



REFERENCE SYLLABUS

For

**FOURTH CLASS
POWER ENGINEER'S**

**CERTIFICATE of COMPETENCY
EXAMINATION**

October 2012



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GENERAL INFORMATION

Introduction:

This syllabus has been approved by the Standardization of Power Engineer Examinations Committee (SOPEEC) and the Association of Chief Inspectors (ACI).

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

The requirements to qualify for a New Fourth Class Engineer's Examination are outlined in the Safety Codes Act, Power Engineers Regulation.

Recommended Study Programme:

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 posted on the SOPEEC web site.

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, and may be provided, the following items in the examination room:

- A non-technical English language dictionary provided by the local jurisdiction;
- Handbook of Formulae and Physical Constants, Steam Tables and Refrigeration Tables are normally provided;
- 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;
- CSA B51, Boiler, Pressure Vessel and Pressure Piping Code;
- CSA B52, Mechanical Refrigeration Code;
- Extract for CSA B51 and CSA B52 Codes;
- Extract for CSA B51 and CSA B52 Codes;



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- Act and Regulations for the examining Jurisdiction;
- Pens and pencils;



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- Non-programmable calculator ^{see important note} and
(Normally, the above items are useful for all classes of examination.)
- 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.
- **Important:** If your calculator is programmable, you must reset it in the company of the examiner so that the examiner is sure that all memories are clear. Or the examiner may request that you remove the battery to erase all memory. This may be done during your examination time, so be aware that you may have less time to complete your exam. If the memories do not clear by resetting the calculator or by removing the battery, the calculator shall not be used. Also, if your calculator fails to function after reset or battery removal, the examiner is not responsible and you may be at a significant disadvantage.
- The information in the 1983 Edition of the ASME Boiler and Pressure Vessel Code Academic Extract is outdated. Using this 1983 Edition of the ASME Extract for any power engineering examination is not recommended. Besides using the 2007 Edition of the ASME Academic Extract and Supplement, candidates may use the current edition of the ASME Code.

Contact your local jurisdiction to find out the details.



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Part "A"

**3½ Hours
Multiple Choice Examination**

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



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Part "A"

3½ Hours
Multiple Choice Examination

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



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Part "A"

3½ Hours
Multiple Choice Examination

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



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Part "B"

3½ Hours
Multiple Choice Examination

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



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Part "B"

3½ Hours
Multiple Choice Examination

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



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Part "B"

3½ Hours
Multiple Choice Examination

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



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Multiple Choice Examination

- 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



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Multiple Choice Examination**

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