



REFERENCE SYLLABUS

FOR

FOURTH CLASS

POWER ENGINEER'S

CERTIFICATE of QUALIFICATION

EXAMINATION



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 2 OF 17



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

GENERAL INFORMATION

Introduction

The Fourth Class Syllabus has been approved by the Association of Chief Inspectors (ACI). This syllabus is intended to assist candidates studying for the New Third Class Power Engineering examinations. You may also access our web site at <http://www.safetyauthority.ca/> and the national examination web site at www.sopeec.org.

Recommended Study Program

It is recommended that, before undertaking the Fourth Class Power Engineer Examination, the candidate completes Fourth Class Power Engineer's Course offered through either a British Columbia or national institute or technical college recognized by the provincial safety manager. Candidates would be well advised to have a good basic knowledge of mathematics, sciences, and English, before enrolling in an approved college, technical, vocational, or correspondence course. In addition to the foregoing and in order to prepare for the examination, it is recommended that the candidate becomes familiar with the pertinent publications listed in the "Reference Material for Candidates of Power Engineer Examinations", which is obtainable from the various technical colleges.

Reference Material for Candidates of Power Engineer Examinations

The publications listed here are intended to supplement the course material for students studying for Fourth, Third, Second and First Class Power Engineering Certificate of Qualification Examinations. Inquiries regarding the above mentioned course materials should be directed to the Energy and Natural Resources Department at the Southern Alberta Institute of Technology (SAIT), telephone numbers (403) 284-8451 or 1-800-661-1268 and the British



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 3 OF 17



Columbia Institute of Technology (BCIT) at telephone number (604) 432-8390. The following listed publications can be ordered through most bookstores or directly from the publisher using the ISBN number. The code books listed are quite expensive, and they may change annually. Therefore, it is suggested that candidates use the codes located at their company library or at public libraries to obtain the necessary information. It is strongly recommended that candidates complete an appropriate formal course of study offered by a recognized Technical Institute before undertaking to write any of the "Standardized Power Engineers' Certificate of Qualification Examinations". Candidates should be aware that the following list of publications are "Reference Material Only" and although candidates do not have to purchase all these publications, they should have access to them. This list was compiled and approved by the Interprovincial Power Engineering Curriculum Committee (IPECC), and the Standardization of Power Engineering Examinations Committee (SOPEEC). It is intended to assist candidates in achieving an excellent working knowledge of related topics, and to contribute to attaining passing grades on the standardized examinations. Candidates who are entering into the Power Engineering field should realize that as they progress through their career it becomes necessary to build a good personal library. Candidates should start building their library at the Fourth Class level and regard their library as a necessary tool of their career. The Interprovincial Power Engineering Curriculum Committee (IPECC) would also like to remind candidates that they may also supplement their course material by purchasing periodicals and special reports from engineering and power related magazines. Candidates should refer to the appropriate SOPEEC reference syllabus for the level of examination that they are preparing to attempt, as well as receive assistance from their local technical institute before commencing their studies.

Code Books

The following code books are used from the Fourth Class level to the First Class level. The candidates must be aware that although there will be questions on all levels of examinations from the following codes, the difficulty and depth of questions will increase significantly as the



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 4 OF 17



candidate advances in levels. We wish to repeat at this point, these Code books are quite expensive and some are revised on an annual basis. Therefore we recommend to students that they use Code books from their company library or from public libraries to assist with their studies. In most jurisdictions it is the students' responsibility to bring code books into the examination.

