PROGRAM OUTLINE

Instrumentation and Control Technician
(Industrial Instrument Mechanic)
INDUSTRIAL INSTRUMENT MECHANIC
PROGRAM OUTLINE

APPROVED BY INDUSTRY
MARCH 2015

BASED ON
NOA 2013

Developed By
Industry Training Authority
Province of British Columbia
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Section 1

INTRODUCTION

Industrial Instrument Mechanic
Introduction

Foreword

This Program Outline is for use in the Instrumentation and Control Technician (Industrial Instrument Mechanic) apprenticeship training classes as sponsored by the Industry Training Authority and will be used as a guide for instructors in the formal classroom portions of apprenticeship training. The 2013 NOA and Alberta curriculum for this trade were examined by provincial Subject Matter Experts in the process of creating the BC 2015 Program Outline.

Practical demonstration and student participation should always be integrated with classroom sessions.

Safe working practices, though not always specified in each of the competencies and learning tasks, are an implied part of the program and should be stressed throughout the apprenticeship.

The technical training times calculated by the Industry Subject Matter Experts are based on six hours of instructional time (“student contact time”) per day.

This Program Outline includes a list of recommended reference textbooks that are available to support the learning objectives and the minimum shop requirements needed to support instruction. Appendix C of this document contains a sample lab assessment tool which is intended to assist new instructors in creating lab assessment instruments.

School-based training for this trade does NOT include practical safety certification (rigging, fall protection, confined space entry, etc.). Apprentices will examine the purpose and intent of work safety documents and regulations, and know how to find this information. It is the responsibility of employers to train apprentices in on-the-job safety practices and procedures (as per BC Occupational Health and Safety Regulations and Employers’ Company Safety Policies).

SAFETY ADVISORY

Be advised that references to the WorkSafeBC safety regulations contained within these materials do not/may not reflect the most recent Occupational Health and Safety Regulation (the current Standards and Regulation in BC can be obtained on the following website: http://www.worksafebc.com). Please note that it is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulation pertaining to his/her work.
Acknowledgements

Subject Matter Experts retained to assist with the review and update of the Program Outline (2014 and 2015):

- Jim Armstrong | BC Institute of Technology
- Wes Babcock | AutoPro Automation
- Shane Stirling | Epscan
- Erik Jensens | Epscan
- Leo Paradis | Catalyst Paper
- Max Tinsley | Thompson Rivers University
- Levi Jackson | AltaGas
- Aron Reid | Howe Sound Pulp and Paper Corporation

Facilitators (2015)

- Jennifer Booth | ITA (Industry Training Authority)
- Angela Caughy | ITA (Industry Training Authority)
- Farah Tamanna | ITA (Industry Training Authority)

Facilitators (2014)

- Ed Jarvis | RTO (Resource Training Organization)
- Leslie Marining | RTO (Resource Training Organization)

The Industry Training Authority would like to acknowledge the dedication and hard work of all the industry and training provider representatives appointed to identify the training requirements of the Industrial Instrument Mechanic occupation.
Introduction

How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below describes how each section can be used by each intended audience.

<table>
<thead>
<tr>
<th>Section</th>
<th>Training Providers</th>
<th>Employers/ Sponsors</th>
<th>Apprentices</th>
<th>Challengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Credentialing Model</td>
<td>Communicate program length and structure, and all pathways to completion</td>
<td>Understand the length and structure of the program</td>
<td>Understand the length and structure of the program, and pathway to completion</td>
<td>Understand challenger pathway to Certificate of Qualification</td>
</tr>
<tr>
<td>OAC</td>
<td>Communicate the competencies that industry has defined as representing the scope of the occupation</td>
<td>Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification</td>
<td>View the competencies they will achieve as a result of program completion</td>
<td>Understand the competencies they must demonstrate in order to challenge the program</td>
</tr>
<tr>
<td>Training Topics and Suggested Time Allocation</td>
<td>Shows proportionate representation of general areas of competency (GACs) at each program level, the suggested proportion of time spent on each GAC, and percentage of time spent on theory versus practical application</td>
<td>Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application</td>
<td>Understand the scope of competencies covered in the technical training, the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical application</td>
<td>Understand the relative weightings of various competencies of the occupation on which assessment is based</td>
</tr>
<tr>
<td>Program Content</td>
<td>Defines the objectives, learning tasks, high level content that must be covered for each competency, as well as defining observable, measurable achievement criteria for objectives with a practical component</td>
<td>Identifies detailed program content and performance expectations for competencies with a practical component; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice</td>
<td>Provides detailed information on program content and performance expectations for demonstrating competency</td>
<td>Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels</td>
</tr>
</tbody>
</table>
## Introduction

<table>
<thead>
<tr>
<th>Section</th>
<th>Training Providers</th>
<th>Employers/Sponsors</th>
<th>Apprentices</th>
<th>Challengers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Training Provider Standards</strong></td>
<td>Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program</td>
<td>Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own</td>
<td>Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors</td>
<td>Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment</td>
</tr>
<tr>
<td><strong>Appendix – Glossary of Acronyms</strong></td>
<td></td>
<td></td>
<td>Defines program specific acronyms</td>
<td></td>
</tr>
</tbody>
</table>
Section 2

PROGRAM OVERVIEW

Industrial Instrument Mechanic
Program Overview

Program Credentialing Model

Apprenticeship pathway
This graphic provides an overview of the Instrumentation and Control Technician (Industrial Instrument Mechanic) apprenticeship pathway.

