TECHNICAL STANDARDS & SAFETY AUTHORITY

TRAINING, EXAMINATION AND CERTIFICATION

3RD CLASS POWER (OPERATING) ENGINEER

EXAMINATION & CERTIFICATION GUIDE

REVISION 3

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

August 2009

- This version replaces previous

NEW IN THIS VERSION

- The 3rd Class updated version replaces the (**New**) Syllabus dated September 2003 and March 2007, Ontario.
- The 'General Information section' has been amended to accommodate Ontario's jurisdictional examination process requirements.
- The actual 3rd Class SOPEEC syllabus content is identical to the SOPEEC version and the previous September 2003, Ontario version, presently in use.
- 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 3A-1

The candidate is to have a thorough knowledge of Section 1 of the Third Class Power Engineering course materials to successfully challenge the exam. There are ten lectures in this section covering Mechanics, Thermodynamics, Chemistry, Engineering Materials and Mechanical Drawing.

The examination consists of 150 multiple choice questions, each having 5 choices. Although many of the topics for this examination involve calculation, the numbers of questions requiring calculations, and those that do not, are balanced.

- Note: Since this course originated in another province, some Codes and Regulations may not be applicable in Ontario. Candidates are to reference the Technical Standards & Safety Act, related Regulations and Directors Orders, for this component.

- **Sample Questions** for the above materials can be accessed under 'Study Guide' on the SOPEEC website at www.sopeec.org

Topics of Study (Syllabus) for Paper 3A-1:

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

1. APPLIED MATHEMATICS:

Use these mathematics disciplines to complete engineering calculations:

Elementary algebra (simple equations); trigonometry; mensuration (areas, volumes of plane and solid figures); natural and naperian logarithms (using calculators)

2. APPLIED MECHANICS:

Explain theories, define terminologies, and perform problem-solving calculations involving the following topics:

a. Application of forces; vector diagrams.
b. Forces on level and inclined surfaces.
c. Linear and angular velocity and acceleration.
d. Work, power and energy.
e. Moments of force and simple machines; mechanical advantage; velocity ratio; efficiency.
f. Stress and strain; safe working stress; yield point and ultimate strength; factor of safety.
g. Bending of beams; equilibrium, shearing forces and bending moments.
h. Density and specific gravity.

3. THERMODYNAMICS:

Explain theories, define terminologies and perform problem-solving calculations involving the following topics:

a. Temperature measurement units/scales.
b. Expansion of solids (linear, area and volume) and liquids.
c. Quantity of heat; specific heat.
d. Changes of state: sensible and latent heat, heat content in mixtures of water, ice and steam; saturated and superheated steam.
e. Steam tables; temperature-enthalpy charts; critical temperature and pressure; dryness fraction; equivalent evaporation, factor of evaporation.
f. Methods of heat transfer; conduction, convection, radiation.
g. Work and heat; mechanical equivalent of heat; laws of thermodynamics.
h. Expansion and compression of gases: Boyle's and Charle's laws of perfect gases, general gas law, characteristic gas constant; isothermal, adiabatic and polytropic processes; pressure-volume diagrams; work done in cylinders; indicated horsepower; thermal efficiency.

4. APPLIED SCIENCE:

a. Basic Chemistry:

I. Molecules, atoms, elements, compounds, mixtures.
II. Structure of the atom, atomic number, atomic weight, formula weights, the mole; molar mass calculations; periodic table of the elements.
III. Chemical formulae; balancing chemical equations.
IV. Properties of acids, bases, salts.
V. Simple organic chemistry; structure of hydrocarbons.
VI. Typical industrial applications of chemistry: water treatment, combustion; corrosion.

b. Metallurgy and Engineering Materials:

I. ANSI and ASME classifications of metals; methods of steel and iron production.
II. Properties, grades and applications of cast iron

III. Properties, grades and applications of steel; alloying metals and applications.
IV. Properties and applications of non-ferrous metals
V. Properties and applications of non-metallic materials; plastics, carbon fibres, ceramics, polymers.
VI. Corrosion principles; types of corrosion, corrosion monitoring and prevention methods and devices, corrosion inspection.

c. Industrial Drawings:
Identify components and interpret symbols for the following engineering drawings:
I. Mechanical flow drawings (MFDs).
II. Process and instrument drawings (P&IDs).
III. Engineered construction drawings for pressure vessels and other equipment.
IV. Equipment layout.
V. Material balance.

