

# **Instrumentation and Control Technician On-the-Job Training Guide**

**2019**



Online: [www.saskapprenticeship.ca](http://www.saskapprenticeship.ca)

*Recognition:*

*To promote transparency and consistency, this document has been adapted from the 2013 Instrumentation and Control Technician National Occupational Analysis (Employment and Social Development Canada).*

*A complete version of the Occupational Analysis can be found at [www.red-seal.ca](http://www.red-seal.ca)*

# STRUCTURE OF THE ON-THE-JOB TRAINING GUIDE

To facilitate understanding of the occupation, this on-the-job training guide contains the following sections:

**Description of the Instrumentation and Control Technician trade:** an overview of the trade's duties and training requirements.

**Essential Skills Summary:** an overview of how each of the nine essential skills is applied in this trade.

**Harmonization:** a brief description on the pan-Canadian Harmonization Initiative for the Instrumentation and Control Technician trade.

**Task Matrix:** a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard detailing the essential skills and the level of training where the content is covered.

**Major Work Activity (MWA):** the largest division within the standard that is comprised of a distinct set of trade activities.

**Task:** distinct actions that describe the activities within a major work activity.

**Sub-task:** distinct actions that describe the activities within a task.

**On-the-Job and In-school Training Content for the Instrumentation and Control Technician Trade:** a chart which outlines on-the-job examples for apprentices to achieve relevant work experience to prepare for topics of technical training.

# DESCRIPTION OF THE INSTRUMENTATION AND CONTROL TECHNICIAN TRADE

*Instrumentation and Control Technicians maintain, diagnose, calibrate and repair measurement and control systems in commercial and industrial settings.*

Instrumentation and control technicians are knowledgeable in overall plant systems and the interactions of processes. They install and service a variety of systems including safety and security, energy delivery (hydraulic, pneumatic and electrical), communication, and process control systems. They also install and service measuring and indicating instruments to monitor process control variables, monitor the operation of equipment and measure the characteristics of the material within a process. Instrumentation and control technicians work with final control devices such as valves, actuators and positioners to manipulate the process medium. They install and terminate electrical, pneumatic and fluid connections. They also work on network and signal transmission systems such as fibre optic and wireless.

Along with the calibration, repair, adjustment and replacement of components, instrumentation and control technicians inspect and test the operation of instruments and systems to diagnose faults and verify repairs. They establish and optimize process control strategies, and configure related systems such as Programmable Logic Controllers (PLCs), Distributed Control Systems (DCSs), Human Machine Interfaces (HMIs) and Supervisory Control and Data Acquisition (SCADA) systems. Instrumentation and control technicians maintain backups, documentation and software revisions as part of maintaining these computer-based control systems. Scheduled maintenance and the commissioning of systems are also important aspects of the work. Instrumentation and control technicians consult technical documentation, drawings, schematics and manuals. They may assist engineering in plant design, modification and hazard analysis, and work with plant operators to optimize plant controls.

Instrumentation and control technicians use hand, power and electronic tools, test equipment, and material handling equipment. They work on a range of instruments including primary control elements, transmitters, analyzers, sensors, detectors, signal conditioners, recorders, controllers and final control elements. These instruments measure and control variables such as pressure, flow, temperature, level, motion, force and chemical composition.

Instrumentation and control technicians work in various industrial sectors such as pulp and paper/fibre processing; nuclear, thermal and hydro power generation; mining; petrochemical; oil and gas; steel; water treatment; manufacturing; and industrial/commercial instrument servicing.

When performing their duties, instrumentation and control technicians must comply with federal, jurisdictional, industrial and site-specific standards, codes and regulations. They must ensure that all processes operate and are maintained within these set standards, codes and regulations. Keeping up-to-date with advances in technology in industry and the trade is important.

Instrumentation and control technicians can work in hazardous environments where they may be exposed to confined spaces, heights, noise, dust, cold and heat. There may also be risks with working with chemicals, gases, radiation, laser equipment and substances under pressure.

Key attributes for people entering this trade are manual dexterity, attention to detail, strong problem solving skills, communication skills, technological aptitude and mathematical and scientific aptitude.

This analysis recognizes similarities or overlaps with other tradespersons and professionals such as process operators, steamfitters/pipefitters, industrial mechanics (millwrights), electricians and engineers.

With experience, instrumentation and control technicians may act as mentors and trainers to apprentices in the trade. They may also move into supervisory, design, advanced control, training, sales and other related positions.

