



TECHNICAL STANDARDS & SAFETY AUTHORITY

TRAINING, EXAMINATION AND CERTIFICATION

CERTIFICATIONS PURSUANT TO THE OPERATING ENGINEERS REGULATION
(O. REG. 219/01)

4TH CLASS POWER (OPERATING) ENGINEER EXAMINATION & CERTIFICATION GUIDE

REVISION 3

August 2009

- This version replaces all previous

NEW IN THIS VERSION

- The 4th Class updated version replaces the Syllabus dated May 2005 and March 2007, Ontario.
- The 'General Information section' has been amended to accommodate Ontario's jurisdictional examination process requirements.
- The actual 4th Class SOPEEC syllabus is identical to the SOPEEC version dated July 31, 2002, and the previous May 2005, Ontario version.
- The '**General Information Section**' about SOPEEC, Examinations, Certification, Applications, Text Materials, etc., is located at the end of the document to permit easy syllabus access.

• **Important: Candidates for any class of certification as an Operating Engineer or Operator who have passed the required examinations, or any parts thereof, MUST obtain their certificate of qualification within five (5) years of such passing or re-writing of the examination will be required.**

Syllabus: The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined .

Paper 4-A

Paper 4-A examines the candidate on all of the materials contained in Section 'A' of the 4th Class Power Engineering Program. Examination questions are taken from each of the topics.

- **Note:** Candidates are to reference the Ontario TSSA Act, Operating Engineers Regulation, and Boiler, Pressure Vessel Regulations, when appropriate, instead of the Province of Alberta's Codes, if referenced in the Course materials.
- **Sample Questions** for the above examination(s) are available on the SOPEEC Website.

AA. APPLIED MATHEMATICS:

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

AB. 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.

AC. 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.

AD. MECHANICAL DRAWING, ADMINISTRATION:

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

AE. APPLICABLE OPERATING ENGINEERS REGULATIONS & CODES:

- a. Thorough knowledge of the Operating Engineers Regulation, the Occupational Health & Safety Act.
- b. Codes:
 - I. ASME Section 1 - Power Boilers
 - II. ASME Section VI - Recommended rules for the Care and Operation of Heating Boilers
 - III. ASME Section VII - Recommended rules for the Care and Operation of Power Boilers
 - IV. CSA Standard B-51 - Boilers, Pressure Vessels and Pressure Piping Code
 - V. CSA Standard B-52 - Mechanical Refrigeration Code

AF. WORKPLACE HAZARDOUS MATERIALS:

WHMIS: classification of controlled products, labeling of controlled products, materials safety data sheets.

AG. PLANT SAFETY:

- a. Costs and effects of workplace injuries, personal protective equipment.
- b. Isolation of mechanical and electrical equipment, confined space entry.
- c. Handling of gases and hydrocarbon fluids, hydrogen sulphide safety.
- d. First aid, CPR and artificial respiration, safety committees.

AH. PLANT FIRE PROTECTION:

- a. Fire fundamentals and procedures, fires and extinguishing methods, electrical fires.
- b. Portable fire extinguishers; construction and operation.

AI. ENVIRONMENT:

- a. Environmental terms and definitions, gas and noise pollution, solid and liquid pollution.
- b. Potential environmental impact of liquids, vapours, and of operating facilities.

AJ. MATERIALS, WELDING:

- a. Engineering materials; selection, properties.
- b. Heat treatment and case hardening, fabrication and welding methods.
- c. Welding processes and electrode use and selection, welding terms and inspection.
- d. Welder qualifications.

AK. PIPING AND VALVES:

- a. Materials; sizes and identification.
- b. Piping, pipe fittings and connections.
- c. Expansion joints, bends, support, hangers and insulation.
- d. Drainage; separators, traps, water hammer.
- e. Valve types; construction and application.