C of Q = Certificate of Qualification
C of A = Certificate of Apprenticeship
C of C = Certificate of Completion
WBT = Work Based Training

CROSS-PROGRAM CREDITS
Individuals who hold the credentials listed below are entitled to receive partial credit toward the completion requirements of this program

None

Industrial Instrument Mechanic Foundation Program
Technical Training: 21 weeks*

Industrial Instrument Mechanic Level 1
Technical Training: 300 hours (10 weeks*)
Work-Based Training: Accumulate hours

Industrial Instrument Mechanic Level 2
Technical Training: 300 hours (10 weeks*)
Work-Based Training: Accumulate hours

Industrial Instrument Mechanic Level 3
Technical Training: 300 hours (10 weeks*)
Work-Based Training: Accumulate hours

Industrial Instrument Mechanic Level 4
Technical Training: 300 hours (10 weeks*)
Work-Based Training: 6,000 hours total
Interprovincial Red Seal Exam

APPRENTICESHIP - DIRECT ENTRY

*Suggested duration based on 30-hour week
Program Overview

Occupational Analysis Chart

**INDUSTRIAL INSTRUMENT MECHANIC**

**Occupation Description:** “Industrial Instrument Mechanic” means a person who installs, repairs, maintains, replaces, calibrates, programs and services process monitoring and/or control instruments including indicators, recording devices, control loops and computers. These instruments may be pneumatic, hydraulic, electronic, electrical, mechanical, nuclear, optical or chemical, and include signal transmission, telemetering and digital devices in industrial operations.

<table>
<thead>
<tr>
<th>OCCUPATIONAL SKILLS</th>
<th>A</th>
<th>Plan and perform routine trade activities</th>
<th>A1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A2</td>
<td>Organize work and maintain records</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A3</td>
<td>Use computers and related applications</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A4</td>
<td>Explain codes, standards and regulations</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A5</td>
<td>Identify electrical hazards and apply safe work practices (includes CEC)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A6</td>
<td>Use trade related schematics and drawings</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MEASURING AND INDICATING DEVICES</th>
<th>B</th>
<th>Calibrate and service indicating and recording instruments</th>
<th>B1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B2</td>
<td>Measure pressure</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B3</td>
<td>Measure temperature</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B4</td>
<td>Measure level</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B5</td>
<td>Measure density</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B6</td>
<td>Measure weight</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

|                      | B7 | Measure flow (volumetric and mass flow) | 2 |
|                      | B8 | Measure consistency and viscosity | 3 |
|                      | B9 | Measure and service environmental monitoring devices | 4 |
|                      | B10 | Measure vibration | 3 |
|                      | B11 | Measure speed | 3 |
|                      | B12 | Measure position | 3 |

<table>
<thead>
<tr>
<th>ANALYTICAL INSTRUMENTATION</th>
<th>C</th>
<th>Measure analytical properties of process gases</th>
<th>C1</th>
<th>4</th>
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<tbody>
<tr>
<td></td>
<td>C2</td>
<td>Measure analytical properties of process liquids</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C3</td>
<td>Measure analytical properties of process solids</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C4</td>
<td>Measure analytical properties of flue gases</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>SAFETY AND PROCESS MONITORING SYSTEMS</td>
<td>D</td>
<td>Service and test flame safety systems</td>
<td>Install and service process cameras</td>
<td>Service ESD (emergency shutdown devices)</td>
</tr>
<tr>
<td>----------------------------------------</td>
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<td>------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>D1</td>
<td>D2</td>
<td>D3</td>
</tr>
<tr>
<td>PNEUMATIC AND HYDRAULIC SYSTEMS</td>
<td>E</td>
<td>Examine air supply systems</td>
<td>Install tubing and fittings</td>
<td>Install and service pneumatic instruments</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>E1</td>
<td>E2</td>
<td>E3</td>
</tr>
<tr>
<td>ELECTRICAL AND ELECTRONIC SYSTEMS</td>
<td>F</td>
<td>Examine electrical theory</td>
<td>Apply basic principles of DC electricity</td>
<td>Apply basic principles of AC electricity</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>F1</td>
<td>F2</td>
<td>F3</td>
</tr>
<tr>
<td>FINAL CONTROL ELEMENTS</td>
<td>G</td>
<td>Service regulators and examine relief valves</td>
<td>Service, size and install control valves and actuators</td>
<td>Install and service valve positioners (includes advanced diagnostics)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>G1</td>
<td>G2</td>
<td>G3</td>
</tr>
<tr>
<td>COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION SYSTEMS</td>
<td>H</td>
<td>Examine communication systems</td>
<td>Install wiring in accordance with CEC</td>
<td>Examine communication network structures and components</td>
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<td></td>
<td>3</td>
<td>H1</td>
<td>H2</td>
<td>H3</td>
</tr>
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</table>

