



Boiler & Pressure Vessel

Reference Syllabus

for

**Fifth Class Power Engineer=s
(Refrigeration Endorsement)**

Certificate of Qualification Examination

**Boiler & Pressure Vessel
Reference Syllabus for 5th Class Refrigeration Endorsement Examinations**

Note: Please ensure that this is the appropriate reference syllabus for the examination applied for.

General Information

Introduction

This syllabus is intended to assist candidates studying for the 5th Class Refrigeration Endorsement Certificate of Qualification Examination. You may also access our website at <http://www.safetyauthority.ca/>.

The requirements to qualify for a 5th Class Refrigeration Endorsement Examination are outlined in the *Safety Standards Act* and applicable regulation.

Recommended Study Programme

It is recommended that, before undertaking a 5th Class refrigeration endorsement examination, the candidate completes a 5th Class Refrigeration Endorsement Course offered through either a British Columbia or national institute or technical college recognized by the provincial safety manager.

In addition to the foregoing, it is recommended that the candidate becomes familiar with the pertinent publications listed in the "Reference Material for Candidates for 5th Class Refrigeration Endorsement Examinations", which is obtainable from the various technical colleges and publication store houses.

5th Class Refrigeration Endorsement Recommended Reading List

Title	Publisher	Or
<i>Safety Standards Act</i> & applicable regulation	Crown Publications 521 Fort Street Victoria, BC V8W 1K8 Tel: 250-386-4636	Power Engineering Books Ltd. 7 Perron Street St. Albert, Alberta T8N 1E3 Tel: 1-800-667-3155
CSA Standard B52 Mechanical Refrigeration Code	Crown Publications 521 Fort Street Victoria, BC V8W 1K8 Tel: 250-386-4636	Power Engineering Books Ltd. 7 Perron Street St. Albert, Alberta T8N 1E3 Tel: 1-800-667-3155

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Principles of Refrigeration
R.J. Dossat

John Wiley & Sons
605 - 3rd Avenue
New York, NY, USA
10158

Power Engineering Books Ltd.
7 Perron Street
St. Albert, Alberta
T8N 1E3

Tel: 1-800-667-3155

Refrigeration & Ice Making

Ontario Recreation
Facilities Inc.
ISBN 0-919939-78-X

Power Engineering Books Ltd.
7 Perron Street
St. Albert, Alberta
T8N 1E3

Tel: 1-800-667-3155

ASHRAE Handbook
Current Edition
Refrigeration Systems
and Applications

American Society of
Heating, Refrigeration and
Air Conditioning, Inc.
345 East 57th Street
New York, NY, USA
10017

Power Engineering Books Ltd
7 Perron Street
St. Albert, Alberta
T8N 1E3

Tel: 1-800-667-3155

List of Reference Sources for AOn-the-job® only

A.N.S.I./A.S.M.E. Code For
Pressure Piping
B31.5 Refrigeration Piping

American Society of Heating,
Refrigeration and
Air Conditioning, Inc.
345 East 57th Street
New York, NY, USA 10017

Power Engineering Books
Ltd.
7 Perron Street
St. Albert, Alberta
T8N 1E3

Tel: 1-800-667-3155

Modern Refrigeration and Air
Conditioning
Althouse, Turnquist & Bracciano

The American Society of
Mechanical Engineers
United Engineering Centre
345 East 47th Street
New York, NY USA 10017

Power Engineering Books
Ltd.
7 Perron Street
St. Albert, Alberta
T8N 1E3

Tel: 1-800-667-3155

Industrial Health and
Safety Regulations

Workers=Compensation Board
of BC
1700 W 75th
Vancouver, BC V6P 6G2

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Excerpts:

Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation

Fifth class power engineer's certificate of qualification (refrigeration endorsement)

- 25** (1) An applicant for a fifth class power engineer's certificate of qualification (refrigeration endorsement) must
- (a) have been employed for a period of not less than one year assisting in the operation of a refrigeration plant that uses
 - (i) group A3, B2 or B3 refrigerants and has a capacity of more than 25 kW of prime mover name plate rating, or
 - (ii) group A1, A2 or B1 refrigerants and has a capacity of more than 125 kW of prime mover name plate rating, or
 - (b) be a refrigeration mechanic.
- (2) If an applicant has successfully completed a fifth class power engineering (refrigeration endorsement) course that has been approved by a provincial safety manager, the required periods of employment referred to in subsection (1) (a) are reduced by 4 months.

