REFERENCE SYLLABUS

For

FOURTH CLASS
POWER ENGINEER’S

CERTIFICATE of COMPETENCY
EXAMINATION

AB-54
Edition 1, Revision 1, 2017-09

This syllabus is being phased out and will be discontinued on October 31, 2020.
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GENERAL INFORMATION

Introduction:
The Standardization of Power Engineers Examination Committee (SOPEEC) has developed a Fourth Class Power Engineer’s Syllabus (SOPEEC Syllabus) which has been approved by the Association of Chief Inspectors (ACI) to be used across Canada.

As provided for under the Power Engineers Regulation, the Administrator in the pressure equipment discipline has established this Syllabus to identify the examination subjects for Fourth Class Power Engineer’s Certificate of Competency examinations. The subjects described in this Syllabus are identical to the subjects in the SOPEEC Syllabus.

This Syllabus is intended to assist candidates studying for the New Fourth Class Power Engineer’s Certificate of Competency Examination.

The requirements to qualify for New Fourth Class Power Engineer’s Certificate of Competency examinations are outlined in the Power Engineers Regulation.

Recommended Study Program:

It is recommended that, before undertaking a New Fourth Class Engineer’s Examination, the candidate completes a New Fourth Class Power Engineering Course offered through a technical institute.

In addition to the foregoing course, it is recommended that the candidate becomes familiar with the publications listed in the “Reference Material for Power Engineering Students and Examination Candidates” which is obtainable from the various technical institutes or from the SOPEEC website. (www.sopeec.org)

Application to Undertake Examination:

A candidate must submit an application and the prescribed fee at least twenty-one (21) days before the date of examination.
Examination Instructions:

The examination consists of two papers, each of 3½ hours duration. Each of the Paper A and Paper B examinations consists of 150 multiple-choice questions.

To pass a 4th Class Power Engineer’s Certificate of Competency examination, a candidate must obtain at least 65% of the total marks allotted for each examination paper.

A candidate is allowed to use the following items in the examination room:

- The Safety Codes Act and Regulations under the Safety Codes Act;
- CSA B51, Boiler, Pressure Vessel and Pressure Piping Code;
- CSA B52, Mechanical Refrigeration Code;
- Extract for CSA B51 and CSA B52 Codes;
- ASME Boiler & Pressure Vessel Codes except for Sections VI and VII;
- The 2007 ASME Boiler & Pressure Vessel Code Academic Extract and Supplement produced by PanGlobal Training Systems;
- ASME/ANSI B31.1 Pressure Piping Code and B31.3 Process Piping Code;
- Handbook of Formulae and Physical Constants, Steam Tables and Refrigeration Tables are normally provided;
- A non-technical English language dictionary;
- Pens and pencils;
- Non-programmable calculator and
- Drawing instruments and drawing templates.

Note:

- The candidate must provide picture ID to the Examiner prior to the examination.
- No cell phone or any electronic communication devices are allowed to be brought into the examination room.
- The items referenced above must be shown to the Examiner for approval.
- No other reference material is allowed.
A. **Applied Mathematics**

S.I. units, basic arithmetical operations, fractions, decimals and percentages, ratio and proportion, simple algebra, mensuration, length, lines and simple plane figures, area and volumes

B. **Elementary Mechanics and Dynamics**

Definitions of mechanical properties, moments and forces, simple machines, mechanical advantage, scalars and vectors, linear velocity and acceleration; force, work, pressure, power and energy, friction, stress and strain, factor of safety, power transmission

C. **Elementary Thermodynamics**

Basic thermodynamic concepts, temperature and thermal expansion, specific, sensible and latent heat, thermodynamics of steam, steam tables, interpolation, basic chemical and physical properties

D. **Mechanical Drawing, Administration**

Mechanical drawing fundamentals, various views, drawing instruments, writing fundamentals; sentence, paragraph and memo composition

E. **Industrial Legislation**

i. Thorough knowledge of the Safety Codes Act, Occupational Health & Safety Act, and applicable regulations

ii. Codes

- ASME Section VI - Recommended Rules for the Care and Operation of Heating Boilers
- ASME Section VII - Recommended Guidelines for the Care and Operation of Power Boilers
- CSA Standard B-51 - Boiler, Pressure Vessel, and Pressure Piping Code
- CSA Standard B-52 - Mechanical Refrigeration Code