**Training Requirements:** 6800 hours (4 years) including: four 10-week training sessions at Saskatchewan Polytechnic in Moose Jaw.

Journeyman to apprentice ratio for this trade is: 1:2

The information contained in this document serves as a guide for employers and apprentices. Apprenticeship training is mutually beneficial to both employer and apprentice. The employer's investment in training apprentices results in skilled and certified workers. The document summarizes the tasks to be covered by the apprentice during their on-the-job portion of apprenticeship training. An apprentice spends approximately 85% of their apprenticeship term training on-the-job.

**It is the employer's or journeyman's responsibility to supervise an apprentice's practical skills development until a satisfactory level of proficiency has been reached.**

#### **EMPLOYER TRAINING RESPONSIBILITY**

- expose the apprentice to all appropriate equipment
- provide guided, hands-on practice in the set-up, safe operation, calibration and
- performance evaluation of measurement and control systems
- demonstrate the techniques for installation, servicing, maintenance and
- calibration
- where possible, expose the apprentice to new technology in the trade.

Employers should make every effort to expose their apprentices to work experience in as many areas of the trade as possible.

In the On-the-Job Training Guide, in-school instruction is listed first; on-the-job suggestions to help employers assist the apprentice to prepare for in-school training are listed next.

The content of the training components is subject to change without notice.

#### **Entrance Requirements for Apprenticeship Training**

Your grade twelve transcript (with no modified classes) or GED 12 is your guarantee that you meet the educational entrance requirements for apprenticeship in Saskatchewan. In fact, employers prefer and recommend apprentices who have completed high school. This ensures the individual has all of the necessary skills required to successfully complete the apprenticeship program, and receive journeyman certification.

Individuals with "modified" or "general" classes in math or science do not meet our entry requirements. These individuals are required to take an entrance assessment prescribed by the SATCC.

English is the language of instruction in all apprenticeship programs and is the common language for business in Saskatchewan. Before admission, all apprentices and/or "upgraders" must be able to understand and communicate in the English language. Applicants whose first language is not English must have a minimum Canadian Language Benchmark Assessment of six (CLB6).

Note: A CLB assessment is valid for a one-year period from date of issue.

Designated Trade Name	Math Credit at the Indicated Grade Level❶	Science Credit at Grade Level
Instrumentation and Control Technician	Grade 11	Grade 10
<p>❶ - (One of the following) WA – Workplace and Apprenticeship; or F – Foundations; or P – Pre-calculus, or a Math at the indicated grade level (Modified and General Math credits are not acceptable.).</p> <p>*Applicants who have graduated in advance of 2015-2016, or who do not have access to the revised Science curricula will require a Science at the minimum grade level indicated by trade.</p> <p>For information about high school curriculum, including Math and Science course names, please see:  <a href="http://www.curriculum.gov.sk.ca/#">http://www.curriculum.gov.sk.ca/#</a></p> <p><b>Individuals not meeting the entrance requirements will be subject to an assessment and any required training</b></p>		

# ESSENTIAL SKILLS SUMMARY

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

The tools are available online or for order at: [www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml](http://www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml)

The application of these skills may be described throughout this document within the skills and knowledge which support each sub-task of the trade. The most important essential skills for each sub-task have also been identified. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at [www.red-seal.ca](http://www.red-seal.ca).

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## READING

Instrumentation and control technicians require reading skills to locate and interpret technical information for their trade. These texts include technical articles about new products and industry practices, bulletins from manufacturers and on health and safety, calibration and service guides, incident reports, procedures, manuals and notes.

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## DOCUMENT USE

Instrumentation and control technicians locate and interpret information in both print and electronic formats. Types of documents referenced include computer printouts with numeric information, supplier catalogue listings and engineering documentation such as forms, graphs, tables, charts, schematics, assembly diagrams and drawings. They may also create documents such as on-site sketches and detailed schematics, assembly drawings, graphs and charts.

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## WRITING

Writing skills are used by instrumentation and control technicians to create parts lists, maintenance schedules, and inspection reports. Instrumentation and control technicians write procedures for the control and operation of equipment and to troubleshoot faults. They use writing skills when communicating through e-mail and providing status updates in logbooks.

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## ORAL COMMUNICATION

In order to coordinate work, instrumentation and control technicians interact with other tradespeople such as steamfitter/pipefitters, welders, machinists, electricians and industrial mechanics (millwrights). They may also discuss systems design and problems with supervisors and engineers, and provide expert advice and opinion. Instrumentation and control technicians also exchange technical repair and troubleshooting information and speak to process operators about equipment and machinery breakdown. At times, they may make formal presentations to explain monitoring procedures or new equipment.