Exam 3A-2

The candidate is to have a thorough knowledge of Section 2 of the Third Class Power Engineering course materials to successfully challenge the examination.

… There are 15 lectures in this section covering Codes, Safety, Environment, Fuels, Combustion, Piping Instrumentation, Electricity and the different types of power plants.

… The examination consists of 150 multiple-choice/free format questions, with 5 choices given for multiple choice type questions.

Sample Questions
For the above materials can be accessed under 'Study Guide' on the SOPEEC website at www.sopeec.org, see direct link on home page

Exam 3A-2 Syllabus: The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined:

5. INDUSTRIAL LEGISLATION:

a. General knowledge of the purpose, content and application of the boiler and pressure vessel codes and regulation, including the Power Engineers' Regulations in the student's jurisdiction.
b. State the purpose and describe the general content of each of the following codes:

I.
ASME Section I	-Power Boilers
ASME Section IV	-Heating Boilers
ASME Section V	-Nondestructive Examination
ASME Section VI	-Suggested Rules for Care of Heating Boilers
ASME Section VII	-Suggested Rules for Care of Power Boilers
ASME Section IX	-Welding & Brazing Qualifications

II.
CSA Standard B.51	-For Construction and Inspection of Boilers and Pressure Vessels
CSA Standard B.52	-Mechanical Refrigeration Code

III. National Board Inspection Code

6. CODE CALCULATIONS, A.S.M.E. Code Section I :

Use Code formulae and information to calculate the following (using SI units):

a. Designed thickness and allowable pressures of boiler tubes, drums, dished and hemispherical heads.

b. Sizes and capacities of boiler safety valves.

7. FUELS AND COMBUSTION:

a. Requirements for efficient combustion of boiler fuels; complete and incomplete combustion.
b. Classification, properties and combustion characteristics of coal, fuel oil and natural gas; other (non-fossil) fuels.
c. Fuel analysis; proximate, ultimate, fuel heat value; calorimetry.
d. Combustion chemistry; combustion equations for coal, oil, and gas; molar masses for combustion products.
e. Combustion calculations; oxygen, air and excess air required, given fuel analysis.
f. Flue gas analysis methods and devices; CO; CO_2 and O_2
g. Control of emission standards: NOx, SO_2, particulates.

8. PIPING:

a. Codes and standards for pressure piping: ASME, ANSI, CSA, ASTM; identification and sizes of piping; B31.1, B31.3; power piping vs. pressure piping.
b. Ferrous piping materials and methods of manufacture; specifications and service ratings; non-ferrous materials.
c. Non-metallic piping: materials and applications.
d. Strength of piping; effects of temperature on piping.
e. Piping connection methods: threaded, flanged, welded; design, materials, selection and installation of gaskets.
f. Designs and applications of expansion devices, supports and anchors.
g. Types of steam traps; trap sizing and selection; trap installation configurations, trap inspection installation configurations; trap inspection and maintenance; trap flow calculation.
h. Water hammer: effects; causes; design and operational preventions.
i. Insulation: purposes; benefits; characteristics; common materials and their uses; methods of application; cladding; care of insulated piping systems; calculations using configurations; valve trim; actuator types.