	1 st	2 nd	3 rd	4 th
Safety Standards Act and Applicable regulation	X	X	X	X
Canadian Regulation (C. S. A. B-51, For the Construction and Inspection of Boilers and Pressure Vessels (Latest edition) ISSN # 0317-5669	X	X	X	X
Canadian Regulations (C. S. A.) B-52, Mechanical Refrigeration Code, (latest Edition) ISSN # 0317-5669	X	X	X	X
A.S.M.E. Code. Section I Power Boilers (Latest edition) LCCCN # 56-3934	X	X	X	
A.S.M.E. Code Section IV Heating Boilers (Latest edition) LCCCN # 56-3934	X	X	X	
A.S.M.E. Code Section VI Recommended Rules for Care and Operation of Heating Boilers (Latest edition) LCCCN # 56-3934	X	X	X	X
A.S.M.E. Code Section VII Recommended Rules for Care and Operation of Power Boilers (Latest edition) LCCCN # 56-3934	X	X	X	X
A.S.M.E. Code Simplified (Power Boilers-Section 1- Latest edition) LCCCN # 56-3934	X	X	X	X

One of the most comprehensive and complete sets of books for Power Engineer Candidates to study from, is the Reed's Marine Engineering Series. It is recommended that Candidates start to



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 5 OF 17



compile this series from the beginning of their Power Engineer career. However, by the time a Candidate begins to study for the Second Class examination; they should have or have access to all Of these books. This series does not cover all topics in the syllabus, however it is very useful.

	1st	2nd	3rd	4th
Vol. 1 Mathematics ISBN # 0-947-637-90-7	X	X	X	X
Vol. 2 Applied Mechanics ISBN #0-901-281-55-7	X	X		
Vol. 3 Applied Heat ISBN #0-947-637-51-6	X	X		
Vol. 6 Basic Electrotechnology ISBN #0-900-335-96-3	X	X	X	
Vol. 7 Advanced Electrotechnology ISBN #0-901-281-65-4	X	X		
Vol. 8 General Engineering Knowledge ISBN #0-947-637-76-1	X	X	X	
Vol. 9 Steam Engineering Knowledge ISBN #0-900-335-58-0	X	X	X	X
Vol. 10 Instrumentation and Control Systems ISBN #0-947-637-86-9	X	X		

The following books will cover other topic areas in the syllabus from Fourth Class to First Class Power Engineering Exams.

	1st	2nd	3rd	4th
Applied Engineering Mechanics First Canadian, Jensen, Chenoweth Snail & Stassen-(Latest edition) ISBN#007-032-492-1	X	X		
National Board Inspection Code LCCCN #52-44738	X	X		



BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
 for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION

REVISION 1
 DATE 2006/01/01
 PAGE 6 OF 17



Applied Thermodynamics for Engineering Technologists. T.D. Eastop (Latest edition) ISBN #0-582-09193-4	X	X	X	
Blueprint Reading and Technical Sketching for Industry Thomas P Olivo (Latest edition) ISBN#0-8273-5077-5	X	X	X	
Electric Circuits & Machines Lister, Golding (Latest edition) ISBN#0-07-552603-4	X	X	X	
Process/Industrial Instrumentation and Control Handbook-Considine (Latest edition) ISBN#0-07-012445-0	X	X	X	
Standard Handbook of Power Plant Engineering-Elliot, Chen, Swanehart (Latest edition) ISBN#0-07-019435-1	X	X	X	
Engineering Manual of Automatic Controls Purchased through Honeywell Offices I-P Edition	X	X	X	
Trane Air Conditioning Manual (780) 454-4905 The Trane Company	X	X	X	
Metals and How to Weld Them T.B. Jefferson, Gorham Woods (Latest edition) LCCCN# 54-2508	X	X	X	X
Betz Handbook of Industrial Water Conditioning (Latest edition) LCCCN# 62-21097	X	X	X	X
Steam Babcock and Wilcox (Latest edition) LCCCN# 92-074123	X	X	X	X

Note: Texts other than those listed above, which are current and are of a similar technical content may be considered equivalent.

Students preparing for Standardized Power Engineer Examinations will find the "Periodicals" and "Special Reports" from Engineering and Power related magazine(s) very beneficial not only for examination preparation, but also for current general engineering knowledge.