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## NUMERACY

Instrumentation and control technicians must apply measurement and calculation, data analysis and numerical estimation skills to their tasks. Some of these tasks include measuring analyzer malfunctions, calculating flow, calculating volume displacement, monitoring pressure, interpreting deviations on graphs, and comparing values and measurements. Instrumentation and control technicians evaluate sets of data collected from tests and simulations to troubleshoot faults, assess equipment performance and assess the progress of wear.

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## THINKING

Instrumentation and control technicians troubleshoot malfunctions, take corrective measures to avoid potential hazards and decide whether to repair or replace components based on time and cost factors. They plan and organize maintenance schedules, the installation of new machinery and the tradespeople assigned to install the machinery. Instrumentation and control technicians must be able to think quickly and synthesize the information at hand to deal with emergencies such as serious equipment malfunctions that could cause injury, or property and environmental damage.

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## WORKING WITH OTHERS

Even though instrumentation and control technicians often work alone, they may also work with other tradespeople, professionals and process operators. Instrumentation and control technicians work with process operators to ensure instrumentation is properly maintained and emergencies are handled quickly. They work with other tradespeople to perform functions such as testing transmitters or controllers, and installing control valves. Instrumentation and control technicians sometimes work as part of a crew, for example when running wires. In doing so they may fill the role of either team member or team leader on project teams

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## DIGITAL TECHNOLOGY

Instrumentation and control technicians install and service programmable process control systems such as PLCs, DCSs, SCADA systems and HMIs. They may use hand-held digital devices to configure settings and to access data such as measurement and operational values. Instrumentation and control technicians may use word processing software, databases, spreadsheets, communication software and devices, the Internet, and computer-assisted design (CAD), manufacturing or machining software depending on the task at hand.

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## CONTINUOUS LEARNING

Instrumentation and control technicians may attend training in areas that are new or continually evolving in the trade such as safety, digital technology and more sophisticated computer applications relating to process control. They may attend technical courses offered by suppliers' representatives covering new equipment, as well as team leadership/communication seminars. Continuous learning also occurs through the reading of technical literature and by troubleshooting.

# HARMONIZATION

At the request of industry, the Harmonization Initiative was launched in 2013 to *substantively align* apprenticeship systems across Canada by making training requirements more consistent in the Red Seal trades. Harmonization aims to improve the mobility of apprentices, support an increase in their completion rates and enable employers to access a larger pool of apprentices.

As part of this work, the Canadian Council of the Directors of Apprenticeship (CCDA) identified four main harmonization priorities in consultation with industry and training stakeholders:

## **1. Trade name**

The official Red Seal name for this trade is Instrumentation and Control Technician.

## **2. Number of Levels of Apprenticeship**

The number of levels of technical training recommended for the Instrumentation and Control Technician trade is four.

## **3. Total Training Hours during Apprenticeship Training**

The total hours of training, including both on-the-job and in-school training for the Instrumentation and Control Technician trade is 6800.

## **4. Consistent sequencing of training content (at each level) using the most recent Occupational Standard**

Implementation for harmonization will take place progressively. Level one to be implemented in 2021.

# INSTRUMENTATION AND CONTROL TECHNICIAN TASK MATRIX CHART

This chart outlines the major work activities, tasks and sub-tasks from the 2013 Instrumentation and Control Technician National Occupational Analysis.

The Task Matrix Chart will be updated every year until Harmonization implementation is complete. Implementation for harmonization will take place progressively. Level one to be implemented in 2021.

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## A – COMMON OCCUPATIONAL SKILLS

<b>A-1 Performs safety-related functions</b>	<b>1.01 Maintains safe work environment</b>  1	<b>1.02 Uses personal protective equipment (PPE) and safety equipment</b>  1	<b>1.03 Performs de-energizing, lock-out and tag-out procedures</b>  1		
<b>A-2 Organizes work</b>	<b>2.01 Uses diagrams, drawings and schematics</b>  1	<b>2.02 Plans tasks</b>  1,2,3			
<b>A-3 Performs routine trade activities</b>	<b>3.01 Maintains calibration, configuration and test equipment</b>  1	<b>3.02 Maintains tools</b>  1	<b>3.03 Maintains documentation.</b>  1,3	<b>3.04 Operates material handling equipment</b>  1	

