

# FOURTH CLASS POWER ENGINEER SYLLABUS - 2017



**TECHNICAL  
SAFETY BC**

Safe technical systems. Everywhere.



## INTRODUCTION

The following syllabus has been approved by the Standardization of Power Engineer Examinations Committee (SOPEEC) and adopted by Technical Safety BC.

Please Note: This syllabus is intended to assist applicants studying for the Fourth Class Engineer's Certificate of Qualification Examination in the 2017 syllabus which came into effect on November 1, 2017. Examination applicants who complete the Fourth Class Power Engineering course after November 1, 2017 will only be eligible to write the examinations under this new syllabus.

The requirements to qualify for a Fourth Class Power Engineer's Certificate of Qualification are outlined in the Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation.

For more information on Fourth Class Power Engineer certification, visit our [website](#).

## COURSE MATERIAL

It is mandatory that, before undertaking a Fourth Class Power Engineer's Certificate of Qualification Examination, the applicant completes a Fourth Class Power Engineering Course offered through Technical Safety BC approved course provider. However, applicants holding a degree in mechanical engineering (Canadian equivalent) or marine engineer certificate of competency (Third Class or higher) may be exempted from completing Fourth Class Power Engineering Course.

## CURRICULUM

Applicants should review the SOPEEC curriculum for more detailed information on the materials covered here. Applicants should also become familiar with the publications listed in the reference material posted on the SOPEEC [website](#).

## APPLICATION TO UNDERTAKE EXAMINATION

Submit completed application along with clear copies of prerequisites. Examination application (FRM-1004) and fees must be received and approved before the registration cut-off date in order to reserve an examination date, subject to seating availability. Read the examination scheduling policy [here](#).

## EXAMINATION INSTRUCTIONS

There are two examinations (4A1 and 4B1) which are of 3½ hours duration each. Each examination consists of 150 multiple-choice questions.

To pass a Fourth Class Power Engineer's Certificate of Qualification examination, an applicant must obtain at least 65% of the total marks allotted for each examination.

Following items are allowed in the examination room:

- Academic supplement containing Handbook of Formulae and Physical Constants, Steam Tables and Refrigeration Tables;
- Extract of CSA standards containing subset of materials from:
  - B51 Boiler, Pressure Vessel and Pressure Piping Code
  - B52 Mechanical Refrigeration Code
- ASME Extract containing a subset of materials from sections I, II, IV and VIII of the ASME Boiler and Pressure Vessel Code
- ASME Extract Supplement containing subset of materials from sections VIII-UW, IX, B31.1 and B31.3 of the ASME Boiler and Pressure Vessel Code;
- Safety Standards Act;
- Safety Standards General Regulation;
- Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation;
- Pens and pencils;
- A non-technical English language dictionary;
- Non-programmable calculator;
- Drawing instruments and drawing templates.

## EXAMINATION APPLICANT'S RULES

- The applicant must provide valid, current government-issued photo identification to the examination invigilator prior to the examination.
- Examinees must leave all bags and electronic devices (e.g., cameras, cell phones, digital watches, electronic pens, Google glasses, etc.) in the area assigned for personal belongings outside of the examination room, before taking a seat. Hats must be removed. Bags and electronic devices (e.g., cameras, cell phones, digital watches, electronic pens, Google glasses, etc.) are prohibited in the examination room.
- Refer to the detailed examination applicant rules here.
- Any breaches of the examination applicant rules may result in cancellation of your examination mark, restrictions on your ability to write future examinations or obtain qualifications, assessment of pre-existing qualifications, and suspension or revocation of existing qualifications.

## EXAMINATION 4A1 - NEW

### A1. Elementary Mechanics and Dynamics

1. Perform basic calculations and define basic terms used in the study of mechanics.
2. Perform calculations using forces and moments, and determine whether or not a system is in equilibrium.
3. Define simple machines and perform calculations relating to mechanical advantage, velocity ratio and efficiency.
4. Define and identify scalar and vector quantities and solve simple vector problems graphically.
5. Define speed, velocity, distance, displacement, and acceleration and solve simple linear

problems involving these terms.

6. Define force, work, pressure, power and, energy and perform calculations involving the relationships between these mechanical terms.
7. Describe friction and solve problems involving friction on a horizontal plane.
8. Explain:
  - a) The physical properties of materials and how these properties affect the materials behavior when external forces are applied.
  - b) 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.
9. Explain the common examples of power transmission systems, including speed changes, transmitted power and efficiency.

#### **A2. Elementary Chemistry and Thermodynamics**

10. Explain basic chemistry principles, basic types of matter and their properties.
11. Explain the principles of thermodynamics, including the laws of thermodynamics.
12. Explain the modes of heat transfer and theory of operation of heat exchangers.
13. Describe the principles of the thermodynamics of steam and the associated terms.

#### **A3. Jurisdictional Legislation, Codes and Standards for Power Engineers**

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

#### **A4. Power Plant / Heating Plant Safety**

16. Describe general plant safety in Power, Heating, Pressure and Industrial plants that employ Power Engineers.
17. Describe the common safety programs that are generally implemented in plants.
18. Describe the procedures for safe storage and handling of dangerous materials.
19. Explain fire safety in a plant.
20. Describe the causes of, extinguishing methods and preventive measures for fires.

#### **A5. Environment**

21. Explain how the environment is related to the operating plant.
22. Explain how gas and noise emissions affect plant operation.
23. Explain how liquid and solid emissions affect plant operation.