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Industrial Instrument Mechanic
05/16

Industry Training Authority
12
### Program Overview

<table>
<thead>
<tr>
<th>CONTROL SYSTEMS</th>
<th>Examine fundamental theories of process operation and equipment</th>
<th>Examine control theory</th>
<th>Examine process control techniques and strategies</th>
<th>Implement process control strategies</th>
<th>Install and service stand-alone controllers</th>
<th>Install, configure, maintain and service Distributed Control Systems (DCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
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<tr>
<td>I</td>
<td>3 4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>I1</td>
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<td>I2</td>
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<td>I3</td>
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<td>I4</td>
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<td>I5</td>
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<tr>
<td>I7</td>
<td>Install, configure, maintain and service Programmable Logic Controllers (PLC)</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
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<td>1 3 4</td>
<td>3</td>
<td>3</td>
<td>4</td>
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</tr>
<tr>
<td>I8</td>
<td>Install, configure, maintain and service human machine interface (HMI)</td>
<td><img src="image18.png" alt="Image" /></td>
<td><img src="image19.png" alt="Image" /></td>
<td><img src="image20.png" alt="Image" /></td>
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<td><img src="image27.png" alt="Image" /></td>
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<td></td>
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<tr>
<td>I9</td>
<td>Install and demonstrate knowledge of advanced supervisory control systems</td>
<td><img src="image29.png" alt="Image" /></td>
<td><img src="image30.png" alt="Image" /></td>
<td><img src="image31.png" alt="Image" /></td>
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<td><img src="image36.png" alt="Image" /></td>
<td><img src="image37.png" alt="Image" /></td>
<td><img src="image38.png" alt="Image" /></td>
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<td>4</td>
<td></td>
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</table>
## Training Topics and Suggested Time Allocation

### INDUSTRIAL INSTRUMENT MECHANIC – LEVEL 1

<table>
<thead>
<tr>
<th>Line</th>
<th>Topic</th>
<th>% of Time</th>
<th>% of Time</th>
<th>% of Time</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Theory</td>
<td>Practical</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5%</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Line A</strong></td>
<td><strong>OCCUPATIONAL SKILLS</strong></td>
<td>5%</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>A1</td>
<td>Plan and perform routine trade activities</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>Use computers and related applications</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Explain codes, standards and regulations</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>Identify electrical hazards and apply safe work practices (includes CEC)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>Use trade related schematics and drawings</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td><strong>Line B</strong></td>
<td><strong>MEASURING AND INDICATING DEVICES</strong></td>
<td>15%</td>
<td>40%</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>B1</td>
<td>Calibrate and service indicating and recording instruments</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>Measure pressure</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Line D</strong></td>
<td><strong>SAFETY AND PROCESS MONITORING SYSTEMS</strong></td>
<td>5%</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>D3</td>
<td>Service ESD (emergency shutdown devices)</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>Service and calibrate personal safety systems</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td><strong>Line E</strong></td>
<td><strong>PNEUMATIC AND HYDRAULIC SYSTEMS</strong></td>
<td>7%</td>
<td>60%</td>
<td>40%</td>
<td>100%</td>
</tr>
<tr>
<td>E1</td>
<td>Examine air supply systems</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>E2</td>
<td>Install tubing and fittings</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td>Install and service pneumatic instruments</td>
<td>✓</td>
<td>✓</td>
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<td></td>
</tr>
<tr>
<td><strong>Line F</strong></td>
<td><strong>ELECTRICAL AND ELECTRONIC SYSTEMS</strong></td>
<td>30%</td>
<td>40%</td>
<td>60%</td>
<td>100%</td>
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<tr>
<td>F1</td>
<td>Examine Electrical Theory</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>Apply basic principles of DC electricity</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F3</td>
<td>Apply basic principles of AC electricity</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F5</td>
<td>Apply Boolean logic and principles of digital electronics</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Line G</strong></td>
<td><strong>FINAL CONTROL ELEMENTS</strong></td>
<td>25%</td>
<td>40%</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>G1</td>
<td>Service regulators and examine relief valves</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G2</td>
<td>Service, size and install control valves and actuators</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G3</td>
<td>Install and service valve positioners (includes advanced diagnostics)</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Program Overview

<table>
<thead>
<tr>
<th>Line</th>
<th>Category</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION</td>
<td>3%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Install wiring in accordance with CEC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>CONTROL SYSTEMS</td>
<td>10%</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Install, configure, maintain and service Programmable Logic Controllers (PLCs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Percentage for Industrial Instrument Mechanic Level 1</td>
<td>100%</td>
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</table>
## Training Topics and Suggested Time Allocation