F. **Workplace Hazardous Materials**

- WHMIS - Classification of Controlled Products
- Labelling of Controlled Products
- Material Safety Data Sheets
G. **Plant Safety**
   i. Costs and effects of workplace injuries
   ii. Personal protective equipment
   iii. Isolation of mechanical and electrical equipment
   iv. Confined space entry
   v. Handling of gases and hydrocarbon fluids
   vi. Hydrogen sulphide safety
   vii. First aid, CPR and artificial respiration
   viii. Safety Committees

H. **Plant Fire Protection**
   i. Fire fundamentals and procedures
   ii. Fires and extinguishing methods
   iii. Portable fire extinguishers; construction and operation
   iv. Electrical fires

I. **Environment**
   i. Environmental terms and definitions
   ii. Gas and noise pollution
   iii. Solid and liquid pollution
   iv. Potential environmental impact of liquids
   v. Potential environmental impact of vapours
   vi. Potential environmental impact of operating facilities
J. **Material and Welding**
   i. Engineering materials: selection and properties
   ii. Heat treatment and case hardening
   iii. Fabrication and welding methods
   iv. Welding processes and electrode use and selection
   v. Welding terms and inspection
   vi. Welder qualifications

K. **Piping and Valves**
   i. Materials: sizes and identification
   ii. Piping, pipe fittings and connections
   iii. Expansion joints, bends, support, hangers and insulation
   iv. Drainage: separators, traps, water hammer
   v. Valve types: construction and application

L. **High Pressure Boiler Design**
   i. Development of boiler design
   ii. Boiler terminology
   iii. Firetube boilers: construction, stays, tubes, tube sheets, shell
   iv. Watertube boilers: construction, drums and walls
   v. Electric boilers
   vi. Boiler construction: support, suspension, refractory
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Part “A”
3½ Hours
Multiple Choice Examination

M. **High Pressure Boiler Parts and Fittings**
   i. Combustion theory, composition of fuel, fuel heating value
   ii. Boiler draft equipment: natural, forced, induced, balanced
   iii. Boiler combustion equipment: coal, oil and gas burners and safety
   iv. Fluidized bed and grate systems
   v. Safety and relief valves
   vi. Water columns and gauge glasses
   vii. Steam Drum Internals
   viii. Superheaters, reheaters, economizers, air heaters
   ix. Insulation

N. **High Pressure Boiler Operation**
   i. Boiler prestart, start-up, operation and shut-down
   ii. Emergency boiler operation
   iii. Soot blowers
   iv. Continuous and intermittent blowdown
   v. Chemical and mechanical cleaning, boil out and lay-up
   vi. Hydrostatic testing, inspection, safety precautions
   vii. Cause and prevention of boiler furnace explosions

O. **Feedwater Treatment**
   i. External feedwater treatment: filtration, lime soda, zeolite, deaeration
   ii. Internal feedwater treatment and testing
   iii. Knowledge and control of: pH, sludge, scale, foaming, caustic embrittlement, blow-down and corrosion
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Part “B”
3½ Hours
Multiple Choice Examination

A. Prime Movers and Engines
   i. Heat engines, prime mover terminology
   ii. Simple steam engine: construction, details, operation and maintenance, lubrication
   iii. Steam turbines: construction, impulse, reaction, governing, overspeed trip, lubrication, start-up, operation, shut-down
   iv. Cooling towers, condensers
   v. Basic gas turbines: construction, applications, open cycle, regeneration, steam and gas turbine plants
   vi. Internal combustion engines: construction, working cycles, fuels, lubrication, start-up, operation, shut-down

B. Pumps and Compressors
   i. Pumps
      a. Pumping theory
      b. Pump operation and maintenance
      c. Reciprocating pumps: simplex, duplex, valves, drivers
      d. Centrifugal pumps: volute, diffusers, impellers, wear rings, seals, packing, start-up, operation and shut-down
      e. Turbine pump, rotary pump
   ii. Air Compression
      a. Theory, altitude, barometers
      b. Reciprocating compressors: construction, stages, cooling components, valves, control, lubrication and operation
      c. Axial: construction, components, lubrication and operation
      d. Systems: receivers, intercoolers, aftercoolers, driers, moisture, safety devices
C. **Lubrication**
   i. Lubrication: principles, lubricants, classes, viscosities, applications, systems
   ii. Bearing lubrication: operation, maintenance, failure