#### **A6. Material and Welding**

24. 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.
25. Describe the welding processes that are relevant to the plant and Power Engineer.
26. Describe the inspection and testing methods of welds and materials used in plants.

#### **A7. Piping and Valves**

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

#### **A8. Electricity**

29. Describe the concepts of basic electricity and perform simple AC & DC calculations using voltage, current, resistance and power.
30. Describe the basic principles of magnetism as it relates to electricity.

31. Describe the designs and uses of electrical metering devices.
32. Describe the operating principles of the various types of AC and DC motors and generators.
33. Describe the operating principles of electrical transformers.
34. Describe an electrical distribution system and safe operation

#### **A9. Energy Plant Instrumentation and Controls**

35. Describe the overall purpose and function of plant instrumentation and control systems.
36. Describe the construction and operation of common devices used to measure pressure, level, flow, temperature, humidity, and composition.
37. Describe the basic types and functions of transmitters, recorders, controllers, and control actuators.
38. Describe the operation of programming controls for boilers and discuss testing and maintenance procedures for these controls.
39. Describe the design and operation of electronic control systems.
40. Describe the design and operation of electrical control systems.

#### **A10. Plant Communication**

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

#### **A11. Boilers**

44. Describe the historical development of boilers, boiler design, components and configuration.
45. Describe the design, components and characteristics of fire-tube boilers.
46. Describe the design, components and characteristics of water-tube boilers.
47. Explain the general design and application of electric boilers
48. Describe the special designs of boilers used in heating plants.
49. Describe the differences between ASME section I and ASME section IV boilers.

#### **A12. Boiler Systems**

50. Discuss the basic theory of combustion in a boiler, and the equipment used to provide proper combustion conditions.
51. Describe the common fuel systems used in boiler systems.
52. Describe draft and the basic equipment used to supply combustion air to a boiler furnace.
53. Describe the types of feed water systems used for boilers.
54. Describe the purpose, equipment and operation of blow down in boiler systems.
55. Describe the purpose, equipment and operation of fireside cleaning in boiler systems.

## **EXAMINATION 4B1 – NEW**

#### **B1. Lubrication**

1. Describe the importance of lubrication and the operating principles of lubrication.
2. Describe the methods for basic care and maintenance of bearings and their related lubrication systems.

#### **B2. Pumps and Compressors**

3. Describe the construction and operating principles of various types of pumps used in buildings and industrial plants.

4. Describe maintenance procedures for efficient and reliable pump operation.
5. Describe the construction and operating principles of the different types of compressors.
6. Describe the startup, operation and shut down of different types of compressors.

### **B3. Boiler Safety Devices**

7. Explain the code and standards requirements, design and operation of pressure relief valves for power boilers, heating boilers, and pressure vessels.
8. Explain the design and operation of combustion safety controls on burners and boilers.
9. Describe feedwater control methods and devices used on boilers.
10. Describe the code and standards required and operation required fittings, along with the operating principles of fittings found on boilers.
11. Name and describe the operating and safety controls found on boilers.

### **B4. Plant (Boiler) Operations**

12. Describe the safe and efficient operational procedures that relate to starting up the auxiliary equipment in a boiler plant.
13. Describe the safe and efficient operational procedures that relate to starting up boiler systems.
14. Describe the safe and efficient operational procedures that relate to operating boilers.
15. Describe the operational checks that need to be conducted for an operating boiler plant.
16. Describe generic shutdown and layup procedures for different boilers.
17. Describe the essential points and readings that need to be monitored and recorded in a plant.

### **B5. Power Plant /Heating Plant Maintenance**

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

### **B6. Water Treatment**

22. Describe the general principles, methods and equipment used in preparing raw feedwater for steam production in a boiler.
23. Describe the general principles, methods and equipment used for the internal treatment of boiler water.
24. Discuss the general principles, methods and equipment used for the treatment of condensate.
25. Discuss the general principles, methods and equipment used for the treatment of cooling tower and condenser water.
26. Describe cooling water/chilled water effects, treatment and tests.
27. Describe heating system water effects, treatment and tests.

### **B7. Prime Movers and Engines**

28. Describe the conversion of heat into mechanical energy and the history of steam engine.
29. Describe the construction and operation of steam turbines.
30. Describe the operation and maintenance of cooling towers and condensers.
31. Describe the application, set up operation and maintenance required for gas turbines.
32. Describe the application, construction, and operation of internal combustion engines.

**B8. Auxiliary Building Systems**

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

**B9. Refrigeration**

36. Explain the basic concept of refrigeration and refrigerants.
37. Describe the operating principles, operation and maintenance of compression refrigeration systems.
38. Describe the purposes and operating principles of the operational and safety controls on a refrigeration system.
39. Describe the operating principle, maintenance and operation of absorption refrigeration systems.

**B10. Heating Ventilating and Air Conditioning**

40. Explain the methods and techniques for conditioning air for human comfort and health.
41. Explain the equipment and principles of humidification.
42. Describe the air flow behaviour and movement of air through distribution systems.
43. Describe the various ventilation systems found in buildings, as well as describe the various types of air filters used in these systems.
44. Describe the designs and components of duct systems used in air conditioning.
45. Describe the various types of coils used in HVAC systems, and their operation.

**B11. Heating and Cooling Systems**

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

**B12. Types of Plants**

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