### INDUSTRIAL INSTRUMENT MECHANIC – LEVEL 2

<table>
<thead>
<tr>
<th>Line</th>
<th>Topics</th>
<th>% of Time</th>
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<th>Total</th>
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<tr>
<td>A</td>
<td>OCCUPATIONAL SKILLS</td>
<td>5%</td>
<td>60%</td>
<td>40%</td>
<td>100%</td>
</tr>
<tr>
<td>A3</td>
<td>Use computers and related applications</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>Use trade related schematics and drawings</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>MEASURING AND INDICATING DEVICES</td>
<td>45%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>B3</td>
<td>Measure temperature</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>Measure level</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>B5</td>
<td>Measure density</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>B6</td>
<td>Measure weight</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>B7</td>
<td>Measure flow (volumetric and mass flow)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>PNEUMATIC AND HYDRAULIC SYSTEMS</td>
<td>20%</td>
<td>40%</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>E4</td>
<td>Install and maintain signal conditioners</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>E5</td>
<td>Install and service control devices for hydraulic systems</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>ELECTRICAL AND ELECTRONIC SYSTEMS</td>
<td>20%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>F4</td>
<td>Apply principles of electronics</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>FINAL CONTROL ELEMENTS</td>
<td>10%</td>
<td>60%</td>
<td>40%</td>
<td>100%</td>
</tr>
<tr>
<td>G2</td>
<td>Service, size and install control valves and actuators</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>G3</td>
<td>Install and service valve positioners (includes advanced diagnostics)</td>
<td></td>
<td>✓</td>
<td>✓</td>
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**Total Percentage for Industrial Instrument Mechanic Level 2**: 100%
## Training Topics and Suggested Time Allocation

**INDUSTRIAL INSTRUMENT MECHANIC – LEVEL 3**

<table>
<thead>
<tr>
<th>Line</th>
<th>Topic</th>
<th>% of Time</th>
<th>% of Time Allocated to:</th>
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<tr>
<td></td>
<td></td>
<td>5%</td>
<td>Theory</td>
</tr>
<tr>
<td></td>
<td><strong>OCCUPATIONAL SKILLS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>Organize work and maintain records</td>
<td>5%</td>
<td>80%</td>
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<tr>
<td>A3</td>
<td>Use computers and related applications</td>
<td>5%</td>
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<tr>
<td>A6</td>
<td>Use trade related schematics and drawings</td>
<td>5%</td>
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</tr>
<tr>
<td></td>
<td><strong>MEASURING AND INDICATING DEVICES</strong></td>
<td>13%</td>
<td>60%</td>
</tr>
<tr>
<td>B8</td>
<td>Measure consistency and viscosity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B10</td>
<td>Measure vibration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B11</td>
<td>Measure speed</td>
<td></td>
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</tr>
<tr>
<td>B12</td>
<td>Measure position</td>
<td></td>
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</tr>
<tr>
<td>B13</td>
<td>Measure motion</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>ANALYTICAL INSTRUMENTATION</strong></td>
<td>25%</td>
<td>40%</td>
</tr>
<tr>
<td>C2</td>
<td>Measure analytical properties of process liquids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>Measure analytical properties of process solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PNEUMATIC AND HYDRAULIC SYSTEMS</strong></td>
<td>10%</td>
<td>50%</td>
</tr>
<tr>
<td>E3</td>
<td>Install and service pneumatic instruments</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>FINAL CONTROL ELEMENTS</strong></td>
<td>10%</td>
<td>50%</td>
</tr>
<tr>
<td>G4</td>
<td>Install and service variable speed drive (VSD) and variable frequency drive (VFD)</td>
<td></td>
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<tr>
<td></td>
<td><strong>COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION SYSTEMS</strong></td>
<td>10%</td>
<td>70%</td>
</tr>
<tr>
<td>H1</td>
<td>Examine communication systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td>Examine communication network structures and components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4</td>
<td>Troubleshoot signal transmission systems</td>
<td></td>
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## Program Overview

### % of Time Allocated to:

<table>
<thead>
<tr>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
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<tr>
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</table>

<table>
<thead>
<tr>
<th>Line I</th>
<th>CONTROL SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>Examine fundamental theories of process operation and equipment</td>
</tr>
<tr>
<td>I2</td>
<td>Examine control theory</td>
</tr>
<tr>
<td>I3</td>
<td>Examine process control techniques and strategies</td>
</tr>
<tr>
<td>I4</td>
<td>Implement process control strategies</td>
</tr>
<tr>
<td>I7</td>
<td>Install, configure, maintain and service programmable logic controllers (PLCs)</td>
</tr>
<tr>
<td>I8</td>
<td>Install, configure, maintain and service human machine interface (HMI)</td>
</tr>
</tbody>
</table>

