



**TECHNICAL STANDARDS & SAFETY AUTHORITY**

# **TRAINING, EXAMINATION AND CERTIFICATION**

**REFRIGERATION OPERATOR CLASS "B"**

**CERTIFICATION & EXAMINATION GUIDE**

**REVISED EDITION 2**

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

*August 2009*

This document replaces all previous issues.

*Revisions/updates to this document are reflected by a change in the above date*

**NEW IN THIS VERSION:**

Please note: As of Jan.1, 2003, Examination RB-1, is to be written and passed prior to attempting the RB-2 examination

**Please Note: Power Engineering Training Systems (PETS), formerly PEJV/SAIT, is the SOPEEC sanctioned providers of Power Engineering reference materials**

## **Syllabus**

*The topics that follow are intended to be a study guide, and in no way implies that additional knowledge obtained from experience is not needed to successfully challenge the Refrigeration Operator "B" Examination.*

### **1. ACT, REGULATIONS AND CODES:**

The candidate is expected to be able to locate information relating to the staffing, operation, maintenance, inspection, and testing of the compressor plant and its equipment resourcing the:

- 1.1 *Technical Standards & Safety Act, 2000*
- 1.2 *Operating Engineers Regulation and Directors Orders*
- 1.3 *Boilers and Pressure Vessels Regulation*
- 1.4 *CSA B52: Mechanical Refrigeration Code*
- 1.5 *SA Z94.4 Selection, Care and use of Respirators*
- 1.6 *CEPA E2 Environmental Emergency Regulations*

### **2. SAFETY:**

The candidate is expected to be able to fully explain the dangers associated with the operation of a refrigeration plant and state the precautions to be taken to minimize or prevent such dangers.

- 2.1 gas detection and monitoring
- 2.2 gas exposure limits
- 2.3 personal protective equipment
- 2.4 basic WHIMIS
- 2.5 isolation (electrical & mechanical), confined space and fall protection
- 2.6 basic first aid and CPR
- 2.7 plant fire protection

### **3. ADMINISTRATION:**

- 3.1 mechanical drawing
- 3.2 maintenance planning
- 3.3 materials and welding
- 3.4 basic communication

### **4. FUNDAMENTALS:**

The candidate must demonstrate an understanding of refrigeration fundamentals, including:

- 4.1 identifying basic thermodynamic principles
- 4.2 a basic understanding of gas behaviour

- 4.3 differentiating between CFC's, HCFC's and HFC refrigerants
- 4.4 an awareness of the environmental impact that each type of refrigerant can pose
- 4.5 a thorough understanding of the purpose of the components of a vapour compression refrigeration cycle
- 4.6 a thorough understanding of the compression refrigeration cycle, including the function of the:
  - 4.6.1 -compressor
  - condenser
  - metering device
  - evaporator
- 4.7 the basic operating principle of an absorption refrigeration system
- 4.8 direct and indirect refrigeration systems
- 4.9 the use of secondary refrigerants, the mediums used and the applications of such coolants as used in the commercial and industrial sector
- 4.10 the essential qualities of a good refrigerant such as the main properties of:
  - 4.10.1 -R-134A
  - R-22
  - R-717
- 4.11 types of refrigeration systems and their associated equipment
  - 4.11.1 -direct expansion
  - flooded
  - liquid overfeed
  - low pressure receivers
  - liquid recirculation pumps
- 4.12 lubrication principles

## **5. PUMPS & COMPRESSORS:**

The candidate must demonstrate an understanding of compressors, including the:

- 5.1 main types of refrigeration compressors and have a basic understanding of each type, including packaged types
- 5.2 application and the types of "booster" compressors used within a two-stage or compound refrigeration system
- 5.3 main types of prime movers used to drive refrigeration compressors
- 5.4 difference between hermetic, semi-hermetic and open –type compressors
- 5.5 methods used to prevent leakage of refrigerant at the compressor shaft and of preventing liquid refrigerant from entering the compressor
- 5.6 different methods employed to control the "capacity" of the various types of refrigeration compressors, including; start-stop, slide valves (variable clearance volume), variable frequency drives, etc.
- 5.7 two-stage centrifugal chillers
- 5.8 compressor cooling
- 5.9 main types of refrigeration pumps and a basic understanding of each type and principles