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 7 OF 17



Excerpts:

Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation

Application for fourth class power engineer's certificate of qualification

- 19** (1) An applicant for a fourth class power engineer's certificate of qualification must
- (a) be the holder of a third class marine engineer (motor) certificate of competency, or
 - (b) have been employed
 - (i) for a period of not less than 12 months as a power engineer in a fifth class plant in a position requiring a fifth class power engineer's certificate of qualification,
 - (ii) for a period of not less than 12 months as a power engineer trainee in a power plant that exceeds 10 m² of boiler capacity, or
 - (iii) for a period of at least 18 months in the operation, design, construction, repair or maintenance of equipment to which this regulation applies, and have successfully completed a fourth class power engineering course that has been approved by a provincial safety manager or provide proof of having an equivalent technical educational background that is approved by a provincial safety manager.
- (2) If an applicant has successfully completed a fourth class power engineering course that has been approved by a provincial safety manager, the required periods of employment referred to in subsection (1) (a) or (b) are reduced by 6 months.
- (3) If an applicant holds an engineering degree acceptable to a provincial safety manager, the required periods of employment for the positions and types of plants set out in subsection (1) (a) or (b) are reduced by one half.
- (4) Despite subsection (1) but subject to section 7 (2) and (3), a fourth class power engineer's certificate of qualification may be issued to a person who holds a diploma issued after completing a one year full time day program in fourth class power engineering that has been approved by a provincial safety manager.



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 8 OF 17



What a fourth class power engineer may do

20 A fourth class power engineer's certificate of qualification entitles the holder to be

- (a) chief engineer of a power plant that has a boiler capacity of 150 m² or less,
- (b) chief engineer of a low pressure steam plant that has a boiler capacity of 500 m² or less,
- (c) chief engineer of a fluid plant or a low pressure thermal fluid plant that has a boiler capacity of
1000 m² or less,
- (d) chief engineer of a low temperature low pressure fluid plant,
- (e) chief engineer of an unfired plant that has a boiler capacity of 1 000 m² or less,
- (f) chief engineer of any refrigeration plant,
- (g) shift engineer of a power plant that has a boiler capacity of 500 m² or less,
- (h) shift engineer of any low pressure steam plant, or
- (i) shift engineer of a low pressure fluid plant or a low pressure thermal fluid plant or low temperature low pressure fluid plant.

Fourth class or higher engineer may do limited electrical work

21 The holder of a valid power engineer's certificate of qualification of 4th class or higher issued under the Act may, while employed by a licensed boiler contractor or working under an operating permit and without requiring any additional authorization, do any of the following with respect to electrical equipment that is part of a boiler plant:

- (a) connect branch circuit wiring to the boiler equipment integral connection box from a junction box or disconnect mounted in close proximity to the boiler equipment;
- (b) perform work on class 2 circuit wiring up to a rated output of 100 Volt amps;
- (c) perform work on low voltage controls or 24 volt thermostats;
- (d) perform work on three phase motors or controllers integral to the boiler equipment.



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 9 OF 17



Part "A" Examination

**First Paper
Morning Session
3 ½ Hours**

I. Applied Mathematics

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

II. Elementary Mechanics and Dynamics

Definitions of mechanical properties, moments and forces, simple machines, mechanical advantage, scalars and vectors, linear velocity and acceleration; force, work pressure, power and energy, friction I, stress and strain, factor of safety, power transmission.

III. Elementary Thermodynamics

Basic thermodynamics concepts, temperature and thermal expansion, specific, sensible and latent heat; thermodynamics of steam, steam tables, Extrapolation, basic chemical and physical properties.

IV. Mechanical Drawing, Administration

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

V. The Act and Regulations

- A. *Safety Standards Act* and applicable regulation
- B. Codes
 - A.S.M.E. Section VI - Recommended rules for the Care and Operation of Heating Boilers
 - A.S.M.E. Section VII - Recommended rules for the Care and Operation of Power Boilers
 - C.S.A. Standard B-51 - Boiler, Pressure Vessel and Pressure Piping Code
 - C.S.A. Standard B-52 - Mechanical Refrigeration Code

VI. Workplace Hazardous Materials



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 10 OF 17



WHMIS Part I - Classification of Controlled Products

WHMIS Part II - Labelling of Controlled Products

WHMIS Part III - Materials Safety Data Sheets

VII. Plant Safety

- A. Costs and effects of workplace injuries
- B. Personal protective equipment
- C. Isolation of mechanical and electrical equipment
- D. Confined space entry
- E. Handling of gases and hydrocarbon fluids
- F. Hydrogen sulphide safety
- G. First aid CPR and artificial respiration
- H. Safety Committee