**Total Percentage for Industrial Instrument Mechanic Level 3** 100%
## Training Topics and Suggested Time Allocation

### INDUSTRIAL INSTRUMENT MECHANIC – LEVEL 4

<table>
<thead>
<tr>
<th>Line</th>
<th>Topic</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
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<tr>
<td>Line A</td>
<td>OCCUPATIONAL SKILLS</td>
<td>5%</td>
<td>40%</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>A3</td>
<td>Use computers and related applications</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>Use trade related schematics and drawings</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line B</td>
<td>MEASURING AND INDICATING DEVICES</td>
<td>10%</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>B9</td>
<td>Measure and service environmental monitoring devices</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>Line C</td>
<td>ANALYTICAL INSTRUMENTATION</td>
<td>10%</td>
<td>50%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>C1</td>
<td>Measure analytical properties of process gases</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>Measure analytical properties of flue gases</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Line D</td>
<td>SAFETY AND PROCESS MONITORING SYSTEMS</td>
<td>15%</td>
<td>50%</td>
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<td>100%</td>
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<tr>
<td>D1</td>
<td>Service and test flame safety systems</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>D2</td>
<td>Install and service process cameras</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>Service ESD (emergency shutdown devices)</td>
<td>✓</td>
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</tr>
<tr>
<td>Line H</td>
<td>COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION SYSTEMS</td>
<td>13%</td>
<td>40%</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>H5</td>
<td>Install, configure, maintain and service supervisory control and data acquisition (SCADA) systems</td>
<td>✓</td>
<td>✓</td>
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<td></td>
</tr>
<tr>
<td>Line I</td>
<td>CONTROL SYSTEMS</td>
<td>47%</td>
<td>40%</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>I1</td>
<td>Examine fundamental theories of process operation and equipment.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I4</td>
<td>Implement process control strategies</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I5</td>
<td>Install and service stand-alone controllers</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>I6</td>
<td>Install, configure, maintain and service Distributed Control Systems (DCS)</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I7</td>
<td>Install, configure, maintain and service Programmable Logic Controllers (PLCs)</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I9</td>
<td>Install and demonstrate knowledge of advanced supervisory control systems</td>
<td>✓</td>
<td>✓</td>
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</table>

Total Percentage for Industrial Instrument Mechanic Level 4: 100%
Section 3

PROGRAM CONTENT

Industrial Instrument Mechanic
Level 1

Industrial Instrument Mechanic
Line (GAC): A  OCCUPATIONAL SKILLS
Competency: A1  Plan and perform routine trade activities

Objectives:
To be competent in this area, the individual must be able to:

- Perform routine trade activities.

LEARNING TASKS

1. Communicate with others

2. Examine types of trade related personal protective equipment

3. Maintain safe work environment

4. Use and maintain hand and power tools

5. Examine mounting and installation hardware and practices

CONTENT

- Trade terminology
- Effective verbal communication skills
- Effective written communication skills
- Consulting to solve problems

- Head protection
  - CSA approved hard hat

- Eye protection
  - CSA approved goggles and face shield

- Hearing protection
  - Ear plugs
  - Ear muffs

- Hand protection
  - Types of gloves and mitts

- Clothing
  - Types of materials suitable to work environment (FR rated)

- Foot protection
  - CSA approved safety boots with suitable soles

- Personal Breathing Apparatus

- Safe housekeeping practices
- Appropriate recycling and disposal procedures

- Trade specific hand and power tools
  - (See tools and equipment lists in Appendix)

- Manufacturer instructions
- Types of mounting hardware (uni-strut, clamps, u-bolts...)
- Location for installation of mounting hardware
LEARNING TASKS

6. Confirm and maintain integrity of test equipment

CONTENT

- Test gauge
- Multimeter
- Manometer
- Dead weight tester
- Digital test equipment
- Portable personal gas monitors

Achievement Criteria:

Performance  The learner will be evaluated on the ability to:
  - Use test equipment
  - Mount and install devices

Conditions  As part of practical lab tasks, given the required tools and materials (see Appendix C: Sample Evaluation Sheet)

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Program Content
Level 1

Line (GAC)  A  OCCUPATIONAL SKILLS
Competency:  A3  Use computers and related applications

Objectives
To be competent in this area, the individual must be able to:
• Configure and program Level 1 instrumentation devices to manufacturers’ specifications.

LEARNING TASKS

1. Examines diagnostic and configuration software, hardware and firmware

2. Uses diagnostic and configuration software, hardware and firmware

3. Maintains back-up data and documentation

CONTENT
• Configuration and programming software, hardware and firmware used in Level 1

Achievement Criteria:
Performance
The learner will be evaluated on the ability to:
• Use configuration and programming software, hardware and firmware
• Produce back up data and documentation

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): A OCCUPATIONAL SKILLS
Competency: A4 Explain codes, standards and regulations

Objectives:
To be competent in this area, the individual must be able to:
- Access and explain the purpose and applications of standards, codes and regulations.