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## B – PROCESS MEASURING AND INDICATING DEVICES

<b>B-4 Installs and services pressure, temperature, level and flow devices</b>	<b>4.01 Installs pressure, temperature, level and flow devices</b>  1,2	<b>4.02 Maintains pressure, temperature, level and flow devices</b>  1,2	<b>4.03 Diagnoses pressure, temperature, level and flow devices</b>  1,2	<b>4.04 Repairs pressure, temperature, level and flow devices</b>  1,2
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<b>B-5 Installs and services motion, speed, position and vibration devices</b>	<b>5.01 Installs motion, speed, position and vibration devices</b>  3	<b>5.02 Maintains motion, speed, position and vibration devices</b>  3	<b>5.03 Diagnoses motion, speed, position and vibration devices</b>  3	<b>5.04 Repairs motion, speed, position and vibration devices</b>  3
<b>B-6 Installs and services mass, density and consistency devices</b>	<b>6.01 Installs mass, density and consistency devices</b>  3	<b>6.02 Maintains mass, density and consistency devices</b>  3	<b>6.03 Diagnoses mass, density and consistency devices</b>  3	<b>6.04 Repairs mass, density and consistency devices</b>  3
<b>B-7 Installs and services process analyzers</b>	<b>7.01 Installs process analyzers</b>  3	<b>7.02 Maintains process analyzers</b>  3	<b>7.03 Diagnoses process analyzers</b>  3	<b>7.04 Repairs process analyzers</b>  3
<b>B-8 Installs and services multiple variable computing devices</b>	<b>8.01 Installs multiple variable computing devices</b>  4	<b>8.02 Maintains multiple variable computing devices</b>  4	<b>8.03 Diagnoses multiple variable computing devices</b>  4	<b>8.04 Repairs multiple variable computing devices</b>  4

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## C – SAFETY AND SECURITY SYSTEMS AND DEVICES

<b>C-9 Installs and services safety systems and devices</b>	<b>9.01 Installs safety systems and devices</b>  4	<b>9.02 Maintains safety systems and devices</b>  4	<b>9.03 Diagnoses safety systems and devices</b>  4	<b>9.04 Repairs safety systems and devices</b>  4	
<b>C-10 Installs and services facility security systems. (NOT COMMON CORE)</b>	<b>10.01 Installs facility security systems. (NOT COMMON CORE)</b>	<b>10.02 Maintains facility security systems. (NOT COMMON CORE)</b>	<b>10.03 Diagnoses facility security systems. (NOT COMMON CORE)</b>	<b>10.04 Repairs facility security systems. (NOT COMMON CORE)</b>	
<b>C-11 Installs and services safety instrumented systems (SISs)</b>	<b>11.01 Installs SISs</b>  4	<b>11.02 Configures SISs</b>  4	<b>11.03 Maintains SISs</b>  4	<b>11.04 Diagnoses SISs</b>  4	<b>11.05 Repairs SISs</b>  4

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## D – HYDRAULIC, PNEUMATIC AND ELECTRICAL SYSTEMS

<b>D-12 Installs and services control devices for hydraulic systems</b>	<b>12.01 Installs control devices for hydraulic systems</b>  1,2	<b>12.02 Maintains control devices for hydraulic systems</b>  1,2	<b>12.03 Diagnoses control devices for hydraulic systems</b>  1,2	<b>12.04 Repairs control devices for hydraulic systems</b>  1,2
<b>D-13 Installs and services pneumatic equipment</b>	<b>13.01 Installs pneumatic equipment</b>  1,2	<b>13.02 Maintains pneumatic equipment</b>  1,2	<b>13.03 Diagnoses pneumatic equipment</b>  1,2	<b>13.04 Repairs pneumatic equipment</b>  1,2
<b>D-14 Installs and services electrical and electronic equipment</b>	<b>14.01 Installs electrical and electronic equipment</b>  1,2,3	<b>14.02 Maintains electrical and electronic equipment</b>  1,2,3	<b>14.03 Diagnoses electrical and electronic equipment</b>  1,2,3	<b>14.04 Repairs electrical and electronic equipment</b>  1,2,3

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## E – FINAL CONTROL DEVICES