9. ELECTROTECHNOLOGY:

a. Direct Current Theory:
   I. Electron theory; theory of magnetism; magnetic field; force on conductor.
   II. Electromagnetic Induction: induced EMF; Faraday's and Lenz's Laws of Induction; Fleming's right-hand rule; self-induction in a coil; mutual induction.

b. Direct Current Machines:
   I. Generators: operating principles, construction, commutation, speed and voltage control; types (shunt, series and compound).
   II. Motors: principle of operation, torque development and measurement, armature reaction, interpoles, speed control, methods of starting, types (shunt, series and compound), protection devices.

c. Alternating Current Theory:
   I. Generation of an alternating EMF; sinusoidal waveforms; phase relationships.
   II. Resistance in AC circuits; inductive and capacitive reactance; impedance; power and power factor; single and multi-phase circuits.

d. Alternating Current Machines:
   I. Alternators: principle of operation, construction, voltage regulation, excitation methods, parallel operation, synchronizing procedures; automatic synchronizers, taking off the line, switchboard components (meters, breakers, machine protection relays).
   II. Motors: principle of operation of induction and synchronous motors; construction; speed and slip; starting methods for induction motors; speed control; variable speed starting, step-starting.
   III. Transformers: operating theory; types (design and construction), losses and efficiency; methods of cooling; safety and fire protection.

e. AC Systems, Switchgear, Safety:
   I. Components, layout, and operation of a typical industrial AC power system.
   II. Components of an AC generator panel.
   III. Circuit protective and switching equipment: fuses, safety switches; circuit breakers; circuit protection relays; automatic bus switchover (emergency supply to normal supply); grounding; lightning arresters.
   IV. UPS/Inverter Systems: purpose, components, operation; battery design and maintenance.
   V. Electrical safety for operators.

10. ELECTRICAL CALCUALTIONS:

Explain theories and perform calculations for:

a. Current, voltage, resistance in series and parallel circuits; using Ohm's Law and Kirchhoff's Laws; Wheatstone Bridge.
b. Temperature coefficient of resistance.
c. Work, energy, power: relationship between electrical, mechanical and heat units.
d. Sinusoidal Wave Forms: maximum, average and root mean square root values; frequency; phase.
e. AC Circuits: inductive reactance, capacitive reactance, impedance, KVA; power factor.
f. Relationship between poles, frequency, speed for AC machines.
g. Transformer calculations; step up and step down.

11. CONTROL INSTRUMENTATION:

a. Control loops and strategies:
   I. Applications of pneumatic, electric and electronic (digital) control systems; components and operation of typical control loops.
   II. On-off, proportional, reset, derivative control strategies.
   III. Feed forward, feedback, cascade, ratio, split-range, select control.
   IV. Alarm and shutdown functions in a control loop; operator interfaces with control loops

b. Instrument and Control Devices: design and principles of common temperature, pressure, flow, and level instruments.

c. Distributed and Logic Control Systems:
   I. Components, layout, functions of distributed control system.
   II. DCS operator interface components; trending; data logging; alarms and shut-downs.
   III. Programmable logic controllers: purpose, design, components; applications; ladder diagrams.
   IV. Supervisory control and data acquisition systems (SCADA) as used in process control: purpose and general functions.

12. INDUSTRIAL SAFETY AND FIRE PROTECTION:

a. Safety Management Programs
   I. Introduction to OH&S Acts in general
   II. Workplace OH&S Programs: setting up a program; purpose and interaction with WCB; company and employee responsibilities; typical components of an OH&S program: safety committees, hazard identification, incident investigation, personal safety equipment; work permit systems (equipment lock-out, confined space entry, hot and cold work, excavations); WHMIS (overview); emergency response plans.

b. Fire Protection Systems
   I. Classes of fire; extinguishing methods.
   II. Components and operation of industrial fire detection and alarm system.
   III. Sprinkler systems (dry and wet stand); pre-action and deluge; design and operation.
   IV. Fixed fire systems: firewater pump, loops, hydrants; vessel deluge system; foam systems.
   V. Industrial fire response

Exam 3B-1

The candidate is to have a thorough knowledge of Section 3 of the Third Class Power Engineering course materials to successfully challenge the exam. There are 15 lectures in this section, eleven with power boilers.

- This essay style examination requires one to explain, sketch, describe, state, or any combination of the above.

- 8 out of the 10 given questions are to be answered with each question worth 15 marks. Most questions will have several parts to them.
- Write in pen, sketch/draw in pencil.