LEARNING TASKS
1. Navigate WorkSafeBC website to access work-related safety regulations and publications

CONTENT
- http://worksafebc.com
- OHS Regulation
  - Purpose of Regulation
  - General Requirements of OHS
  - Right to refuse unsafe work
  - Government/Employer/Employee responsibilities
  - Chemical and biological agents
  - Noise, vibration, radiation and temperature
  - Tools machinery and equipment safety
  - Ladders, scaffolds and temporary work platforms
  - Rigging, cranes and hoists
  - Mobile equipment
  - Transportation of workers
  - Traffic control
  - Electrical safety
  - Oil and gas industries
- PDF documents from WorkSafeBC website (publications):
  - Effective Safety and Health Programs
  - Lockout/Tagout
  - Fall Protection
  - Confined Space Hazards
  - Confined Space Entry
  - Working Safely Around Electricity
  - Chlorine Safe Work Practices
  - WHMIS manuals
  - Hazard Symbols Key Booklet
  - Hazard Alerts
LEARNING TASKS
2. Examine safety and certification bodies related to this trade

CONTENT
- Purpose and intent of codes / regulations/standards
  - WHMIS and use of MSDS
  - CSA certification standards
  - ISA documentation
  - CEC (Canadian Electrical Code)
  - Boiler and Pressure Vessel Code
  - CNSC (Canadian Nuclear Safety Commission)
  - National Energy Board Regulations for Custody Transfer
  - Oil and Gas Commission Accepted Practices for Measurement
  - Transportation of Dangerous Goods
  - BC Mines Act
  - BC Environmental Regulations
- Other related codes and standards, as needed
Line (GAC)       A  OCCUPATIONAL SKILLS
Competency:      A5  Identify electrical hazards and apply safe work practices (includes CEC)

Objectives
To be competent in this area, the individual must be able to:
• Explain standards and safe practices when working with AC and DC electrical circuits and devices.

LEARNING TASKS
1. Examine CEC regulations
   • Scope, general rules and applications
     o Sizing of wire and fuses
     o Class 1 and Class 2 circuits
     o Proper installation and grounding of electrical equipment
     o Area classification
     o Other sections as needed

2. Examine OHS guide to electrical hazards
   • Reference WorkSafeBC Publications – e.g., Working Safely Around Electricity
Line (GAC) A OCCUPATIONAL SKILLS

Competency: A6 Use trade related schematics and drawings

Objectives:
To be competent in this area, the individual must be able to:
• Use schematics and drawings related to Level 1 instrumentation.

LEARNING TASKS

1. Examine types of schematics and drawings
   • P&ID, SAMA, isometric and orthographic drawings

2. Examine symbols and conventions
   • ISA and SAMA symbols

3. Use basic schematics and drawings
   • P&ID/P&C drawings

Achievement Criteria

Performance The learner will be evaluated on the ability to:
• Use drawings and schematics

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade 70%
Line (GAC): B MEASURING AND INDICATING DEVICES
Competency: B1 Calibrate and service indicating and recording instruments

Objectives
To be competent in this area, the individual must be able to:
- Calibrate and service specified chart recorders and gauges using principles of links and levers.

LEARNING TASKS

1. Examine types of recording devices
   - Chart recorders
     - Pneumatic
     - Electronic
   - Principles of links and levers
     - Motion multiplication
     - Angularity
     - Zero
     - Span

2. Examine indicating devices
   - Displays
     - Configurable
     - CRT
     - LCD/LED
     - Plasma

3. Calibrate and service indicating devices using principles of zero, span and angularity adjustments as they relate to links and levers
   - Gauges
     - Panel
     - Field
   - Accessories
     - Pigtail siphons
     - Dampening
     - Chemical seals
   - Calculation of head correction
   - Measuring element and range
     - Bourdon tube
     - Helical
     - Spiral
     - Bellows
     - Diaphragm capsule
     - Slack diaphragm
LEARNING TASKS

CONTENT
- Applications
  - Metallurgies
  - Oil filled
  - Compound
  - Combination
  - Duplex
  - Differential
  - Draft
  - Oxygen service
  - Refrigeration service

4. Service recording devices
- Identification of measuring element and input measurement scale
- Device calibration using principles of zero, span and angularity adjustments as they relate to links and levers
- Pen arcing time line
- Power supply
- Pens
- Paper

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
- Calibrate pressure gauges
  - Draft gauge
  - Bourdon gauge
- Calibrate mechanic, pneumatic and electrical chart recorders

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
LINE (GAC): B MEASURING AND INDICATING DEVICES
Competency: B2 Measure Pressure

Objectives
To be competent in this area, the individual must be able to:
• Configure and calibrate pneumatic, electronic and digital measuring devices to process requirements.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 1. Examine types of pressure | • Absolute  
• Differential  
• Gage  
• Vacuum  
• Conversion tables  
  o Pressure conversion formulas  
  o Steam tables (relationship between temperature and pressure)  
• Head correction calculation |
| 2. Examine types of pressure measuring devices | • Pneumatic  
• Electronic  
• Digital |
| 3. Examine installation of pressure measuring devices | • Manufacturers’ specifications  
• Selection of device  
• Air/power supply requirements  
• Location of device  
• Isolation of device  
• Connection of device to process  
• Connection of device to control system  
• Sealants and gaskets |
LEARNING TASKS