<b>E-15 Installs and services valves</b>	<b>15.01 Installs valves</b>  2	<b>15.02 Maintains valves</b>  2	<b>15.03 Diagnoses valves</b>  2	<b>15.04 Repairs valves</b>  2
<b>E-16 Installs and services actuators</b>	<b>16.01 Installs actuators</b>  2	<b>16.02 Maintains actuators</b>  2	<b>16.03 Diagnoses actuators</b>  2	<b>16.04 Repairs actuators</b>  2
<b>E-17 Installs and services positioners</b>	<b>17.01 Installs positioners</b>  2	<b>17.02 Maintains positioners</b>  2	<b>17.03 Diagnoses positioners</b>  2	<b>17.04 Repairs positioners</b>  2
<b>E-18 Configures and services variable speed drives (VSDs)</b>	<b>18.01 Configures VSDs</b>  3	<b>18.02 Maintains VSDs</b>  3	<b>18.03 Diagnoses VSDs</b>  3	<b>18.04 Repairs VSDs</b>  3

## F – COMMUNICATION SYSTEMS AND DEVICES

<b>F-19 Installs and services control network systems</b>	<b>19.01 Performs installation and configuration on control network systems</b>  <b>3</b>	<b>19.02 Diagnoses control network systems</b>  <b>3</b>	<b>19.03 Performs maintenance and repairs on control network systems</b>  <b>3</b>
<b>F-20 Installs and services signal converters</b>	<b>20.01 Performs installation and configuration of signal converters</b>  <b>3</b>	<b>20.02 Diagnoses signal converters</b>  <b>3</b>	<b>20.03 Performs maintenance and repairs on signal converters</b>  <b>3</b>
<b>F-21 Installs and services gateways, bridges and media converters</b>	<b>21.01 Performs installation and configuration of gateways, bridges and media converters</b>  <b>3</b>	<b>21.02 Diagnoses gateways, bridges and media converters</b>  <b>3</b>	<b>21.03 Performs maintenance and repairs on gateways, bridges and media converters</b>  <b>3</b>

## G – CONTROL SYSTEMS AND PROCESS CONTROL

<b>G-22 Establishes and optimizes process control strategies</b>	<b>22.01 Determines process control strategy</b>  <b>3,4</b>	<b>22.02 Optimizes process control</b>  <b>3,4</b>	
<b>G-23 - Installs and services stand-alone controllers (SACs)</b>	<b>23.01 Installs SACs</b>  <b>3,4</b>	<b>23.02 Configures SACs</b>  <b>3,4</b>	<b>23.03 Performs maintenance, diagnostics and repairs on SACs</b>  <b>3,4</b>
<b>G-24 Installs and services programmable logic controllers (PLCs)</b>	<b>24.01 Installs PLCs</b>  <b>4</b>	<b>24.02 Configures PLCs</b>  <b>4</b>	<b>24.03 Performs maintenance, diagnosis and repairs on PLCs</b>  <b>4</b>

<b>G-25 Installs and services distributed control systems (DCSs)</b>	<b>25.01 Installs DCSs</b>  4	<b>25.02 Configures DCSs</b>  4	<b>25.03 Performs maintenance, diagnosis and repairs on DCSs</b>  4
<b>G-26 Installs and services human machine interface (HMIs)</b>	<b>26.01 Installs HMIs</b>  4	<b>26.02 Configures HMIs</b>  4	<b>26.03 Performs maintenance, diagnosis and repairs on HMIs</b>  4
<b>G-27 Installs and services supervisory control and data acquisition (SCADA) systems</b>	<b>27.01 Installs SCADA systems</b>  4	<b>27.02 Configures SCADA systems</b>  4	<b>27.03 Performs maintenance, diagnosis and repairs on SCADA systems</b>  4

# ON-THE-JOB AND IN-SCHOOL TRAINING CONTENT FOR THE INSTRUMENTATION AND CONTROL TECHNICIAN TRADE

This chart outlines on-the-job examples for apprentices to achieve relevant work experience to prepare for the topics of technical training. Topics of technical training are provided with the associated learning outcomes.