## **6. CONTROLS AND INSTRUMENTATION**

Candidates must demonstrate an understanding of the controls and accessories, including:

- 6.1 basic computer control and instrumentation
- 6.2 six commonly used types of refrigerant flow metering devices used to control the flow of

- refrigerants
- 6.3 the operation of a thermostatic expansion valve
- 6.4 the function, principle of operation and the location(s) of the following controllers:
  - 6.4.1 -temperature and/or pressure actuated
  - humidity actuated
  - evaporator pressure regulator
  - condenser cooling water regulating valve
- 6.5 the safety controls used in a refrigeration system, and the operation of each type, such as:
  - 6.5.1 -high pressure cut-out
  - low pressure cut-out
  - oil failure protection
  - high discharge cut-outs
  - high oil temperature cut-out
  - motor overload devices
- 6.6 the function and location of the following components in a system:
  - 6.6.1 -oil separators in reciprocating compressors
  - oil separators in screw compressors
  - suction strainers and scale traps
  - filter- driers
  - moisture indicators
  - crankcase heaters in reciprocating compressors and oil heaters in screw compressors
  - oil stills
  - purge and charging valves
  - pressure relief devices
- 6.7 the type of piping/tubing allowed for the different types of refrigerants
- 6.8 the use of receivers in a refrigeration system, their location, and the Code required safety fittings attached, including:
  - 6.8.1 -high pressure receivers
  - low pressure receivers
  - intermediate or controlled pressure receivers
- 6.9 the methods employed to control humidity

## **7. CONDENSERS AND COOLING TOWERS**

Candidates must demonstrate an understanding of condensers and cooling towers, including the:

- 7.1 different types of air-cooled and water-cooled condensers
- 7.2 evaporative type condenser and the effects of humidity on this type of condenser's operation
- 7.3 main factors on which the rate of heat transfer is dependent on in a cooling tower
- 7.4 evaporative cooling effect and its consequences
- 7.5 need for water treatment and the water tests required
- 7.6 ability to recognize bacteria concerns associated with water sumps and what can be done to prevent associated risks

## **8. EVAPORATORS AND COOLING COILS**

Candidates must demonstrate an understanding of evaporators and cooling coils, including the:

- 8.1 construction and application for each of the following:
  - 8.1.1 -bare tube construction
  - fin and tube construction
  - plate type construction
- 8.2 chillers, including:
  - 8.2.1 -shell & tube construction
  - plate and frame construction

- 8.3 differences between a “dry expansion” (also called “direct expansion”) and a “flooded expansion” and “liquid overfeed” evaporators
- 8.4 thermal storage systems

## **9. OPERATION AND MAINTENANCE**

Candidates must demonstrate an understanding of operation and maintenance, including:

- 9.1 the refrigeration leak tests used
- 9.2 how you would start-up and shut down a single-stage refrigeration compressor
- 9.3 how air is removed from an operating system, including both manual and automatic purging
- 9.4 how to add oil to a running compressor and an understanding of basic refrigerant charging
- 9.5 some common reasons for the following conditions:
  - 9.5.1 -failure of a compressor to start
    - causes for compressor short cycling
    - causes of continuous operation of the compressor under light loads or while system cooling is not required
    - discharge pressure too high or too low
    - suction pressure too high or too low
- 9.6 the maintenance requirements for compressors, system pumps, valves, metering devices, evaporators and condensers to ensure safe and continuous operation
- 9.7 the precautions to be taken when draining oil separators to prevent unsafe conditions
- 9.8 the methods used to defrost evaporators with the emphasis on industrial/commercial refrigeration defrost methods
- 9.9 what crystallization is with respect to absorption refrigeration systems
- 9.10 oil removal from refrigeration systems
- 9.11 pumping down systems
- 9.12 equipment isolation
- 9.13 low temperature receivers
- 9.14 low temperature liquid recirculation (liquid overfeed)
- 9.15 chemical treatment for condensers and cooling towers

## **10. ELECTRICAL**

Candidates must demonstrate a basic understanding of electricity and calculations:

- 10.1 the use and function of the following electrical components: circuit breakers, relays, rheostats, fuses, electrical switches and safety cut-outs
- 10.2 the dangers and maintenance requirements of electric motors
- 10.3 the basic differences with motor starters and the application of different types

