Professional qualification of construction contractors

Competency profile

17.1 - Contractor – Instrumentation and control systems

Régie du bâtiment Québec

This document was produced with the collaboration of the team of competency assessment advisors (Direction de la qualification) of the Régie du bâtiment du Québec.

In this document, the masculine gender is used without discrimination and solely for the sake of brevity.

Changes to the content may be made at any time.

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Introduction

Successful candidates may act as guarantors for construction work included in subclass 17.1 - Contractor – Instrumentation and control systems.

This competency profile is based on the scope of application of the *Building Act*, as well as on Section (21-22-23 or 24) of the *Regulation respecting the professional qualification of contractors and owner-builders*.

Subclass definition

17.1 - Contractor – Instrumentation and control systems

This subclass authorizes construction work that is not reserved exclusively for electrical contractors relating to instrumentation and control systems.

It also authorizes construction work in subclass 17.2 of Schedule III.

Lastly, it authorizes similar or related construction work.

Module 1 – DEFINITIONS AND TYPES OF SYSTEMS

Elements of competency covered in this module:

1. Define and explain concepts and terms related to instrumentation and control systems
2. Describe the characteristics and operating principles of the various instrumentation and control components
3. Describe the features and operating principles of energy management (HVAC systems)

Module 1 – DEFINITIONS AND TYPES OF SYSTEMS

Elements of competency	Skills required
1. Define and explain concepts and terms related to instrumentation and control systems	1.1. Define control and instrumentation
	1.2. Define the concepts of home automation, building automation and efficient energy management
	1.3. Define the components of an instrumentation and control system: probe, servomotor, PLC, valve, conductor, etc.
	1.4. Define basic IT concepts: server, network, operating system (Windows and others), software (Word, Excel, Access, etc.)
	1.5. Define the concepts of "centralized control station," "distributed control station" and "data accumulation and processing station"
	1.6. Define the concepts associated with information flow communications networks for the regulation, monitoring and control functions of HVAC systems: Ethernet, Arcnet, MSTP, TCP/IP, RS-485, analog and digital data, input and output data, etc.
	1.7. Define the concepts associated with domain protocols and information integration for the regulation, monitoring and control functions of HVAC systems: BACnet, Echelon, Modbus, Fieldbus, etc.
	1.8. Define the following terms related to instrumentation and control systems: voltage, ampere, resistance, induced current, dry contact, normally open contact, normally closed contact, etc.
2. Describe the characteristics and operating principles of the	2.1. Explain the operation and features of the three main categories of instrumentation and control

Elements of competency	Skills required
various instrumentation and control components	systems (pneumatic, electromechanical and digital)
	2.2. Explain the operating principles of closed-loop and open-loop control and their scope of application
	2.3. Describe the operation of different types of system measurement and control equipment (probe, transmitter, servomotor, valve, thermostat, etc.) and their scope of application
	2.4. Describe the features of the various decision-making components in equipment operation (PLCs)
	2.5. Describe the various cables and conductors used to install an instrumentation and control system, and their characteristics (network and subnetwork wiring, FT-1 @ FT-4, ISO 8802-3 and EIA-485 standards, etc.)
	2.6. Describe the characteristics of the different types of communication networks used in an instrumentation and control system (Ethernet, Arcnet, RS-485)
	2.7. Describe and explain the features of normal and emergency power sources to which instrumentation and control systems can be connected (distribution circuits, accumulators and generators)
	2.8. Describe power supply issues affecting instrumentation and control components (interference, interruptions, fluctuations, etc.)
3. Describe the features and operating principles of energy management (HVAC systems)	3.1. Explain the operation and components of the various heating systems and their interrelationship with the instrumentation and control system
	3.2. Explain the operation and components of the various air conditioning and refrigeration

Elements of competency	Skills required
	systems and their interrelationship with the instrumentation and control system
	3.3. Explain the operation and components of the various ventilation systems and their interrelationship with the instrumentation and control system
	3.4. Explain the operational features of peripheral system equipment that can be connected to an HVAC instrumentation and control system (surveillance, access management, elevators, parking, etc.)
	3.5. Explain the principles of energy management (control strategy) in relation to different systems, languages or protocols in a building's energy-efficiency logic (free cooling, temperature reduction, etc.)