<b>Level One</b>	<b>10 weeks</b>	<b>300 hours</b>
<b>Physics</b>		<b>30 hours</b>
<ul style="list-style-type: none"> <li>• calculate the pressures of static and moving liquids</li> <li>• examine the expansion and contraction properties of materials with temperature</li> <li>• compare how matter stores heat with temperature changes</li> <li>• classify three forms of heat transfer</li> <li>• demonstrate four methods of vector addition</li> <li>• differentiate between work, power and energy</li> <li>• compare the mechanical advantage of simple machines</li> </ul>		
<b>Mentors can assist the apprentice to prepare for this section of technical training by:</b>		
<ul style="list-style-type: none"> <li>• <i>exposure to the force-balance principles of instruments and applications</i></li> <li>• <i>explaining the principle of thermo-dynamics as it applies to temperature measurement</i></li> <li>• <i>encouraging the review of manuals to understand the theory of operation</i></li> </ul>		
<b>Basic Electronics – Theory</b>		<b>50 hours</b>
<ul style="list-style-type: none"> <li>• analyse/measure current, voltage and resistance in an electrical circuit</li> <li>• analyse Ohm's law, power and energy</li> <li>• analyse series, parallel and combination circuits</li> <li>• analyse inductance and capacitance in simple RC and RL circuits</li> <li>• determine <math>r</math>, <math>x</math> and <math>z</math> in AC circuits and resonant circuits</li> <li>• measure characteristics of diodes</li> <li>• evaluate dc rectifier circuits</li> <li>• evaluate Zener diode circuits</li> </ul>		
<b>Basic Electronics – Shop</b>		<b>50 hours</b>
<ul style="list-style-type: none"> <li>• measure current, voltage and resistance in an electrical circuit</li> <li>• analyze Ohm's and Kirchhoff's laws</li> <li>• measure the equivalent resistance of series-parallel circuits</li> <li>• evaluate various theorems</li> <li>• evaluate ac measurements</li> <li>• measure time constant of RC and RL circuits</li> <li>• evaluate voltages and phase angles in AC circuits</li> <li>• measure characteristics of diodes</li> <li>• evaluate the rectified DC power supply using half-wave, full-wave and bridge rectified configurations</li> <li>• measure load regulations for Zener regulator circuits</li> </ul>		

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *introducing the apprentice to the basic theory of ac and dc circuits*
- *exposure to the test equipment used in ac and dc circuits*
- *familiarisation with basic electronic schematics and diagrams*

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**Instrument Measurement – Theory**

**60 hours**

- evaluate instrument tube installation
- describe pressure measurement
- describe level measurement
- describe temperature measurement
- describe flow measurement

**Instrument Measurement – Shop**

**50 hours**

- install instrument tube lines
- measure pressure
- measure level
- measure temperature
- measure flow

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *exposure to various styles of tubing installations*
- *familiarisation with the test equipment and its application*
- *exposure to the installation, maintenance and calibration of field devices*
- *providing an explanation of the principles of operation for process application*

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**Safety and Shop Practice**

**30 hours**

- work safely in an industrial environment
- discuss dangerous gasses
- utilize tools in practical applications
- examine tools and equipment, their applications, maintenance and procedures for use
- assemble piping and cable fittings and their associated components
- examine material handling equipment and accessories, their applications and limitations
- explain the basics of oxy-acetylene cutting and welding

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing training in safe work practices*
- *providing hands-on experience in the use of precision measuring tools*
- *training in the use of common hand tools*
- *training in the safe start-up and use of oxyacetylene welding and cutting equipment*
- *training in electronic soldering*

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**Mathematics**

**30 hours**

- perform basic numerical computations
- perform basic algebraic operations
- perform basic trigonometry functions
- perform basic graphing with linear equations
- perform basic operations with exponentials and logarithms

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *instruction in mathematically determining outputs with given inputs*
- *training in basic unit conversions*