AL. HIGH PRESSURE BOILER DESIGN:

- a. Development of boiler design.
- b. Boiler terminology.
- c. Firetube boilers; construction, stays, tubes, tube sheets, shell.
- d. Watertube boilers; construction, drums and walls.
- e. Electric boilers.
- f. Boiler construction; support, suspension, refractory.

AM. HIGH PRESSURE BOILER PARTS AND FITTINGS:

- a. Combustion theory, composition of fuel, fuel heating value.
- b. Boiler draft equipment; natural, forced, induced, balanced.
- c. Boiler combustion equipment; coal, oil and gas burners and safety.
- d. Fluidized bed and grate systems.
- e. Safety and relief valves.
- f. Water columns and gauge glasses.
- g. Steam drum internals.
- h. Superheaters, reheaters, economizers, air heaters.
- i. Insulation.

AN. HIGH PRESSURE BOILER OPERATION:

- a. Boiler prestart, start-up, operation and shut-down.
- b. Emergency boiler operation.
- c. Soot blowers, continuous and intermittent blowdown.
- d. Chemical and mechanical cleaning, boil out and lay-up.
- e. Hydrostatic testing, inspection, safety precautions.
- f. Cause and prevention of boiler furnace explosions.

AO. FEEDWATER TREATMENT:

- a. External feedwater treatment; filtration, lime soda, zeolite, deaeration.
- b. Internal feedwater treatment and testing.
- c. Knowledge and control of: pH, sludge, scale, foaming, caustic embrittlement, blow-down and corrosion.

Paper 4-B

Exam Paper 4-B examines the candidate on the Part B section of the 4th Class Power Engineering Program. Examination questions are taken from all topics.

- Sample Questions for the above examination(s) are available on the SOPEEC Website.

Syllabus: The following SOPEEC syllabus has been adopted by TSSA: and provides the subject matter upon which the candidates will be examined .

BA. PRIME MOVERS AND ENGINES:

- Heat engines, prime mover terminology.
- Simple steam engine; construction, details, operation and maintenance, lubrication.
- Steam turbines; construction, impulse, reaction, governing, overspeed trip, lubrication, start-up, operation, shut-down.
- Cooling towers, condensers.
- Basic gas turbines; construction, applications, open cycle, regeneration, steam and gas turbine plants.
- Internal combustion engines; construction, working cycles, fuels, lubrication, start-up, operation, shut-down.

BB. PUMPS AND COMPRESSORS:

- Pumps:
 - Pumping theory.
 - Pump operation and maintenance.
 - Reciprocating pumps; simplex, duplex, valves, drivers.
 - Centrifugal pumps; volute, diffusers, impellers, wear rings, seals, packing.
 - Start-up, operation and shut-down.
 - Turbine pump, rotary pump.
- Air Compression:
 - Theory, altitude, barometers.
 - Reciprocating compressors; construction, stages, cooling components, valves, control, lubrication and operation.
 - Axial; construction, components, lubrication and operation.
 - Systems; receivers, intercoolers, aftercoolers, driers, moisture, safety devices.

BC. LUBRICATION:

- Lubrication; principles, lubricants, classes, viscosities, applications, systems.
- Bearing lubrication; operation, maintenance, failure.

BD. ELECTRICITY:

- Electrical; terms, properties, measurement and calculations.
- Power and work.
- Magnetism and electromagnetism.
- Electrical metering devices; voltmeters, ammeters, wattmeters.
- Conductors, insulators.
- Motors and generators: AC and DC, operation.
- Transformers.
- Electrical distribution circuits, breakers, switches, fuses.
- Safe operation.

BE. CONTROLS, INSTRUMENTATION AND COMPUTERS:

- a. Instrumentation terms and definitions.
- b. Methods of process measurement.
- c. Basic control loop components.
- d. Basic boiler instrumentation and control systems, gauges.
- e. Low water fuel cut-offs, mercury switch, thermocouples.
- f. Boiler programming controls.
- g. Types of computers; principles, software programs, languages, applications, components.
- h. Introductory process computer concepts.
- i. Input and output devices, data recording and storage.