Module 2 – LEGISLATIVE, NORMATIVE AND REGULATORY FRAMEWORK

Elements of competency covered in this module:

4. Situate work related to instrumentation and control systems with respect to current regulations, codes and standards

Module 2 – LEGISLATIVE, NORMATIVE AND REGULATORY FRAMEWORK

Elements of competency	Skills required
4. Situate work related to instrumentation and control systems with respect to current regulations, codes and standards	4.1. Recognize the scope of certification standards applied to instrumentation and control system components to ensure compliance (CSA, ULC, etc.)
	4.2. Recognize the scope of the *Québec Construction Code, Chapter I – Building* and the *National Building Code of Canada: 1995 (amended)* (NRC) in relation to work on instrumentation and control systems
	4.3. Recognize the scope of the *Canadian Electrical Code* as it relates to work on instrumentation and control systems
	4.4. Recognize the scope of the *National Fire Code* as it relates to work on instrumentation and control systems (restrictions, precautions and risks)
	4.5. Recognize the scope of municipal, local and regional codes in relation to work on instrumentation and control systems
	4.6. Explain when the *Regulation respecting the quality of the work environment* (c. S-2.1, r.15) applies to work on instrumentation and control systems (fresh air supply and exhaust systems)
	4.7. Explain when the *Regulation respecting energy conservation in new buildings* (c. E-1.1, r.1) applies to work on instrumentation and control systems
	4.8. Recognize the scope of the work performed under their licence and that of others (master electricians, ventilation, refrigeration, lifts, controlled access, etc.)

Elements of competency	Skills required
	4.9. Name the organizations and/or programs that set standards for instrumentation and control (ASHRAE, LEED, AQME, etc.)

Module 3 – PLANS, SPECIFICATIONS AND ESTIMATES

Elements of competency covered in this module:

5. Read and interpret drawings relating to instrumentation and control systems
6. Read and interpret drawings relating to peripheral systems associated with instrumentation and control systems
7. Read and interpret the divisions of specifications relating to instrumentation and control systems
8. Evaluate work for an instrumentation and control system

Module 3 – PLANS, SPECIFICATIONS AND ESTIMATES

Elements of competency	Skills required
5. Read and interpret drawings relating to instrumentation and control systems	5.1. Identify components of the instrumentation and control system in drawings
	5.2. Interpret symbols used for instrumentation and control systems
	5.3. Locate, read and interpret the main dimensions and annotations associated with instrumentation and control systems
	5.4. Locate, read and interpret sections and details associated with instrumentation and control system installations
	5.5. Read and interpret general notes and tables associated with instrumentation and control system installations
	5.6. Read and interpret a single-line diagram of the architecture of the components of an instrumentation and control system (explain the architecture of an instrumentation and control system)
	5.7. Interpret the control schematics of the various devices (HVAC and peripherals) to be managed by the instrumentation and control system
6. Read and interpret drawings relating to peripheral systems associated with instrumentation and control systems	6.1. Identify in all architectural plans the particularities of wire routing and the elements that need to be drilled to ensure the integrity of the structure and fire separations and walls
	6.2. Locate and interpret the various systems (HVAC and others) and their components related to the instrumentation and control system on plans
7. Read and interpret the divisions of specifications	7.1. Define the divisions and sections of specifications associated with instrumentation and control installations

Elements of competency	Skills required
relating to instrumentation and control systems	7.2. Define the divisions and sections of specifications associated with other equipment related to the instrumentation and control system
	7.3. Interpret information associated with instrumentation and control systems in the general terms of specifications
	7.4. Interpret information on the special terms of specifications associated with instrumentation and control systems (capacity, protocol, level of automation penetration, management points, etc.)
8. Evaluate work for an instrumentation and control system	8.1. Assess the existing system's capacity based on an identified need and context
	8.2. Propose a modification, addition or a maintenance and management program for a standards-compliant system
	8.3. Select an instrumentation and control system that complies with plans and specifications
	8.4. Carry out a quantity survey[1] of the quantities required for the instrumentation and control system
	8.5. Determine daily production rate (worker, equipment) and work schedule

[1] Prepare the quantity survey: measure the structure and calculate the quantities of materials required.