VIII. Plant Fire Protection

- A. Fire fundamentals and procedures
- B. Fires and extinguishing methods
- C. Portable fire extinguishers, construction and operation
- D. Electric fires

IX. Environment

- A. Environmental terms and definitions
- B. Gas and noise pollution
- C. Solid and liquid pollution
- D. Potential environmental impact of liquids
- E. Potential environmental impact of vapours
- F. Potential environmental impact of operating facilities

X. Material and Welding

- A. Engineering materials; selection, properties
- B. Heat treatment and case hardening
- C. Fabrication and welding methods



BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION

REVISION 1
DATE 2006/01/01
PAGE 11 OF 17



- D. Processes and electrode use and selection
- E. Welding terms and inspection
- F. Welder qualifications

XI. Piping

- A. Materials, sizes, identification
- B. Piping and pipe fittings; connecting
- C. Expansion joints, bends, support, hangers and insulation
- D. Drainage; separators, traps, water hammer
- E. Valve types, construction

XII. High Pressure Boiler Design

- A. Development of boiler design
- B. Boiler terminology
- C. Firetube boilers; construction, stays, tubes, tube sheets, shell
- D. Watertube boilers; construction, drums and walls
- E. Electric boilers
- F. Boiler construction; support, suspension, Refractory

XIII. High Pressure Boiler Parts and Fittings

- A. Combustion theory, composition of fuel, heating valve
- B. Boiler draft equipment; natural, forced, induced, balanced
- C. Boiler combustion equipment; coal, oil and gas burners and safety
- D. Fluidized bed and grate systems
- E. Safety and relief valves
- F. Water columns and gauge glasses
- G. Steam Drum Internals
- H. Superheaters, reheaters, economizers, air heaters

XIV. High Pressure Boiler Operation

- A. Boiler prestart, start-up operation and shut-down
- B. Emergency boiler operation



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 12 OF 17



- C. Soot blowers
- D. Continuous and intermittent blowdown
- E. Chemical and mechanical cleaning, boil out and lay-up
- F. Hydrostatic testing, inspection, safety precautions
- G. Cause and prevention of boiler furnace explosions

XV. Feedwater Treatment

- A. External feedwater treatment; filtration, lime soda, zeolite, deaeration
- B. Internal feedwater treatment and testing
- C. Knowledge and control of: pH, sludge, scale, foaming, caustic embrittlement, blowdown and corrosion



BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION

REVISION 1
DATE 2006/01/01
PAGE 13 OF 17



Part “B” Examination

First Paper
Morning Session
3 ½ Hours

I. Prime Movers and Engines

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

II. 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
 - v. Turbine pump, rotary pump
- B. Air Compression
 - i. Theory, altitude, barometers
 - ii. Reciprocating compressors; construction stages, cooling components, valves, control, lubrication and operation
 - iii. Axial; construction, components, lubrication and operation
 - iv. Systems; receivers, intercoolers, aftercoolers, driers, moisture, safety devices



BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION

REVISION 1
DATE 2006/01/01
PAGE 14 OF 17



III. Lubrication

- A. Lubrication; principles, lubricants, classes, viscosities, applicators
- B. Bearing lubrication

IV. Electricity

- A. Electrical; terms, properties, measurement and calculations
- B. Power and work
- C. Magnetism and electromagnetism
- D. Electrical metering devices; voltmeters, ammeters, wattmeters
- E. Conductors, insulators
- F. Motors and generators; AC, DC, operation
- G. Transformers
- H. Electrical distribution circuits, breakers, switches, fuses
- I. Safe operation

V. Controls, instrumentation and computers

- A. Instrumentation terms and definitions
- B. Methods of process measurement
- C. Basic control loop components
- D. Basic boiler instrumentation and control systems, gauges
- E. Low water fuel cut-offs; mercury switch, thermocouples
- F. Boiler programming controls
- G. Types of computers; principles, programs, languages, applications, components
- H. Introductory process computer concepts
- I. Input and output devices, data recording and storage