What a fifth class power engineer (refrigeration endorsement) may do

- 26** A fifth class power engineer's certificate of qualification (refrigeration endorsement) or any other power engineer's certificate of qualification higher than fifth class entitles the holder to be a person in charge of any type and size of refrigeration plant.

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Part AA[@] Examination

3 2 Hours

I. Applied Math and Science

- A. Applied Mathematics; Arithmetic, mensuration, volumes and areas, knowledge of S.I. Systems of Measurement.
- B. Applied Science; a thorough working knowledge of applied science applications.

II. The *Safety Standards Act* and applicable regulation

- A. A thorough knowledge of the *Safety Standards Act* and applicable regulation as applied to refrigeration plant operators.
- B. Codes: C.S.A. Standard B-52 Mechanical Refrigeration Code.

III. Plant Safety

- A. General Plant Safety; Safety committee, types of accidents, safety measures.
- B. Safety Equipment; eye, ear, head and respiratory devices.
- C. Precautions taken before entering empty pressure vessels.
- D. Fire protection; classes of fire extinguishing methods; fire extinguishing construction and operation: water, anti-freeze, foam, dry chemical, carbon dioxide.
- E. Refrigeration Code Safety Regulations.
- F. Safety Procedures; General precautions around refrigeration equipment, compressors, condensers, receivers, evaporators, refrigerant handling, electrical precautions.
- G. Describe the use of two approved types of emergency breathing apparatus and their location in relation to the refrigeration plant.

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IV. Elementary Thermodynamics

- A. Temperature; temperature scales, S.I. units of measurement, conversions.
- B. Relationship of matter to refrigeration, structure of matter, molecules, compounds.
- C. Nature and effects of heat energy in refrigeration; sensible and latent heat, superheating and subcooling.
- D. Effect of heat energy on pressure and volume; gauge and absolute pressure, pressure-temperature relationships.
- E. Quantity of heat; specific heat, sensible heat, latent heat of fusion and vaporization, total heat, S.I. units of measurement, refrigerant tables, mollier diagram.
- F. Condensing pressures and boiling point; critical pressure and temperature, importance of vapour pressure in selecting a refrigerant.
- G. Saturated refrigerants; equilibrium, net refrigerating effect, capacity rating.
- H. Basic methods of heat transfer; conduction, convection, radiation, rate of heat transfer.
- I. Insulation materials; moisture vapour seals, dew point temperature, insulating value, total heat leakage.

V. Applications of Refrigeration

- A. Definition of refrigeration.
- B. Modern uses of refrigeration.

VI. Mechanical and Nonmechanical Refrigeration systems, cycles and classification

- A. Absorption system; Principles of operation, simple absorption refrigeration cycle, system components, continuous operating absorption system, commercial systems.
- B. Mechanical refrigeration; Principles of operation, simple mechanical refrigeration cycle, system components.
- C. Classification of refrigerating systems; Temperature ranges of systems, reverse cycle refrigeration systems.
- D. Comparison of nonmechanical and mechanical systems.
- E. Steam-jet refrigeration systems; principles of operation, primary ejector and condenser, flash tank, condensers.
- F. Absorption system controls; limit switches, relief devices, time delay relays.

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VII. Condensers, evaporators, cooling towers

- A. Condensers and receiver design construction and maintenance
 - i. Types of condensers; air cooled, water cooled, evaporative.
 - ii. Effect of noncondensable gases; purge devices.
 - iii. Methods of cooling water for condensers; spray ponds, cooling towers (natural, forced, and induced draft designs), water treatment.
 - iv. Liquid receivers; Liquid receiver safety devices.
 - v. Operating and maintenance procedures.

- B. Evaporators
 - i. Types of evaporators; direct expansion, flooded, recirculation.
 - ii. Secondary refrigerants; applications, types of secondary refrigerants and their properties.
 - iii. Effect of humidity on evaporators; frosting, non-frosting, and defrosting evaporators; defrost methods.

- C. Cooling towers
 - i. Natural draft cooling tower.
 - ii. Cross flow, counter flow tower.
 - iii. Water contained in air stream.
 - iv. Water volume evaporation.