Module 4 – STANDARDS AND EXECUTION OF WORK

Elements of competency covered in this module:

9. Plan and organize work in relation to instrumentation and control systems
10. Install instrumentation and control system components
11. Program and start up an instrumentation and control system
12. Manage, repair and maintain instrumentation and control systems
13. Ensure health and safety in connection with work on instrumentation and control systems and peripheral systems

Module 4 – STANDARDS AND EXECUTION OF WORK

Elements of competency	Skills required
9. Plan and organize work in relation to instrumentation and control systems	9.1. Validate authorizations and permits required for work on peripheral equipment
	9.2. Determine the logical order of execution of work on instrumentation and control systems
	9.3. Evaluate the constraints of working in special spaces (humidity, confined spaces, etc.)
	9.4. Coordinate stages (work schedule) according to progress of work and other stakeholders
	9.5. Order and receive materials required for work on instrumentation and control systems
10. Install instrumentation and control system components	10.1. Evaluate whether the installation site conforms to the initial design and follow up if necessary
	10.2. Provide cable runs and adequate clearances for system components
	10.3. Ensure installation of main ducts, required cabling (including network cables) and outlet boxes
	10.4. Ensure the set up of measurement, control and automated management equipment for a system (probe, servomotor, valves, thermostat, etc.)
	10.5. Ensure the installation of data centralization and integration equipment
	10.6. Ensure the connection of measurement, control and automation equipment to control panels and terminal systems
	10.7. Ensure adequate power supply from disconnect switches to control panels
	10.8. Ensure that no unauthorized modifications are made to the integrity of the walls, fire

Elements of competency	Skills required
	separations and structure (determine risks and adhere to regulations)
	10.9. Ensure operation of system components in accordance with manufacturer's recommendations
	10.10. Ensure that work complies with standards, plans and specifications
11. Program and start up an instrumentation and control system	11.1. Take note of the operating sequences drawn up by the professional designer
	11.2. Take note of additional requirements of the owner and occupants if applicable
	11.3. Ensure the integration of the final needs of the operation sequences before programming
	11.4. Program various sequences (transfer to software)
	11.5. Ensure validation of transmitted values (periodic trend surveys, on-site measurements, veracity method)
	11.6. Ensure the optimization of sequences (monitoring measures, time slots, preventive alarms, etc.)
	11.7. Determine and ensure the programming of multi-level security for access to control stations, configuration, implementation and limitation of interventions according to the expertise of each party involved
	11.8. Identify the risks and precautions to be taken when integrating peripheral system values into instrumentation and control systems (access management, elevators, lighting, etc.)
	11.9. Ensure documentation of finalized sequences of operations integrated into the system

Elements of competency	Skills required
	11.10. Explain system operation to owner or users and train them if necessary
	11.11. Ensure that user manuals are given to the owner or the owner's representative
12. Ensure the management, repair and maintenance of instrumentation and control systems.	12.1. Name the types of tests associated with instrumentation and control systems
	12.2. Ensure the diagnosis of an operating problem involving an instrumentation and control system
	12.3. Ensure a solution for repairing an instrumentation and control system
	12.4. Ensure the production of a periodic maintenance schedule for a system
	12.5. Identify the ways to perform tests and checks (visual, electrical, IT, etc.)
	12.6. Optimize sequences (monitoring measures, operating times, preventive alarms, etc.)
	12.7. Ensure programming, calibration, maintenance and replacement of components
	12.8. Document finalized sequences of operations modified or newly integrated into the system
	12.9. Ensure production of maintenance and repair reports
13. Ensure health and safety in connection with work on instrumentation and control systems and peripheral systems	13.1. Identify the risks associated with work on instrumentation and control systems (hot liquid or gas, confined spaces, high pressure, etc.)
	13.2. Name the precautions to be taken in relation to instrumentation and control systems (lock-out, etc.)