D. **Electricity**
   i. Electrical: terms, properties, measurement and calculations
   ii. Power and work
   iii. Magnetism and electromagnetism
   iv. Electrical metering devices: voltmeters, ammeters, wattmeters
   v. Conductors, insulators
   vi. Motors and generators: AC and DC, operation
   vii. Transformers
   viii. Electrical distribution circuits, breakers, switches, fuses
   ix. Safe operation

E. **Controls, instrumentation and computers**
   i. Instrumentation terms and definitions
   ii. Methods of process measurement
   iii. Basic control loop components
   iv. Basic boiler instrumentation and control systems, gauges
   v. Low water fuel cut-offs, mercury switch, thermocouples
   vi. Boiler programming controls
   vii. Types of computers: principles, software programs, languages, applications, components
   viii. Introductory process computer concepts
   ix. Input and output devices, data recording and storage
F. Heating Boilers
   i. Watertube and tubular heating boilers
   ii. Cast iron sectional and modular heating boilers
   iii. Firetube heating boilers
   iv. Oil and gas burners for heating boilers
   v. Steam heating boiler fittings, attachments and auxiliaries
   vi. Hot water heating boilers; fittings, attachments
   vii. Hot water and steam heating boiler operation and maintenance
   viii. Cleaning, inspection, lay up, safety

G. Heating Systems
   i. Steam heating auxiliaries: radiators, convectors, unit heaters, coils, ventilators, air vents, valves, traps, vacuum pumps
   ii. Steam heating systems: operation and maintenance
   iii. Hot water heating auxiliaries: pumps, controls, valves, expansion tanks, converters, radiant panels, snow melt
   iv. Hot water heating systems: operation and maintenance
   v. Warm air heating system equipment
   vi. Warm air furnace components and maintenance: furnaces, humidifiers, air distribution, trouble shooting
   vii. Ventilation and air filters
   viii. Infrared and electric heating
H. **Heating Boiler and Heating System Controls**
   i. Heating boiler feed water controls
   ii. Heating boiler operating controls
   iii. Heating boiler combustion controls
   iv. Pneumatic controls for heating systems
   v. Electric controls for heating systems
   vi. Electronic controls for heating systems: indoor, outdoor, multi-zone, advantages, disadvantages

I. **Auxiliary Building Systems**
   i. Lighting systems: principles, units, incandescent, fluorescent
   ii. Building water supply systems: operation and maintenance, hot water heaters, controls and protection, trouble shooting
   iii. Sanitary drainage systems: maintenance
   iv. Snow melt systems

J. **Vapour Compression Refrigeration**
   i. Safety, CSA B-52
   ii. Thermodynamics of Refrigeration
   iii. Properties of Refrigerants
   iv. Compression refrigeration systems: components, auxiliaries, relief devices
   v. Refrigeration compressor components
   vi. Heat exchangers for refrigeration systems
   vii. Refrigeration metering devices and capacity controls
   viii. Refrigeration cycle controls
   ix. Refrigeration system accessories
x. Compression refrigeration system pre start-up, start-up, operational checks and procedures, shut-down

xi. Compression refrigeration system maintenance, testing, charging, surging, trouble shooting

K. Absorption Refrigeration

i. Absorption refrigeration systems, components, auxiliaries

ii. Absorption refrigeration system operation and maintenance

L. Air Conditioning

i. Psychrometric properties of air

ii. Applications of the psychrometric chart and comfort conditions

iii. Fans for air distribution systems

iv. Air conditioning duct systems

v. Coil types

vi. Coil operation

vii. Humidification, dehumidification

M. Air Conditioning Systems

i. Unitary and central air conditioning systems

ii. Combined air conditioning systems: components, auxiliaries, operation, maintenance

iii. Air conditioning heat recovery systems

iv. Air conditioning system controls

v. Heat gains and losses in buildings, system components, auxiliaries
N. **Boiler Maintenance**  
   i. Powerhouse maintenance - hand and power tools  
   ii. Powerhouse maintenance - ladders, scaffolding and hoisting  
   iii. Powerhouse maintenance - ropes, cables and fasteners  
   iv. Boiler maintenance, refractory, tubes, stays, safety valves  
   v. Boiler cleaning, inspection, testing, lay up, welder qualification  

O. **Types of Plants**  
   i. Hot oil systems, components, auxiliaries, operation, maintenance  
   ii. Gas plant and pulp mill processes, equipment, operation, safety  
   iii. Steam related oil, food and sawmill processes