Proper labeling of the components is expected, rulers/templates required for sketches and drawings. Detail and neatness on drawings count in the marking scheme

Sample Questions
For the above materials can be accessed under 'Study Guide' on the SOPEEC website at www.sopeec.org, see direct link on home page

Exam 3B-1 Syllabus: *The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined on:*

13. BOILERS:

a. Boiler Classification
   I. Definitions and designs of typical Watertube Boilers:
   Multi-drum bent tube; D, A, O configurations; packaged, once-through, forced circulation, critical vs. super-critical boilers.
   II. Special Boiler Designs; describe the design, components and operation of the following designs:
   Fluidized bed boilers, heat recovery steam generators (HRSG), black liquor boilers, waste heat boilers, refuse boilers, Bio-mass, high-pressure/high-temperature hot water boilers.

b. Boiler Construction
   I. Designs, fabrication, construction methods, and Code requirements for: shells, drums, tubes (include attachment methods), nozzles; headers; handholes/manholes.
   II. Field assembly of a large watertube boiler.
   III. Boiler metals – applications and purpose.

c. Boiler Heat Transfer Components
   I. Watertube boiler settings (brickwork and refractory) baffles; integral furnace designs and waterwalls; studded tubes; water-cooled walls; fin-tube, tangent-tube; flat-stud tube.
   II. Superheaters: primary, secondary, convection, radiant, integral, and separately-fired; operating characteristics.
   III. Reheater designs
   IV. Economizers: integral and separate; tube styles, advantages/disadvantages.
   V. Air Heaters: plate, tubular, rotary regenerative designs; heater corrosion control; advantages/disadvantages.
   VI. Sootblowers: stationary and retractable, locations, shot cleaning.

d. High Pressure Boiler Fittings
   Design, installation/location, operation, testing and Code requirements for each of the following boiler fittings:

   I. Water columns and gauge glasses; types of remote level indicators; illumination; safety shut-off.
   II. Safety valves; setting.
   III. Low-water fuel cut-offs; float and probe designs.
   IV. Steam outlet fittings and non-return designs.
   V. Pressure gauges; feedwater connections; vents; and blowdown valve designs; blowdown procedures; blowdown tank.
   VI. Drum Internals: baffles, scrubbers, separators, driers, piping circulation and separation of steam and water

e. Fuel, Draft, and Flue Gas Systems
   I. Coal firing equipment: mechanical, underfeed, crossfeed and overfeed stokers; pulverizers - impact, ball, ball-race and bowl mills; burner and furnace designs – turbulent vertical, tangential, cyclone; coal feed systems; ash handling systems – hydro and air, bottom ash.
   II. Oil burning equipment: oil burner designs – steam, oil and mechanical atomizing; components of large oil burner systems; start-up/shut-down of large oil burners; cleaning and maintenance.

III. Gas burning equipment: burner designs – spud, multi-spud and ring; burner gas supply system; start-up sequence for gas burner; high-efficiency, low NOx burners.
IV. Draft equipment: natural, forced, induced, balanced draft; draft fan designs, control methods; fan performance curves; draft measurement; windbox and air louvers; primary and secondary air.
V. Flue gas clean-up methods and equipment: precipitators, filters, ash handling systems; SO_2 recovery systems.

f. Boiler Operation and Maintenance
I. Manual start-up and shut-down procedure for large, industrial boilers.
II. Initial start-up (commissioning) of a new boiler.
III. Routine and emergency operations.
IV. Causes and prevention of boiler furnace and pressure explosions.
V. Chemical and mechanical boiler cleaning methods; boiling out.
VI. Methods of cleaning and preparing a boiler for inspection.
VII. Inspection: fire and water sides; safety.
VIII. Hydrostatic test.

14. BOILER CONTROL SYSTEMS:

a. Boiler Water Level Control: components, purpose and operation of single-element, two-element, and three-element control systems; explain swell and shrinkage.

b. Combustion control:
I. Design and operation of each of the following combustion control systems: direct pressure control of fuel and air, steam flow – air flow control, fuel flow – air flow control, air flow- fuel flow, multi-element control.
II. Safety devices and interlocks.
III. Flame failure detection: continuous, intermittent, interrupted pilots; photo-electric cells.
IV. Automatic, programmed boiler start-up and shut-down sequence.

c. Steam temperature control: desuperheating control, attemperation, gas recirculation, gas bypass, tilting burners.