BF. HEATING BOILERS:

- a. Watertube and tubular heating boilers.
- b. Cast iron sectional and modular heating boilers.
- c. Firetube heating boilers.
- d. Oil and gas burners for heating boilers.
- e. Steam heating boiler fittings, attachments and auxiliaries.
- f. Hot water heating boilers; fittings, attachments.
- g. Hot water and steam heating boiler operation and maintenance.
- h. Cleaning, inspection, lay up, safety.

BG. HEATING SYSTEMS:

- a. Steam heating auxiliaries; radiators, convectors, unit heaters, coils, ventilators, air.
- b. Vents, valves, traps, vacuum pumps.
- c. Steam heating systems; operation and maintenance.
- d. Hot water heating auxiliaries; pumps, controls, valves, expansion tanks, converters, radiant panels, snow melt.
- e. Hot water heating systems; operation and maintenance.
- f. Warm air heating system equipment.
- g. Warm air furnace components and maintenance: furnaces, humidifiers, air distribution, trouble shooting.
- h. Ventilation and air filters.
- i. Infrared and electric heating.

BH. HEATING BOILERS AND HEATING CONTROLS:

- a. Heating boiler feedwater controls.
- b. Heating boiler operating controls.
- c. Heating boiler combustion controls.
- d. Pneumatic controls for heating systems.
- e. Electric controls for heating systems.
- f. Electronic controls for heating systems, indoor, outdoor, multi-zone, advantages, disadvantages.

BI. AUXILIARY BUILDING SYSTEMS:

- a. Lighting systems, principles, units, incandescent, fluorescent.
- b. Building water supply systems, operation and maintenance, hot water heaters, controls and protection, trouble shooting.
- c. Sanitary drainage systems, maintenance.
- d. Snow melt systems.

BJ. VAPOUR COMPRESSION SYSTEMS:

- a. Safety, CSA B-52.
- b. Thermodynamics of refrigeration.
- c. Properties of refrigerants.
- d. Compression refrigeration systems; components, auxiliaries, relief devices.
- e. Refrigeration compressor components.
- f. Heat exchangers for refrigeration systems.
- g. Refrigeration metering devices and capacity controls.
- h. Refrigeration cycle controls.
- i. Refrigeration system accessories.
- j. Compression refrigeration system pre start-up, start-up, operational checks and procedures, shut-down.
- k. Compression refrigeration system maintenance, testing, charging, surging, trouble shooting.

BK. ABSORPTION REFRIGERATION:

- a. Absorption refrigeration systems, components, auxiliaries.
- b. Absorption refrigeration system operation and maintenance.

BL. AIR CONDITIONING:

- a. Psychrometric properties of air.
- b. Applications of the psychrometric chart and comfort conditions.
- c. Fans for air distribution systems.
- d. Air conditioning duct systems.
- e. Coil types.
- f. Coil operation.
- g. Humidification, dehumidification.

BM. AIR CONDITIONING SYSTEMS:

- a. Unitary and central air conditioning systems.
- b. Combined air conditioning systems; components, auxiliaries, operation, maintenance.
- c. Air conditioning heat recovery systems.
- d. Air conditioning system controls.
- e. Heat gains and losses in buildings, system components, auxiliaries.

BN. BOILER MAINTENANCE:

- a. Powerhouse maintenance - hand and power tools.
- b. Powerhouse maintenance - ladders, scaffolding and hoisting.
- c. Powerhouse maintenance - ropes, cables and fasteners.
- d. Boiler maintenance, refractory, tubes, stays, safety valves.
- e. Boiler cleaning, inspection, testing, lay up, welder qualification.

BO. TYPES OF PLANTS:

- a. Hot oil systems, components, auxiliaries, operation, maintenance.
- b. Gas plant and pulp mill processes, equipment, operation, safety.
- c. Steam related oil, food and sawmill processes.