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VII. Principles of refrigeration, refrigerants and driers

- A. Describe heat transfer.
- B. Describe various insulation materials and vapour barriers.
- C. Use metric conversions when referring to temperatures and pressures.
- D. Describe basic refrigeration cycles.
- E. Describe qualities of refrigerants; behaviour with heat and temperature, desirable physical and chemical properties.
- F. Describe refrigerant characteristics.
- G. Refrigerants for domestic and commercial systems; handling of refrigerant cylinders.
- H. Refrigerants and moisture; drying devices, properties of desiccants.

VIII. Pumps and compressors

- A. Pumps
 - i. Pumping theory.
 - ii. Pump operation and maintenance.
 - iii. Reciprocating pumps; simplex, duplex, valves, drivers.
 - iv. Centrifugal pumps; volute, diffusers, impellers, wear rings, seals, packing, start-up, operation and shutdown.
- B. Mechanical refrigeration system compressors
 - i. Classifications of compressors; positive displacement and dynamic-reciprocating, rotary, screw, centrifugal.
 - ii. Compressor displacement, compression ratio, clearance volume.
 - iii. Principles of operation; valves, shaft seals, safety springs, cooling methods, lubrication.
 - iv. Compressor regulation; variable speed motor, hot gas bypass, cylinder bypass method, cylinder unloading method; start-up procedures.
 - v. Vibration eliminators, discharge mufflers, crankcase heater.

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Part AB® Examination

3 2 Hours

I. Refrigeration System Operation

- A. Prepare system start-up procedures.
- B. Prepare system shut-down procedures.
- C. Describe routine system operation.
- D. Describe procedures for evaporator defrosting.
- E. Describe refrigeration capacity control.
- F. Describe condensing capacity control.
- G. Describe operation of refrigerant pumps.
- H. Describe the location and use of the KING Valve.
- I. Describe the use of the refrigeration plant emergency shut down control and the location of the switch in relation to the plant.
- J. Describe the approved posting of emergency evacuation procedures and the location of signs including valve identification in relation to the plant.
- K. Describe the location and use of relief valves, fire line valves and diffuser.

II. Refrigeration auxiliaries & instrumentation

- A. System controls; types and functions of refrigerant control devices, hand-operated needle valve, low-side float, high-side float, automatic expansion valve, thermal-electric expansion valve, capillary tube.
- B. Supplementary refrigeration controls; modulating controls, thermostatic expansion valve capacity, water regulating valves; pneumatic control system, principles of operation.
- C. Multiple unit installations; multiple evaporators, control valves, suction-pressure regulating valves, evaporator regulator valves, thermostatic suction-pressure valves, check valves, solenoid valves, multiple condensing units principle of operation and control.
- D. Accumulators; suction line filter, suction line filter drier, strainers, moisture liquid indicators, oil separators, heat exchangers.
- E. Steam piping; water hammer causes and prevention, steam separators and traps, steam pressure-regulating valves.

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III. Refrigeration system maintenance/inspection and trouble-shooting procedures

A. System maintenance

- i. Describe ammonia refrigerant charging procedures.
- ii. Determine methods of purging ammonia systems.
- iii. Describe system evacuation.
- iv. Describe leak testing procedures.
- v. Describe simple maintenance of valves, controls, piping and auxiliaries.
- vi. Describe water treatment and chemical additions.
- vii. Describe inspection of relief valves and discharge lines.
- viii. Describe inspection of refrigerant flow and capacity control devices.
- ix. Describe inspection of refrigerant dryers and associated fittings.
- x. Describe inspection and replacement of motor drive belts.
- xi. Describe inspection of electrical motor operating conditions.
- xii. Describe electric motor replacement (7.5 HP, 1 phase, 220V, max.).
- xiii. Describe oil removal from ammonia systems.

B. Inspection

- i. Describe the important points of breathing apparatus inspections and need for insuring inspection tags are up to date.
- ii. Describe the visible indicators of leaking relief valves, fire line valves and condition of a fire line valve box.
- iii. Describe the importance of maintaining signs; labels and notices in good condition and correct location in the refrigeration plant.
- iv. List safety shut-down devices and identify those requiring operator attention.