15. FEEDWATER TREATMENT:

a. Feedwater impurities and their effects on boiler operation.
b. External, feedwater treatment: explain the purpose, physical and/or chemical operating principles, system/equipment design and operation for each of the following: settling, coagulation and filtering, hot and cold lime-soda softening, hot phosphate softening, sodium and hydrogen zeolite softening, demineralization, dealkalization, mechanical deaeration, evaporation (multi-effect evaporators), reverse osmosis.

c. Internal Boiler Water Treatment:
I. Causes, effects and controls for boiler internal water problems.
II. PH control – magnetite layers, acidic and caustic corrosion.
III. Sludge conditioning and dispersion; modern sludge dispersants.
IV. Chemical deaeration – oxygen corrosion; sulphite programs; hydrazine.
V. Carryover – priming, misting, foaming.
VI. Dissolved solids – blowdown control; conductance; simple and heat recovery blowdown systems; automatic blowdown systems.
VII. Return line corrosion – neutralizing and filming amines.
VIII. Scale control – phosphate and chelate programs.

d. Chemical feed systems: shot and continuous feed systems; chemical feed pumps.
e. Feedwater and boiler water testing methods: automatic sampling systems and monitors; boiler and steam system parameters and test locations.

16. PUMPS:

a. Theory of pumping: define and explain pump head terms, perform pump head and pressure calculations, explain cavitation.
b. Reciprocating pumps: pump drivers; single and double-acting designs; plunger type; diaphragm type; pump protection.
c. Centrifugal pumps:
I. Classification and principles of operation for volute, diffuser and turbine pumps; axial and mixed flow.
II. Construction and components: single and multi-stage; impeller types; wear rings; shaft sealing arrangements – stuffing box, lantern ring, mechanical seals; balance disc; drum; opposed impellers.
III. Operation: starting and stopping, priming

IV. Typical pump installation; auto-recycle valve

d. Rotary pumps: design and operation of gear, lobe, screw.

17. WELDING PROCEDURES AND INSPECTION:

a. Welding Processes (overview): describe and state where each of these processes would be used – metal arc, shielded arc, submerged arc, gas (TIG), MIG.
b. Electrodes: classification, types and uses; where and why each would be used.
c. Fabrication and repairs: weld preparation; preheating, performing a boiler tube repair, postweld heat treatment (stress relieving).
d. Causes and effects of common weld defects.
e. Weld inspection procedures: non-destructive examination techniques; destructive examination techniques.
f. Welding Procedure and Welder's Performance Qualifications per ASME Code, Sect. 9.

18. PRESSURE VESSELS:

a. Explain design, construction, operation and repair regulation of pressure vessels, including stamping and nameplate details.
b. Head, nozzle, manway designs.
c. Loads and stresses on pressure vessels.
d. Typical components/fittings on a pressure vessel.
e. Safe operating and maintenance consideration, including hydro and pneumatic testing; inspection.

Exam 3B-2

The candidate is to have a thorough knowledge of Section 4 of the Third Class Power Engineering course materials to successfully challenge the exam. There are 9 lectures in this section covering Steam and Gas Turbines, Diesel Engines, Air Compression, Refrigeration, Bearings and Lubrication.

- As previously stated, the examinations consist of 150 multiple-choice questions each having 5 choices.

