

# 4<sup>th</sup> Class Power (Operating) Engineer Certification and Examination Guide



Effective: June 2021

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## Syllabus

The following SOPEEC syllabus has been adopted by TSSA and provides the subject matter upon which a candidate will be examined, and all related topics of study.

### **4A (2017)**

#### **A Elementary Mechanics and Dynamics**

- a. Perform basic calculations and define basic terms used in the study of mechanics.
- b. Perform calculations using forces and moments, and determine whether or not a system is in equilibrium.
- c. Define simple machines and perform calculations relating to mechanical advantage, velocity ratio and efficiency.
- d. Define and identify scalar and vector quantities and solve simple vector problems graphically.
- e. Define speed, velocity, distance, displacement, and acceleration and solve simple linear problems involving these terms.
- f. Define force, work, pressure, power and, energy and perform calculations involving the relationships between these mechanical terms.
- g. Describe friction and solve problems involving friction on a horizontal plane.
- h. Explain:
  - i. The physical properties of materials and how these properties affect the materials behaviour when external forces are applied.
  - ii. Stress and the deformation of bodies caused by externally applied forces, and the internal forces that resist these deformations, including tensile, compressive, shear stresses plus factor of safety.
- i. Explain the common examples of power transmission systems, including speed changes, transmitted power and efficiency.

#### **B Elementary Chemistry and Thermodynamics**

- a. Explain basic chemistry principles, basic types of matter and their properties.
- b. Explain the principles of thermodynamics, including the laws of thermodynamics.
- c. Explain the modes of heat transfer and theory of operation of heat exchangers.
- d. Describe the principles of the thermodynamics of steam and the associated terms.

#### **C Jurisdictional Legislation, Codes and Standards for Power Engineers**

- a. Describe the purpose of Jurisdictional acts and regulations with respect to boilers and pressure vessels and piping for Power Engineers.
- b. Describe the purpose of Codes and Standards with respect to boilers and pressure vessels and piping for Power Engineers.

#### **D Power Plant / Heating Plant Safety**

- a. Describe general plant safety in Power, Heating, Pressure and Industrial plants that employ Power Engineers.
- b. Describe the common safety programs that are generally implemented in plants.
- c. Describe the procedures for safe storage and handling of dangerous materials.
- d. Explain fire safety in a plant.
- e. Describe the causes of, extinguishing methods and preventive measures for fires.



### **E Environment**

- a. Explain how the environment is related to the operating plant.
- b. Explain how gas and noise emissions affect plant operation.
- c. Explain how liquid and solid emissions affect plant operation.

### **F Material and Welding**

- a. Describe the mechanical properties of engineering materials and the ability of alloying elements to change the mechanical properties of materials, and identify nonferrous materials as used in engineering.
- b. Describe the welding processes that are relevant to the plant and Power Engineer.
- c. Describe the inspection and testing methods of welds and materials used in plants.

### **G Piping and Valves**

- a. Describe the basic types of piping, piping connections, supports and drainage devices used in the industry.
- b. Describe the design and uses of the valves designs most commonly used in industry plants and on boilers.

### **H Electricity**

- a. Describe the concepts of basic electricity and perform simple AC & DC calculations using voltage, current, resistance and power.
- b. Describe the basic principles of magnetism as it relates to electricity.
- c. Describe the designs and uses of electrical metering devices.
- d. Describe the operating principles of the various types of AC and DC motors and generators.
- e. Describe the operating principles of electrical transformers.
- f. Describe an electrical distribution system and safe operation.

### **I Energy Plant Instrumentation and Controls**

- a. Describe the overall purpose and function of plant instrumentation and control systems.
- b. Describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity, and composition.
- c. Describe the basic types and functions of transmitters, recorders, controllers, and control actuators.
- d. Describe the operation of programming controls for boilers and discuss testing and maintenance procedures for these controls.
- e. Describe the design and operation of electronic control systems.
- f. Describe the design and operation of electrical control systems.

### **J Plant Communication**

- a. Describe how to setup plant and equipment sketches, and how to complete a plant line tracing diagram.
- b. Describe the common types of diagrams used in plants.
- c. Describe the different types of and proper use of plant communication systems.

### **K Boilers**

- a. Describe the historical development of boilers, boiler design, components and configuration.
- b. Describe the design, components and characteristics of firetube boilers.



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- c. Describe the design, components and characteristics of watertube boilers.
- d. Explain the general design and application of electric boilers
- e. Describe the special designs of boilers used in heating plants.
- f. Describe the differences between ASME section I and ASME section IV boilers.

### **L Boiler Systems**

- a. Discuss the basic theory of combustion in a boiler, and the equipment used to provide proper combustion conditions.
- b. Describe the common fuel systems used in boiler systems.
- c. Describe draft and the basic equipment used to supply combustion air to a boiler furnace.
- d. Describe the types of feedwater systems used for boilers.
- e. Describe the purpose, equipment and operation of blow down in boiler systems.
- f. Describe the purpose, equipment and operation of fireside cleaning in boiler systems.