<b>Level Two</b>	<b>10 weeks</b>	<b>300 hours</b>
<b>Computer Aided Drafting and Design (CADD) - Process Control Drawings</b>		<b>40 hours</b>
<ul style="list-style-type: none"> <li>• interpret various technical drawings such as: process and instrument (P&amp;ID), loop and installation drawings</li> <li>• develop isometric and orthographic drawings</li> <li>• produce manual drafting of P&amp;ID, loop and installation drawings</li> <li>• use CAD to draw ISA symbols</li> <li>• use CAD to draw instrument loop diagrams</li> </ul>		
<b>Mentors can assist the apprentice to prepare for this section of technical training by:</b>		
<ul style="list-style-type: none"> <li>• <i>exposure to instrumentation drawings</i></li> <li>• <i>training in basic drawings, including CAD</i></li> </ul>		
<b>Electronics</b>		<b>90 hours</b>
<ul style="list-style-type: none"> <li>• analyze the fundamentals of solid state devices</li> <li>• analyze the operation of transistors</li> <li>• determine output voltages for various op-amp configurations</li> <li>• convert base numbers</li> <li>• analyze the characteristics of gates and truth tables</li> <li>• design Boolean equations for logic diagrams</li> <li>• evaluate flip-flops</li> <li>• design counters and registers using gates and flip-flops</li> <li>• investigate basic properties of logic families</li> <li>• explain some of the general network topologies used in local area networks (LANs)</li> <li>• classify the various media used in the transmission of signals in LAN systems</li> </ul>		
<b>Mentors can assist the apprentice to prepare for this section of technical training by:</b>		
<ul style="list-style-type: none"> <li>• <i>introducing the set up and operation of electronic equipment</i></li> <li>• <i>training in servicing and troubleshooting electronic circuits</i></li> </ul>		
<b>Instrument Control – Theory</b>		<b>30 hours</b>
<ul style="list-style-type: none"> <li>• describe commonly used control theory terms and the two basic types of control along with their modes</li> <li>• draw a theoretical single, two, and three mode controller and explain its principle of operation and calibration</li> <li>• select the proper settings and tuning method of a controller as it pertains to a specified process</li> <li>• define advanced control techniques including cascade, feedforward, ratio, and override</li> </ul>		
<b>Instrument Control – Shop</b>		<b>30 hours</b>
<ul style="list-style-type: none"> <li>• employ commonly used control modes and terms as they apply to pneumatic analogue controllers</li> <li>• calibrate single, two, and three mode controllers</li> <li>• tune single, two, and three mode controllers</li> <li>• examine advanced control techniques including cascade, feedforward, ratio, and override</li> </ul>		

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing hands-on experience with controller tuning and process optimization*
- *providing exposure to different control strategies*
- *demonstration of controller auto/manual transfers*

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**Final Control Elements – Theory**

**30 hours**

- select valves for various applications
- select inherent flow characteristic for an application
- select control valve accessories
- describe control valve issues
- select methods to eliminate or minimize control valve problems
- examine I/P's (current to pressure converters) transducers
- describe the use of asset management systems (AMS) for configuration and I/P data input purposes

**Final Control Elements – Shop**

**60 hours**

- remove control valves from service
- disassemble control valve assemblies
- overhaul actuators
- rebuild valves
- service positioners
- select the inherent flow characteristic for an application
- select control valve accessories
- reassemble control valve assemblies
- calibrate control valve assemblies
- reinstall control valves back into service
- calibrate current to pressure transmitters (I/P's)
- apply asset management software for configuration and I/P data input

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing hands-on experience in control valve selection, installation, maintenance and troubleshooting*
- *providing hands-on experience with valve accessories*

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**Intrinsic Safety**

**20 hours**

- classify hazardous areas
- state the conditions necessary for an explosion
- select various methods of explosion prevention
- identify principles of flameproof enclosures
- identify principles of intrinsic safety
- design an intrinsically safe system

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing training in instrumentation used in hazardous locations*
- *training in area classifications*

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**Level Three**

**10 weeks**

**300 hours**

**Chemistry**

**40 hours**

- demonstrate safe laboratory protocol
- outline the scientific process and the format for an experimental write-up
- perform quantitative physical measurement calculations

- classify periodic table elements
- examine the chemical nomenclature of ionic and molecular compounds
- solve problems involving variables in chemical calculations
- experiment with stoichiometric values in chemical reactions
- determine the conductivity of solutions based on solution concentrations
- contrast the pH of acid and base solutions
- examine the laws that govern the gaseous state of matter

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing exposure to the theory of analytical instrumentation*
- *making available the chemical theory of process*

### **Computer Literacy**

**40 hours**

- use a networked microcomputer system
- use the microcomputer data storage structure
- operate Microsoft Word
- operate Microsoft Excel

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *training in/allowing access to computer systems and software applications*

### **Instrument Control**

**40 hours**

- calibrate a digital controller
- tune a digital controller using process simulators or a process loop
- apply feedforward control
- apply override control
- control a process using the self-tune feature in a digital controller
- solve a multivariable control problem
- describe alternative control applications

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing continued hands-on experience with controller tuning and process optimization*

### **Instrument Logic**

**40 hours**

- connect a basic stop/start circuit using a standard relay
- connect field switches to produce automatic operation
- design automatic circuits employing interlocks and permissive conditions
- connect sequential applications with relays
- explain the operation and features of Variable Frequency Drives and electric actuators
- perform basic operations on PLC's
- design ladder logic applications for PLC's
- test PLC applications

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing training on the installation, programming and troubleshooting of PLCs and hard-wired relay circuits*

### **Analytical Instruments**

**40 hours**

- describe analyzer sampling systems principles
- describe humidity measurement principles, troubleshooting and calibration