Sample Questions

For the above materials can be accessed under 'Study Guide' on the SOPEEC website at www.sopeec.org, see direct link on home page

Exam 3B-2 Syllabus: *The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which the candidates will be examined on:*

19. PRIME MOVERS:

a. Steam Turbines:
   I. Impulse and reaction principles; nozzles; blade shapes.
   II. Turbine arrangements, staging and compounding: principles and p-v diagrams for pressure, velocity, and pressure-velocity compounding.
   III. Turbine components: purpose, design, operation of the following: casings, disc and drum rotors, dummy pistons, journal and thrust bearings, barring gear, blade and shaft sealing glands, couplings, interceptor valves on reheat turbines.
   IV. Explain purpose and arrangements of condensing, bleeder, topping, extraction, cross and tandem compounded turbines.
   V. Turbine governor types; speed-sensitive, pressure-sensitive, nozzle, throttle, bypass, mechanical, mechanical hydraulic, electronic-hydraulic; droop and isochronous operation.
   VI. Starting up and shutting down condensing and extraction turbines.
   VII. Steam turbine condensers: types, air-cooled, water-cooled, Panier style; condenser auxiliaries; condenser operation; feedwater heater system.

b. Gas Turbines:
   I. Applications, advantages and disadvantages of gas turbines.
   II. Basic cycle and improvements: open and closed cycles defined, regeneration, dual shaft arrangement, intercooling and reheating, typical gas turbine operating parameters and efficiency, combined steam and gas turbine cycles.
   III. Main gas turbine components: radial and axial compressors, combustor arrangements and operation, turbine rotor designs.
   IV. Gas turbine support systems: fuel supply systems; lubrication; barring gear; steam injection; intake and exhaust components.
   V. Supervisory, protective, and control systems.
   VI. Starting and stopping procedures and sequences; turbine washing.

c. Internal Combustion Engines:
   I. Gasoline engines: spark ignition defined, two-stroke cycle, four-stroke cycle, carburetion; carburetor design and operation, spark ignition components, fuel injection.
   II. Diesel engines: compression ignition defined, two-stroke cycle, four-stroke cycle, scavenging, fuel injection; fuel injectors; purpose and design of the major mechanical/structural components of a diesel engine; starting and maintenance procedures.
   III. Engine support systems: fuel systems, lubrication, governing, starting systems and methods, magneto system, cooling systems, supercharging and turbo-charging.
   IV. Thermodynamic heat engine cycles: explain the Otto, Diesel, and Brayton cycles.

20. COGENERATION:

Purpose, advantages, components or cogeneration systems; simple and combined cycle, using gas turbines and internal combustion engines; single and dual shaft arrangements; control strategies and components; environmental considerations; heat recovery boilers and water heaters; operating procedures; typical industrial cogeneration applications.

21. COMPRESSORS:

a. Theory of Compression:
   I. Adiabatic and isothermal compression; pressure volume relationships; compression ratio, capacity, multi-staging; effect of altitude and moisture.
   II. Applications for compression, including air and gas.

b. Positive Displacement Compressors:
   I. Reciprocating compressors: clearance volume; indicator diagrams; calculations for displacement and volumetric efficiency.
   II. Free piston compressor.
   III. Rotary compressors: sliding vane, lobe, and screw types (industrial screw type in detail, including control panel).

c. Dynamic Compressors:
   I. Design and operation of centrifugal and axial flow compressors; application as blowers.
   II. Compressor surge: causes and prevention; P-V curve; surge line, anti-surge system and control.

d. Starting and stopping procedures for positive displacement and dynamic compressors
e. Compressor Auxiliaries:
   I. Intercoolers/aftercoolers; moisture separators.
   II. Compressor control systems and devices: start and stop, variable and constant speed; safety devices.
   III. Lubrication: internal and external.
   IV. Compressor installation and piping layouts

f. Compressed Air System Components:
   I. Typical system layout; air receivers (wet and dry) fittings and operation; filters.
   II. Air dryers: system design, flows, operation; dewpoint monitoring.