4. Configure / calibrate pressure measuring devices

CONTENT

- Device operation
- Primary calibration standards
- Manometer types
  - Well
  - Raised Well
  - Dual tube
  - Incline
  - U-tube
  - Slack tube
- Manometer fluids
  - Mercury
  - Unity oil
  - Water
  - Red oil
  - Meriam #3
  - Fluoroscien
- Dead weight testers
  - Pneumatic
  - Hydraulic
- Calibration/configuration parameters
- Interpretation of results
- Identification of cause/effect of calibration errors
- Adjustments to bring device within calibration parameters
- Returning device to service after calibration
- Document calibration results

5. Maintain device

Achievement Criteria

Performance The learner will be evaluated on the ability to:
- Configure and calibrate pressure measuring devices

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): D  SAFETY AND PROCESS MONITORING SYSTEMS
Competency: D3  Service ESD (emergency shutdown devices)

Objectives
To be competent in this area, the individual must be able to:
• Service emergency shutdown devices (ESDs).

LEARNING TASKS
1. Service ESD

CONTENT
• Manipulating process to allow for servicing
  o Alerting operations
  o Awareness of impact on process
• Testing ESD components
• Alarming
  o Audible alarms
  o Visible alarms
  o Response to alarm
  o Notifications

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
• Service ESDs

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): D SAFETY AND PROCESS MONITORING SYSTEMS
Competency: D4 Service and calibrate personal safety systems

Objectives
To be competent in this area, the individual must be able to:
- Identify the types of personal safety systems and explain their applications.

Learning Tasks
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Examine personal gas monitors and standard</td>
<td>- Portable personal gas monitor (Cl, SO₂, H₂S, O₂, LEL, CO )</td>
</tr>
<tr>
<td>calibration routines</td>
<td>- Pull tube (Draeger)</td>
</tr>
<tr>
<td>2. Examine radiation safety devices</td>
<td>- Radiation (gamma) survey meter</td>
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<tr>
<td></td>
<td>- Personal dosimeter</td>
</tr>
</tbody>
</table>
Line (GAC): E  PNEUMATIC AND HYDRAULIC SYSTEMS
Competency: E1  Examine air supply systems

Objectives
To be competent in this area, the individual must be able to:
• Explain the purpose, operation and servicing of air supply systems.

LEARNING TASKS
1. Examine instrument air systems and equipment
   • Need for clean, dry air
   • Air compressors
   • Air dryers
   • Air receivers
   • Air filters

2. Examine air distribution systems
   • Mill air
   • Instrument air
   • System requirements

3. Use relative humidity to infer dew point
   • Chilled mirror
   • Hygrometer
   • Hair hygrometer
   • Sling psychrometer
   • Digital psychrometer
   • Bulk polymer resistance sensor
   • Psychrometric chart

4. Examine the servicing procedures for air supply systems
   • Servicing requirements
     o Traps
     o Dessicant
     o Pre and post filters

Achievement Criteria:
Performance  The learner will be evaluated on the ability to:
• Measure dew point
• Create an instrument air supply drawing from an existing system

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Program Content
Level 1

Line (GAC): E  PNEUMATIC AND HYDRAULIC SYSTEMS
Competency: E2 Install tubing and fittings

Objectives:
To be competent in this area, the individual must be able to:
• Select, assemble and install tubing and assorted fittings as per drawings provided.

LEARNING TASKS
1. Examine types of tubing and installation procedures

CONTENT
• Plastic
• Stainless steel
• Copper
• Rubber
• Process and pressure requirements
  o Sizes
  o Pressure and temperature ratings

2. Examine types of fittings and installation procedures

CONTENT
• Types of fittings
  o Unions
  o Elbows
  o Tees
  o Couplings
  o Bushings
  o Reducers
  o Caps
  o Plugs
  o Bulkhead fittings
  o Others

3. Examine tube bending techniques

CONTENT
• Calculating dimensions
• Manual tube benders
• Hydraulic tube benders
LEARNING TASKS
4. Install tubing and fittings

CONTENT
- Ferrule construction and location
- Tightening fittings
- Follow P&ID drawings
- Select appropriate tubing and fittings

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
- Identify types of fittings
- Bend tubing to a pre-determined pattern

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70% for both tasks
Line (GAC): E  PNEUMATIC AND HYDRAULIC SYSTEMS
Competency: E3 Install and Service Pneumatic Instruments

Objectives
To be competent in this area, the individual must be able to:
• Calibrate pneumatic instruments to required specifications.