End of Part B

GENERAL INFORMATION

The designation of persons operating power plants in Ontario was Stationary Engineer until the summer of 2001 at which time it changed to Operating Engineer by the proclamation of the Technical Standards & Safety Act and its related Operating Engineers Regulation on June 27th, 2001.

In reference to power plant engineering, the previous Ontario designation 'Stationary', the current designation 'Operating' and the standard Canadian designation 'Power' all have the same meaning and cover the same jurisdiction of work, in ALL Provinces and Territories, in Canada.

SOPEEC, stands for Standardization of Power Engineering Examinations Committee.

In the effort to provide mobility for power plant operators across all of Canada, Ontario adopted the SOPEEC examination system in the latter part of 1990's. Currently all jurisdictions except Quebec utilize the standardized SOPEEC examinations system, this makes it now possible to complete writing the required examinations in another province or territory in Canada, in the event a candidate moves.

To receive the 'standardized' designation on your Certificate of Qualification, one must have written ALL of the required examinations in the SOPEEC format. No previously written provincial examinations will be recognized. This 'Standardized' designation allows you to be issued the same level of certification in all other Canadian jurisdictions (except Quebec at this time). No further examination writing is required.

Recommended Study Program

It is recommended that before undertaking examinations, the candidate complete a Fourth Class Power Engineering Course offered through a recognized Technical Institute or Training Provider.

In addition to the foregoing course or courses, it is recommended that the candidate becomes familiar with the publications listed in the Reference Material for Power Engineering Students and Examination Candidates, listed later in this document.

Eligibility to Write

A candidate is expected to have started their training, either in plant and/or in a course of study, before attempting to write any one of the examinations.

Practical Time Requirements

- The current Regulation requires the 4th Class Operating Engineer candidate to obtain a minimum of 12 months practical operating experience before applying for a Certificate of Qualification. This time requirement is now standard for all SOPEEC members.
- It is possible to have this 12 months practical time requirement reduced by graduating from a 'TSSA approved' six-month fulltime daytime training program. Successful course completion entitles the candidate to a 6-month credit (class-time) as well as an additional 3-month 'incentive' credit (for attending full-time classes) for a total of 9 months credit, **leaving only 3 months plant training to be obtained.**
- Persons unable to obtain their in-plant training on a continuous basis may use hours instead of months for their requirement calculation. The current 12 months training time equates to 1920 hours, based on 12 months at 160 hours per month.
- Trainees are to ensure that a Form 1 (Testimonial of Practical Plant Experience, available from our home web page,) is obtained, filled in and signed by the Chief Engineer or Chief Operator upon completion of your training period at each facility. These are required when applying for your Certificate.

Training Providers

As a convenience for students, TSSA has compiled a list of organizations, and/or institutions currently offering 'TSSA Approved for Time Reduction', training. The list can be found in the 'Operating Engineer section', of our TSSA Corporate website located at;

<http://www.tssa.org> or, at TSSA's Operating Engineers information site located at;
<http://www.operatingengineer.ca>

Please note: The process for 'TSSA approval' began in December of 2001.

Trainers that are successful in obtaining TSSA approval, to offer "practical-time-reduction-training", will be identified accordingly by being listed on TSSA's Training Providers list, as approvals are granted.

Examinations

- **There are two SOPEEC examinations for the 4th Class, namely Paper 4A & Paper 4B. Each examination is 3 ½ hours in duration, paper 4A consists of 150 multiple choice/free format questions and paper 4B consists of 150 multiple choice questions, passing mark is 65% and there is a sixty-day (60) re-write period as stipulated in the Operating Engineers Regulation.**

The examination candidate is expected to write legible, neat, and in pen. Sketches or drawings are to be in pencil and properly labeled. Rulers and (drawing) templates are to be used as neatness is considered in the marking scheme.