22. REFRIGERATION:

a. Refrigerant classifications, properties, characteristics.
b. Compression Systems:
   I. Principle of compression refrigeration; typical system temperatures and pressures for simple refrigeration systems.
   II. Multi-stage systems: 2-stage with duplex compressors; 2-stage with booster compressor; low temperature multi-stage.
   III. Direct vs. indirect systems.
   IV. Typical refrigeration applications.

c. Absorption System: ammonia absorption system description and operating parameters.
d. Refrigeration System Auxiliaries:
   I. System controls: expansion valves, low-side float, high-side float, capillary tube.
   II. Compressor controls: temperature and pressure-actuated.
   III. Condenser cooling water control.
   IV. Safety devices and controls: pressure relief devices, high-pressure cut-out, low-pressure lube oil cut-out

e. CSA B52 Regulations: overview of the code for the safe operation, installation and repair of refrigeration equipment.
f. System Operation: Leak testing, charging, purging, troubleshooting (condenser, regulator, refrigerant strength, compressor discharge temperature); effects of moisture in system; effects of oil in the refrigerant; oil removal using oil separators, oil traps, oil still; operating and maintaining brine systems.

23. SPECIAL INDUSTRIAL EQUIPMENT:

Describe the general applications, designs, components, operation for the following:

a. Heat Exchangers: double pipe designs; shell-and-tube configurations, head designs, reboiler and feedwater heater fittings; plate frame; overhead aerial coolers; aerial steam condensers, including operation and control.
b. Cooling Towers: natural draft; atmospheric; hyperbolic; mechanical draft designs; operation and control.
c. Fired Heaters: multi-burner vertical designs; burner components and styles; fuel supply and control; interlocks and safety devices; indirect-fired heaters; horizontal designs; start-up and shutdown procedures.

24. WASTEWATER TREATMENT:

a. Purpose of WWT; typical wastewater pollutants and systems.
b. Theory and equipment for specific treatment process: removal of suspended solids (screening, floatation, sedimentation); removal of colloidal solids (chemical coagulation, flocculation, clarification); biological treatment (activated sludge, rotating biological contactors, trickling filters).
c. Operating parameters, controls and tests: nutrients, BOD, COD, pH, settleability.
d. Safety in wastewater treatment plants.

25. PLANT MAINTENANCE AND ADMINISTRATION:

Explain the purpose, typical design and administration of the following plant functions:

a. Communication and accountability structures.
b. Scheduled and preventative maintenance programs.
c. Record keeping; logbooks; logsheets.
d. Project control; critical path (applied to a complete boiler turnaround, as an example).
e. Operating standards and procedures.
f. Training and development practices; job skill profiles.
g. Environmental practices and supervision.

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 Third 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 the 3rd Class Examinations

A candidate must be in possession of a 4th Class Stationary, Operating, or Power Engineer Certificate of Qualification that is in good standing, in Ontario. Those whose certificates have expired must first have their certificate re-instated.

Practical Time Requirements to obtain the 3rd Class Certificate

- To be eligible for the 3rd Class Operating Engineers Certificate of Qualification, you must have operated a registered, operator attended plant as a 4th Class Operating Engineer for a minimum one year period, if you have not attended a fulltime TSSA approved training program. To determine the power plant size and rating in which you are to obtain your practical operating experience (as a 4th Class operator) towards your 3rd Class time, refer to Table 8 of the Operating Engineers Regulation;

'or'

- The above required practical plant operating time can be reduced by 11 months if you have graduated from a full-time TSSA approved 3rd Class Power Engineering training course. Refer to 'Training Providers' listing on our web page for those eligible to offer the "TSSA approved-for-practical-time-reduction" programs.

- The student is to have successfully completed the program before any time reduction is granted.

- The 1 month practical operating time served for the 3rd Class shall be in an operator attended plant that requires a 3rd Class Operating Engineer or higher. This registered training power plant must be located off-site in cooperation with private industry.

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

Examinations

- There are 4 examinations at the 3rd Class level, each 3.5 hours in duration and the pass mark is 65%. There is a 60 day mandatory waiting period to re-write examinations, as per the OE Regulations.
  - Exams 3A-1 and 3B-2 consist of 150 multiple-choice style questions.
  - Exams 3A2 consists of 150 multiple choice/free format questions.
  - Exam 3B-1 is in essay format requiring the candidate to answer any 8 of 10 given questions.

- The 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 to be used as neatness is considered in the marking scheme.

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.

- **'3rd class Power Engineering'** available 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

- **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'.

Updated: August 6, 2009