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C. Trouble shooting

- i. Determine lubricating oil pressure problems and solutions.
- ii. Determine conditions which result in suction pressure problems.
- iii. Describe conditions which lead to head pressure problems.
- iv. Describe various evaporator operating problems.
- v. Identify condenser operating problems.
- vi. Determine testing procedures for system leaks.
- vii. Describe problems associated with moisture in system.
- viii. Identify cooling water problems.

IV. Refrigeration piping, valves, controls, hand tools, tubing and fittings

A. Piping, valves and controls

- i. Describe the purpose and location of relief valves and discharge lines.
- ii. Describe the purpose of a Fire Line System.
- iii. Describe a simple refrigeration piping system with correct fittings.
- iv. Determine various types of service valves used in refrigeration systems.
- v. Describe refrigerant dryers and associated fittings.
- vi. Describe various refrigerant flow and capacity control devices.
- vii. Describe a thermo siphon used for oil cooling.

B. Refrigeration hand tools, tubing and fittings

- i. Tubing and piping materials and fittings; commercial tubing and piping sizes and classifications, identification of fittings.
- ii. Methods of connecting tubing; hand tools, cutting and forming refrigerant tubing, flaring, compression fittings; selection of soldering materials, soldering procedures.
- iii. Methods of connecting piping; screwed, flanged and welded connections, gasket materials.
- iv. Piping expansion; expansion joints and bends, piping supports and hangers.

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V. Air-handling equipment

- A. Duct construction.
- B. Air-diffusing equipment.
- C. Fans.
- D. Evaporative air cooling equipment.
- E. Humidifiers.
- F. Air-cooling and dehumidifying coils.
- G. Forced-circulation air coolers and defrosting.
- H. Air-heating coils.
- I. Air cleaners.

VI. Air conditioning and heating systems

- A. Principles for evaluation of air conditioning systems.
- B. Basic air conditioning system design.
- C. All air systems.
- D. Panel heating and cooling systems.
- E. Applied heat pump systems.
- F. Air distribution design for small heating and cooling systems.
- G. Steam systems.
- H. Heating and cooling from a central plant.
- I. Low temperature water heating systems.

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VII. Electricity

- A. Introduction to electricity
 - i. Flow of electricity; electron theory, electrostatic charges, electrostatic fields, electric current.
 - ii. Units of measurement; relationship between voltage, current and resistance; simple calculations.
 - iii. Series and parallel circuits; relationships between voltage, current and resistance: simple calculations.
 - iv. Electrical power and relationship to mechanical work.
 - v. Conductors and insulators.
 - vi. Magnetism; laws of magnetism, magnetic fields, electric current and magnetism, electromagnets, the solenoid.
 - vii. Inductance; transformers, turns ratio, transformer losses.
 - viii. Capacitance; capacitors, reactive power, power factor.
- B. Electric motors and motor controls
 - i. Electric motor theory, synchronous speed, capacitors.
 - ii. Types of AC motors; split-phase, capacitor-start, two speed motors, permanent-split capacitor motors, capacitor-start, capacitor-run motors, shaded-pole motors.
 - iii. Single phase motor protectors; internal overload, external overload, fuses.
 - iv. Motor starting relays; starters and contactors.
 - v. Motor control devices; thermostats, pressure controls, oil safety controls, defrost timers.

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VIII. Lubrication principles

- A. Lubrication oils
 - i. Qualities; chemical stability, pour, cloud and floc points; dielectric strength.
 - ii. Viscosity; flash point.
 - iii. Methods of lubrication; splash, force feed.
 - iv. Liquid refrigerant in the compressor crankcase; foaming oil separators.
 - v. Construction and operation.
- B. Grease
 - i. Properties of low temperature grease.
 - ii. Characteristics of grease.

IX. Psychrometric properties of air

- A. Composition of air.
- B. Dalton's Law of Partial Pressure.
- C. Dew point temperature.
- D. Maximum water vapour content.
- E. Absolute and relative humidity.
- F. Humidity and saturation ratio.
- G. Dry bulb and wet bulb temperatures.
- H. The heat content or enthalpy of air.
- I. Sensible heat and total heat of the air.
- J. Psychrometric charts.
- K. Psychrometric, sensible and dehumidification processes.