## **4B (2017)**

### **A Lubrication**

- a. Describe the importance of lubrication and the operating principles of lubrication.
- b. Describe the methods for basic care and maintenance of bearings and their related lubrication systems.

### **B Pumps and Compressors**

- a. Describe the construction and operating principles of various types of pumps used in buildings and industrial plants.
- b. Describe maintenance procedures for efficient and reliable pump operation.
- c. Describe the construction and operating principles of the different types of compressors.
- d. Describe the startup, operation and shut down of different types of compressors.

### **C Boiler Safety Devices**

- a. Explain the code and standards requirements, design and operation of pressure relief valves for power boilers, heating boilers, and pressure vessels.
- b. Explain the design and operation of combustion safety controls on burners and boilers.
- c. Describe feedwater control methods and devices used on boilers.
- d. Describe the code and standards required and operation required fittings, along with the operating principles of fittings found on boilers.
- e. Name and describe the operating and safety controls found on boilers.

### **D Plant (Boiler) Operation**

- a. Describe the safe and efficient operational procedures that relate to starting up the auxiliary equipment in a boiler plant.
- b. Describe the safe and efficient operational procedures that relate to starting up boiler systems.
- c. Describe the safe and efficient operational procedures that relate to operating boilers.
- d. Describe the operational checks that need to be conducted for an operating boiler plant.
- e. Describe generic shutdown and layup procedures for different boilers.
- f. Describe the essential points and readings that need to be monitored and recorded in a plant.

### **E Power Plant/Heating Plant Maintenance**

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- a. Describe the safe use of common hand tools in the powerhouse.
- b. Describe mechanical fasteners and the safe and proper setup of equipment for hoisting and working above ground.
- c. Describe the service and maintenance required for boilers.
- d. Discuss the procedure for preparing a boiler for inspection and cleaning, and describe mechanical and chemical boiler cleaning methods.

### **F Water Treatment**

- a. Describe the general principles, methods and equipment used in preparing raw feedwater for steam production in a boiler.
- b. Describe the general principles, methods and equipment used for the internal treatment of boiler water.
- c. Discuss the general principles, methods and equipment used for the treatment of condensate.
- d. Discuss the general principles, methods and equipment used for the treatment of cooling tower and condenser water.
- e. Describe cooling water/chilled water effects, treatment and tests.
- f. Describe heating system water effects, treatment and tests.

### **G Prime Movers and Engines**

- a. Describe the conversion of heat into mechanical energy and the history of steam engine.
- b. Describe the construction and operation of steam turbines.
- c. Describe the operation and maintenance of cooling towers and condensers.
- d. Describe the application, set up operation and maintenance required for gas turbines.
- e. Describe the application, construction, and operation of internal combustion engines.

### **H Auxiliary Building Systems**

- a. Explain lighting systems and some of the basic design considerations for lighting a space.
- b. Explain the various water supply systems used in buildings.
- c. Describe the design and components of various sanitary drainage systems used in buildings.

### **I Refrigeration**

- a. Explain the basic concept of refrigeration and refrigerants.
- b. Describe the operating principles, operation and maintenance of compression refrigeration systems.
- c. Describe the purposes and operating principles of the operational and safety controls on a refrigeration system.
- d. Describe the operating principle, maintenance and operation of absorption refrigeration systems.

### **J Heating Ventilating and Air Conditioning**

- a. Explain the methods and techniques for conditioning air for human comfort and health.
- b. Explain the equipment and principles of humidification.
- c. Describe the air flow behaviour and movement of air through distribution systems.
- d. Describe the various ventilation systems found in buildings, as well as describe the various types of air filters used in these systems.
- e. Describe the designs and components of duct systems used in air conditioning.
- f. Describe the various types of coils used in HVAC systems, and their operation.

### **K Heating and Cooling Systems**

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- a. Describe the operating principles and maintenance procedures of steam heating systems and the components of these systems.
- b. Describe the various designs of hot water heating systems, as well as their equipment and operation.
- c. Describe the common heating systems that a Power Engineer may encounter.
- d. Describe central, Unitary and Combined types of HVAC systems.
- e. Describe heat gains and losses and the common methods of recovering energy from the system.
- f. Describe the control systems strategies used in HVAC systems.

### L Types of Plants

- a. Identify steam-related processes in some common types of plants that employ Power Engineers.

## Certification Information

### Qualifying Experience Time:

Qualifying experience time served shall be in a plant that is required to be attended by an Operating Engineer or an unattended plant supervised by an Operating Engineer/Operator. Please refer to Table 8 of the Operating Engineers Regulation for plant rating/capacity, Table 8 in the Director's Order, or the Alternate Table 8 in the Minister's Order.

