various forms**:

Electricity basics – Direct Current and Alternative Currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature and pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity and heat transfer, units and conversion, Metric Ton Oil Equivalent conversions.

1.4 **Energy Management & Audit**:

Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering, precautions, thermography, smart metering.

1.5 **Material and Energy balance**:

1.6 Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

1.7 **Energy Action Planning**:

Key elements, force field analysis, Energy policy purpose, perspective, contents, formulation, ratification, Organizing - location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability. Human resource development techniques, Information system-designing barriers, strategies; Marketing and communicating-training and planning.

1.8 **Financial Management**:

Investment-need, appraisal and criteria, financial analysis techniques-simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies(ESCOs).

1.9 **Project Management**:

Definition and scope of project, technical design, financing, contracting, implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement &Verification.

1.10 **Energy Monitoring and Targeting**:

Defining monitoring & targeting, elements of monitoring &targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems(EMIS)

1.11 **Energy, Environment and Climate change**:

Energy and environment, air pollution, climate change United Nations Framework Convention on Climate Change(UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund(PCF).

1.12 **New & Renewable Energy Sources (NRES)** :

Concept of renewable energy, Solar energy, wind energy, biomass boilers and gasifiers, biogas, biofuels, hydro, fuel cells, energy from wastes, biomethanation, wave, tidal, geothermal.

PAPER 2: ENERGY EFFICIENCY IN THERMAL UTILITIES :

2.1 Fuels and Combustion:

Introduction to fuels, properties of fuel oil, coal and gas, storage, handling and preparation of fuels, principles of combustion, combustion of oil, coal and gas. Agro-residue/biomass handling, preparation and combustion.

2.2 Boilers:

Types, combustion in boilers, performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. Boiler efficiency calculation, evaporation ratio and efficiency for coal, oil and gas. Soot blowing and soot deposit

reduction, reasons for boiler tube failures, start up, shut down and preservation, Thermic fluid heaters, super critical boilers.

2.3 Steam System:

Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings. Steam utilization, Performance assessment more details, installation, thermo-compressor, steam pipe insulation, condensate pumping, steam dryers

2.4 Furnaces:

Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery. Forging furnace heat balance, Cupola, non-ferrous melting, Induction furnace, performance evaluation of a furnace, hot air generators.

2.5 Insulation and Refractories:

Insulation-types and application, economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractories, heat loss. Cold insulation.

2.6 Fluidized Bed Combustion FBC boilers:

Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, retrofitting FBC system to conventional boilers, saving potential. Biomass based fluidized bed combustion boilers - application and operation, Atmosphere Fluidized bed combustion boilers, Circulating Fluidized bed combustion boilers, Pressurized Fluidized bed combustion boilers.

2.7 Cogeneration:

Definition, need, application, advantages, classification, saving potentials. Heat balance, steam turbine efficiency, tri-generation, micro turbine.

2.8 Waste Heat Recovery:

Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential.

2.9 Heat Exchangers:

Types, networking, pinch analysis, multiple effect evaporators, condensers, distillation column, etc.

PAPER 3: ENERGY EFFICIENCY IN ELECTRICAL UTILITIES :

3.1 Electrical system:

Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment

of PF capacitors, distribution and transformer losses. Star labelled distribution transformers, Demand side management, Assessment of transmission and distribution efficiency, losses due to harmonics and voltage unbalance, Maximum demand controllers, automatic power factor controllers, energy efficient transformers.

3.2 Electric motors:

Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. Star labelled energy efficient motors, squirrel cage and slip ring and their characteristics, motor history sheet new, 1st rewind, 2ndrewind), Star operation, voltage unbalance, energy efficient motors, soft starters with energy saver, variable speed drives.

3.3 Compressed Air System:

Types of air compressors, reciprocating vs screw, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities, Air Driers.

3.4 Heating, ventilation, air conditioning (HVAC) and Refrigeration System:

Introduction to Psychometrics, Vapour compression refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Vapour absorption refrigeration system: Working principle, types and comparison with vapour compression system and saving potential, heat pumps and their applications, section on ventilation system, ice bank system, and performance assessment of window and split room air conditioners, Star labelled pumps, cold storage refrigeration, and humidification system.

3.5 Fans and blowers:

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pressure drop calculation.

3.6 Pumps and Pumping System:

Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Energy conservation in boiler feed water pump, pumping systems for municipal drinking water, and sewerage, agriculture pump sets.

3.7 Cooling Tower:

Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities assessment of cooling towers. Fan less cooling tower, natural draft cooling tower, cooling water treatment.

3.8 Lighting System:

Light source, choice of lighting, luminance requirements, and energy conservation avenues. Light Emitting Diodes (LEDs), metal halides, fluorescent tube lights, Compact fluorescent

lamps (CFL), labelling scheme, high efficiency street lighting, electronic ballast, occupancy sensors, and energy efficient lighting controls.

3.9 Diesel/Natural gas Power Generating systems:

Factors affecting selection, energy performance assessment of diesel conservation avenues. Waste heat recovery.

3.10 Energy conservation in Buildings and Energy Conservation Building Codes (ECBC): About Energy Conservation Building Codes (ECBC), building envelope, insulation, lighting, Heating, ventilation, air conditioning (HVAC), fenestrations, water pumping, inverter and energy storage/captive generation, elevators and escalators, star labelling for existing buildings, Energy Service Companies based case studies.

PAPER-4: ENERGY PERFORMANCE ASSESSMENT FOR EQUIPMENT AND UTILITY SYSTEMS

4.1 Boilers. 4.2 Furnaces. 4.3 Cogeneration, Turbines (gas, steam). 4.4 Heat Exchangers. 4.5 Electric Motors, Variable Speed Drives. 4.6 Fans and Blowers. 4.7 Water Pumps. 4.8 Compressors. 4.9 HVAC systems. 4.10 Performing Financial Analysis. 4.11 Energy Performance assessment in power plants. 4.12 Energy Performance assessment in steel industry. 4.13 Energy Performance assessment in process industry (cement and textile). 4.14 Energy Performance assessment in buildings and commercial establishments. 4.15 Textile Industry.