## **11. AIR CONDITIONING**

Candidates must demonstrate an understanding of air conditioning, including:

- 11.1 the psychrometrics of air and the air conditioning factors that affect comfort
- 11.2 the ability to analyze/demonstrate on a psychrometric chart the behaviour of air when subjected to cooling, humidification and dehumidification

- 11.3 the different categories of air conditioning systems
- 11.4 how Legionnaires Disease can be drawn into ventilation systems and being able to recognize the effects of the disease

## **12. MATHEMATICS AND SCIENCE**

- 12.1 elementary mathematics
- 12.2 elementary mechanics and dynamics
- 12.3 elementary thermodynamics

### **CALCULATIONS:**

The candidate should be able to perform basic refrigeration calculations to solve for compression capacity, ratio, cylinder volume, volumetric efficiency, system tonnage and calculations based on CSA B-52 Mechanical Refrigeration Code. *Calculation questions will be stated so that they can be performed either in S.I. or in Imperial.*

### **Practical Experience:**

- ... The candidate is expected to be able to sketch and describe (in detail) the equipment they have experience on. This description will include a schematic layout of the system, an explanation of the types of compressor used, compressor size and capacities, pressures and temperatures, methods of capacity control, the safety devices and operational controls installed on the system to ensure safe and efficient operation.
- ... Provide a description of the compressor and refrigeration system maintenance procedures to be in place to ensure safe refrigeration plant operation as well as ensuring compliance with the required Codes, Act and Regulations.

## CERTIFICATION INFORMATION

### **Eligibility to Write**

There are no pre-requisites, however it is expected that the candidate has started their training, either in a plant and/or in a course of study, before attempting to write any one of the exams.

### **Practical Time Requirements:** *(effective June 27, 2001, as per new OE Regulations*

Practical operating time served shall be in a plant that is required to be attended by an Operator or Operating Engineer. *Please refer to Table 6 of the Operating Engineers Regulation for plant rating/capacity.*

- ... practical operating training requirement is **9 months** if you haven't attended full-time school or worked on refrigeration.
- ... practical operating time requirement is **8 months** for candidates having successfully completed a full-time TSSA "approved-for-time-reduction" Refrigeration Operator "B" program at a training facility.
- ... practical operating training requirement is **3 months** for persons having extensive experience in the installation and/or servicing 'registered plant' refrigeration installations.
- ... practical operating training requirement is **2 months** for those having extensive experience in the installation and/or servicing refrigeration installations and also having successfully completed a TSSA "approved-for-time-reduction" Refrigeration Operator "B" course at a training facility.

### **Examination Information**

There are 2 examinations to be written:

- ... Paper **RB-1** will consist of 150 multiple choice questions and is to be written **and passed, prior to attempting the RB-2 examination.**
- ... Paper **RB-2** is essay style and will reflect on the candidate' practical operating experience, refrigeration systems familiarity, and the management of a refrigeration compressor plant.

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

Exams may be written at either MTCU Exam Centres **or** at TSSA in Toronto. To locate nearest centre, refer to "Examination Centres" listing on our web page, **www.tssa.org**. To write at TSSA or the MTCU Centres please call (416) 734-3300.

Examination Centres provide all the necessary formulae booklets, Acts, Regulations, Codes, refrigeration tables, etc., candidate is to bring writing / drawings items and a calculator; no other materials are allowed to be brought in.

**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

- ... **Basic Refrigeration:** Available from (PETS) at 1 866-256-8193
- ... **Basic Refrigeration Plant Operator Course (PETS):** available from PanGlobal (PETS) 1.866.256.8193 (this course includes the Air Conditioning components)
- ... **CSA B52-05: 'Mechanical Refrigeration Code':** available from CSA (416) 747-4000
- ... **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.

**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 Certificate

*Upon successful completion of the examinations 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'
- ⇒ completed Form 1 entitled '**Testimonial of Qualifying Experience**'
- ⇒ **Originals of their examination 'pass' letters**
- ⇒ **cheque** of one hundred dollars (\$100.00) payable to "Technical Standards and Safety Authority" or to "TSSA" and forward 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 Operating Engineers web page (under Forms) or the local MTCU Centre.

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