VI. Heating Boilers

- A. Watertube and tubular heating boilers
- B. Cast iron sectional and modular boilers
- C. Firetube heating boilers
- D. Oil and gas burners for heating boilers



BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION

REVISION 1
DATE 2006/01/01
PAGE 15 OF 17



- E. Steam heating boiler fittings, attachments and auxiliaries
- F. Hot water heating, boilers fittings, attachments
- G. Hot water and steam heating boiler operation and maintenance
- H. Cleaning, inspection, lay up, safety

VII. Heating Systems

- A. Steam heating auxiliaries; radiators, convectors, unit heaters, coils, ventilators, air vents, valves, traps, vacuums, pumps
- B. Steam heating systems
- C. Hot water heating auxiliaries; operation and maintenance; pumps, controls, valves, Expansion tanks, converters, radiant panels, snow melt
- D. Hot water heating systems
- E. Warm air heating system equipment
- F. Warm air furnace components and maintenance; furnaces, humidifiers, air distribution, maintenance, trouble shooting
- G. Ventilation and air filters
- H. Infrared and electric heating

VIII. Heating Boiler and Heating System Controls

- A. Heating boiler feedwater control
- B. Heating boiler operating controls
- C. Heating boiler combustion controls
- D. Pneumatic controls for heating systems
- E. Electric controls for heating systems
- F. Electronic controls for heating systems; indoor, outdoor, multi-zone, advantages, disadvantages

IX. Auxiliary Building Systems

- A. Lighting systems; principles, units, incandescent, fluorescent
- B. Building water supply systems; operation and maintenance, hot water heaters, controls and protection, trouble shooting



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 16 OF 17



C. Sanitary drainage systems, maintenance

D. Snow melt systems

X. Vapour Compression Refrigeration

A. Safety, CSA B-51

B. Thermodynamics of Refrigeration

C. Properties of Refrigerants

D. Compression refrigeration systems; components, auxiliaries, relief devices

E. Refrigeration compressors components

F. Heat Exchangers for Refrigeration systems

G. Refrigeration metering devices and capacity controls

H. Refrigeration cycle controls

I. Refrigeration accessories

J. Compression Refrigeration system pre start-up checks, procedures

K. Compression Refrigeration system operation and maintenance, testing, charging, surging, trouble shooting

XI. Absorption Refrigeration

A. Absorption Refrigeration systems; components, auxiliaries

B. Absorption Refrigeration system operation and maintenance

XII. Air Conditioning

A. Psychrometric properties of air

B. Applications of the psychrometric chart and comfort conditions

C. Fans for air distribution systems

D. Air conditioning duct systems

E. Coil types

F. Coil operation

G. Humidification, dehumidification

XIII. Air Conditioning Systems

A. Unitary and central air conditioning systems



**BOILER & PRESSURE VESSEL SAFETY PROGRAM
REFERENCE SYLLABUS
for
FOURTH CLASS
CERTIFICATE OF QUALIFICATION
EXAMINATION**

REVISION 1
DATE 2006/01/01
PAGE 17 OF 17



- B. Combined air conditioning systems; components, auxiliaries, operation, maintenance
- C. Air conditioning heat recovery systems
- D. Air conditioning system controls
- E. Heat gains and losses in buildings; system components, auxiliaries.

XIV. Boiler Maintenance

- A. Powerhouse maintenance - hand and power tools
- B. Powerhouse maintenance - ladders, scaffolding and hoisting
- C. Powerhouse maintenance - ropes, cables and fasteners
- D. Boiler maintenance, refractory, tubes, stays, safety valves
- E. Boiler cleaning, inspection, testing, lay up, welder qualification

XV. Types of Plants

- A. Hot oil systems; components, auxiliaries, operation, maintenance
- B. Gas plant and pulp mill processes; equipment, operation, safety
- C. Steam related oil, food and sawmill processes