Candidates are to bring a pen, pencil, eraser, ruler/template (for drawing) and a non-programmable calculator. **No other text or materials are allowed into the examination room, by the candidate.**

Please Note: The items referenced above are the responsibility of the candidate to bring to the examination and must be shown to the Examiner or Invigilator for approval, upon request. Any individual not complying with the Invigilator's requests, will not be eligible to write or will not have their paper marked, and forfeit the examination fee for the examination sitting.

The candidate must show picture I.D. at the examination.

Examination Centres will provide all the required reference materials, i.e. formulae booklets, Acts, Regulations, Codes, Steam/Refrigeration Tables, as an Operating Engineering Examination Reference Materials Manual.

Examinations may be written at the MTCU Examination Centres located in major cities in Ontario, or at TSSA in Toronto. To locate the nearest examination centre refer to 'Examination Centres Listing', on our website at; <http://www.tssa.org>, in the 'Operating Engineers' section.

The examination candidate must submit an application and the prescribed fee at least twenty-one (21) days before the date of examination. Please refer to examination procedures for "Examination Registration Form, 2005".

Mail the application directly to "Examination Services", Technical Standards & Safety Authority, or Fax. Direct to TSSA at: (416) 231-4078.

Suggested Reference (Text) Materials

Note: Power Engineering Training Systems (PETS), a Division of Pan Global, formerly PEJV/SAIT, is the SOPEEC sanctioned provider of Power Engineering reference materials.

The following list provides telephone numbers that will assist the student in locating and/or obtaining the needed reference materials for study.

- **'4th class Power Engineering'** available or from the estore linked to (PETS) at <http://www.operatingengineer.ca> or by calling PETS direct at; 1 866.256.8193.
- **Reed's Marine Engineering** series. Nautical Mind Bookstore, Toronto, Canada, 1 800 463-9951.

(See individual exam papers for specific text needed).

- **“Metals & How to Weld Them”** by Jefferson & Woods Reference SOPEEC text list.
- **The Technical Standards and Safety Act, the Operating Engineers Regulation and the Boilers and Pressure Vessels Regulation; these are posted on the TSSA Website and can be printed for use in your studies, free of charge.**
- **CSA B51:** “Boilers, Pressure Vessel and Piping Code” CSA International at; 416.747.4000
- **CSA B52:** “Mechanical Refrigeration Code” CSA International at; 416.747.4000
- **ASME Section I:** Rules for the Construction of Power Boilers Extract: available from TSSA at 416.734.3312.
- **‘ASME Code Simplified’..** Reference SOPEEC text list
- **ASME Section VI** - Recommended Guidelines for the Care and Operation of Heating Boilers.... see below
- **ASME Section VII:** Recommended Guidelines for Care and Operation of Power Boilers ... see below
- **ASME Section IX:** “Welding and Brazing Qualifications.... see below

For ASME Code Books (other than the Section 1 Extract) can be obtained from The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

Visit the SOPEEC website at www.sopeec.org for the “Recommended Reading List for Power Engineering Students” and for further information, other possible resource texts and sample ‘only’ questions.

Additional engineering text and reference materials are available from a broad range of authors and publishers and no specific text or reference material beyond the Act, Regulations and Codes should be considered as official.

Obtaining Your Certificate

Upon successful completion of the examinations and the completion of the required practical operating 'qualifying experience', as per the Operating Engineers Regulation 219/01, the candidate may apply to TSSA for their "Certificate of Qualification" by forwarding:

- The completed 'Application for an Ontario Certificate of Qualification as an Operating Engineer or Operator'.
- The completed Form 1, entitled 'Testimonial of Qualifying Experience'.
- The originals of their examination 'pass' letters. Please retain copies for your records.
- A cheque for one hundred dollars (\$100.00,) payable to "the Technical Standards and Safety Authority" or "TSSA".

Please forward the above to:

Technical Standards and Safety Authority
Operating Engineers Program
3300 Bloor Street West
14th Floor, Centre Tower
Toronto, Ontario
M8X 2X4

Note: The above-required forms are available from the TSSA website, in the Operating Engineers Section, under 'Forms'.

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