- apply humidity measurement principles, troubleshooting and calibration
- describe turbidity measurement principles, troubleshooting and calibration
- apply turbidity measurement principles, troubleshooting and calibration
- describe density measurement principles
- apply density measurement principles
- describe vibration measurement principles
- apply vibration measurement principles
- carry out analyzer servicing and calibration

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *ensuring the apprentice can convert metric to imperial for volume, capacity and mass as they pertain to water*
- *assisting the apprentice to calculate rolling and jumper offsets*
- *having the apprentice demonstrate the calculation of pipe sizes and flow rates*

**Instrument Measurement**

**80 hours**

- operate a hand held communicator
- configure a digital valve controller
- operate a documenting process calibrator
- calibrate conventional and smart transmitters
- investigate capacitance, thermal and resistive level transmitters
- investigate ultrasonic and radar level transmitters
- investigate radiation level transmitters
- investigate density transmitters
- investigate temperature transmitters
- configure a HART (Highway Addressable Transducer) vortex flowmeter
- configure a turbine flowmeter and totalizer
- configure a mass Coriolis flowmeter
- investigate positive displacement (PD) flow transmitters
- investigate magnetic flow transmitters
- investigate ultrasonic and Doppler flow transmitters

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing hands-on experience with the installation and configuration of smart transmitters and control valves*
- *training in troubleshooting and servicing of all transmitters and controlling equipment*
- *providing access to loop wiring diagrams and maintenance documentation*

**Technical Communications**

**20 hours**

- explain the process of communication
- prepare industry documents
- prepare written instructions

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *exposure to failure documentation, maintenance logs and technical reports*
- *emphasizing the importance of communications within operations*

**Level Four**

**10 weeks**

**300 hours**

**Process Applications**

**20 hours**

- describe basic industrial boiler control
- apply boiler control principles using simulation software

- describe fundamental process of mining
- describe fundamental aspects of petroleum refining
- describe fundamental process of pulp and paper production

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing familiarization with boiler systems and controls*

### **Data Communications**

**70 hours**

- explain the function of the local area networks (LAN) devices
- explain some of the common network access methods
- evaluate the supervisory control and data acquisition (SCADA) environment and what functions this equipment performs

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing training in the communication systems of the plant*
- *providing exposure to system administration and configuration*

### **Analytical Instruments – Theory**

**50 hours**

- describe chromatography measurement principles
- describe oxygen measurement principles
- describe pH measurement principles
- describe ORP measurement principles
- describe conductivity measurement principles
- describe toxic and combustible gas measurement principles

### **Analytical Instruments – Shop**

**40 hours**

- apply chromatography measurement principles
- apply oxygen measurement principles
- apply pH measurement principles
- apply ORP measurement principles
- apply conductivity measurement principles
- apply toxic and combustible gas measurement principles

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing hands-on training on available analytical instrumentation*

### **Programmable Logic Controllers**

**40 hours**

- evaluate modular PLC system components
- prepare modules for use in an application
- configure a programmable logic controller
- apply commonly used programming techniques
- apply system design principles
- troubleshoot the PLC system
- service the PLC system
- implement SIS (Safety Instrumented Systems)

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing training on the installation, programming and troubleshooting of PLCs*

### **Distribution Systems**

**50 hours**

- identify DCS system architectures
- identify structure and terminology of DCS systems

- configure HART field devices using AMS or hand held communicator
- configure monitoring modules
- configure PID (proportional, integral, derivative) modules
- configure a cascade control strategy
- create an operator graphics display
- configure discrete control modules
- operate and tune control loops
- configure I/O of a distributed control system (DCS)

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing exposure to DCS system*
- *if possible, training in configuration, operation and troubleshooting of a DCS system*

### **Instrument Control**

**30 hours**

- configure digital controllers
- incorporate digital controllers in a process application
- tune a process using Lambda tuning
- configure a controller using configuration software

**Mentors can assist the apprentice to prepare for this section of technical training by:**

- *providing hands-on experience with controller tuning and process optimization*
- *providing exposure to a variety of control strategies*

**Consider apprenticeship training as an investment in the future of your company and in the future of your workforce. Ultimately, skilled and certified workers increase your bottom line.**

**Get involved in the apprenticeship training system. Your commitment to training helps to maintain the integrity of the trade.**

**Do you have employees who have been working in the trade for a number of years but don't have trade certification? Contact your local apprenticeship office for details on how they might obtain the certification they need.**

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