- The practical operating training requirement for fourth class certification is **1,920 hours** as a trainee in a fourth class, third class, second class or first class plant.
- The practical operating time requirement for fourth class certification is **480 hours** for candidates having successfully completed a full-time TSSA "approved-for-time-reduction" 4<sup>th</sup> Class Operating Engineer program.
- The certification process will require minimum of 33% Qualifying Experience Time in the operation of Boilers at a registered plant. There will be a maximum of 33% of experience permitted on maintenance of regulated equipment, and the remainder of the experience requirements can be any combination of the technologies.

### Qualifying Experience attained in a Canadian Jurisdiction outside Ontario

Qualifying time experience toward Operating/Power Engineering attained in a Canadian Jurisdiction outside Ontario must be attained in the operation and management of boilers at least of the type and capacities indicated on Tables 3 of the Operating Engineers Regulation, Ontario Regulation 219/01. The following information must be demonstrated to TSSA in a request for certification:

- A letter addressed to the candidate, on company letter head and signed, from the Chief Operating/Power Engineer, indicating the number of boilers trained on, the boiler types, boiler manufacturer, boiler(s) pressure, capacities in Kilowatts or Boiler Horsepower and the time periods when the experience was gained (dates). The Chief Operating/Power Engineer must indicate their certificate number and classification, as well as their formal position and contact information (i.e. telephone number, email address, etc.).

## 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 [www.tssa.org](http://www.tssa.org).

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.



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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.

### Examination Information

There are two (2) multiple choice examinations that must be written which is 3 ½ hours in duration.

- The 4A & 4B examinations consist of 150 multiple choice questions.

The minimum passing mark for each examination is 65%, rewrites are allowed after 60 days.

Note: effective June 15, 2021, Operating Engineers/Operators will have the option to pursue exams and meet the experience requirements concurrently or at their own pace.

When answering examination questions, the candidate is expected to give sufficient information to warrant the marks assigned. For questions involving calculations, the candidate is expected to state the formula, insert given data, work through the steps and state your answer with the correct units in an appropriate closing statement.

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.

Examinations may be written at either a Ministry of Labour, Training and Skills Development exam centre or at a TSSA approved examination centre. To locate nearest centre, refer to "Register for an Exam" listing at [www.tssa.org](http://www.tssa.org).

Examination security will be strictly enforced. The examination administrator or invigilator reserves the right to revoke an examination at any time if the examination candidate is found to be in violation of the TSSA examination or MTCU procedures. The examination candidate will be subject to further investigation, which may result in the revocation of an authorization or restrictions may be applied to all future examinations.

**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.**

### Suggested Study Materials

It is recommended that the candidate becomes familiar with the publications listed in the Reference Material for Power Engineering Students and Examination Candidates, listed below:

- **Technical Standards & Safety Act** and the **Operating Engineers Regulation and Directors Orders** are posted on the TSSA website [www.tssa.org](http://www.tssa.org) and can be printed for your studies.
- **'4th class Power Engineering'** available from PanGlobal Publishing
- **Reed's Marine Engineering Series** by Nautical Mind Bookstore
- **"Metals & How to Weld Them"** by Jefferson & Woods
- **2007 ASME Boiler and Pressure Vessel Code** – Academic Extract contains materials from Sections I, II, IV and VIII of the 2007 ASME Boiler and Pressure Vessel Code and is available from PanGlobal Publishing
- **CSA B51: "Boilers, Pressure Vessel and Piping Code"** available from the CSA Group
- **CSA B52: "Mechanical Refrigeration Code"**
- **2007 ASME Extract**



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- **ASME Section I:** Rules for the Construction of Power Boilers Extract
- **ASME Code Simplified**
- **ASME Section VI:** Recommended Guidelines for the Care and Operation of Heating Boilers
- **ASME Section VII:** Recommended Guidelines for Care and Operation of Power Boilers
- **ASME Section IX:** Welding and Brazing Qualifications
- **Stationary Engineering, Fourth Edition**, 2008, by American Technical Publishers, Inc. Author(s) Fredrick M. Steingress, Harold J. Frost and Daryl R. Walker
- **Boiler Operator's Workbook, Fourth Edition** 2008, by American Technical Publishers, Inc. Author R. Dean Wilson

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. More information is made available at [www.sopec.org](http://www.sopec.org).

### **Obtaining Certificate**

Upon successful completion of the examination and the completion of the required practical operating training period, the candidate may apply to TSSA for their "**Certificate of Qualification**" by forwarding:

- A completed '*Application for an Ontario Certificate of Qualification as an Operating Engineer or Operator*'; and,
- The certification fee, please view the **OE Fee schedule** from the Operating Engineers web page.