LEARNING TASKS

1. Examine specifications and hazards of pneumatic equipment
   • Compressed air safety
   • Pneumatic signals (3-15 psi, 6-30 psi, 20-100 kPa)
   • Required air supplies

2. Examine types of pneumatic equipment
   • Transmitters
   • Converters
   • Positioners
   • Controllers
   • Relays

3. Examine operating principles of pneumatic equipment
   • Force balance
   • Motion balance

4. Examine pneumatic equipment installation procedures
   • Selection of equipment
     o Application
     o Materials
   • Location
   • Set up and adjustments
   • Isolation of equipment
   • Repair and replacement methods
   • Component selections

5. Calibrate pneumatic transmitters
   • Force balance calibration procedure
   • Motion balance calibration procedure
   • Documentation of calibration results

Achievement Criteria
Performance
The learner will be evaluated on the ability to:
• Calibrate pneumatic equipment

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): F ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: F1 Examine electrical theory

Objectives
To be competent in this area, the individual must be able to:
• Explain principles, sources, types and measures of electrical power.
• Apply related mathematical formulas.

LEARNING TASKS

1. Examine basic principles of electrical theory
   • Atomic structure
   • Conductivity of an element
     o Conductor
     o Insulator
     o Semiconductor
   • Electrical current
     o Conventional Theory
     o Electron Theory

2. Examine sources of AC/DC electrical energy
   • Generating electricity
     o Friction
     o Temperature differences
     o Light
     o Pressure
     o Chemical reactions
     o Magnetism
   • Magnetic Lines of Force
   • Magnetic induction
     o AC alternating current
     o Generated by power plants by magnetic induction
     o Voltage
     o Voltage levels
     o Polarity
   • DC voltage sources
     o Fixed polarity
       – Constant voltage
       – Fixed direction of flow in a circuit

3. Examine voltage, current and resistance
   • Voltage
   • Amperage
   • Resistance
LEARNING TASKS
4. Explain Ohm’s law

CONTENT
- The relationship between Voltage (E), current (I) and resistance (R) in an electrical circuit
- \( E = I \times R \)
Line (GAC): F ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: F2 Apply basic principles of DC electricity

Objectives
To be competent in this area, the individual must be able to:
• Explain and apply basic principles of DC electricity using DC electrical equipment and instruments.

LEARNING TASKS

1. Examine operation and applications of various batteries
   • Lead acid
   • NiCad
   • NiMh
   • Lithium ion

2. Measure electrical current, voltage and resistance
   • Analog multimeters
   • Digital multimeters

3. Calculate currents, voltages and resistance using Ohm’s law
   • Series circuits
   • Parallel and combination circuits
   • Formula $E = I \times R$

4. Define and reference voltage measurement to circuit common
   • Difference between ground and circuit common
   • Multimeter
   • Oscilloscope and scope meter
   • Circuit schematic

5. Calculate electrical power in watts
   • Apply Watt’s Law to define power rating of appliances
   • Watts = $E \times I$

6. Examine resistors, potentiometers and rheostats
   • Differences
   • Power ratings
   • Applications
   • Colour codes

7. Apply appropriate sections of CEC
   • Scope, general rules and definitions of the CEC

Achievement Criteria:
Performance The learner will be evaluated on the ability to:
• Design and build a circuit
• Test for accuracy by calculating and measuring current, voltage and resistance
• Define and reference voltage measurements

Conditions As part of practical lab tasks, given the required tools and materials
Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): F  ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: F3  Apply basic principles of AC electricity

Objectives
To be competent in this area, the individual must be able to:
• Explain and apply basic principles of AC electricity using AC circuits.

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<td>4. Size electrical components for various circuits</td>
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<tr>
<td>5. Build and test circuits</td>
<td>• Demonstrate use of various AC components in circuits</td>
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<td>• Measuring techniques and equipment</td>
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<td>• Sizing components</td>
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<td>6. Types of AC circuits</td>
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<td>• Shielding</td>
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<td>8. Apply proper circuit connection techniques</td>
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<td></td>
<td>• Crimping</td>
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<td></td>
<td>• Printed circuit board repair</td>
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</tbody>
</table>
 Achievement Criteria

**Performance**  The learner will be evaluated on the ability to:
- Size electrical components
- Build and test AC circuits
- Apply proper circuit connection techniques

**Conditions**  As part of practical lab tasks, given the required tools and materials

**Criteria**  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Program Content
Level 1

Line (GAC): F ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: F5 Apply Boolean logic and principles of digital electronics

Objectives
To be competent in this area, the individual must be able to:
• Explain the principles of digital electronics in logic applications.

LEARNING TASKS

1. Examine principles of digital logic
   • Discrete values
   • Waveforms
   • Logic levels
   • Conversions
     o Digital to analog
     o Analog to digital
     o Binary to decimal
     o Sum of weights
     o Octal to decimal
     o Decimal to octal
     o Binary to octal
     o Binary to hexadecimal
   • Logic gate symbols
     o NOT circuit
     o Negation and polarity indicators
     o AND gate
     o OR gate
     o NAND gate
     o NOR gate
     o XOR gate
     o XNOR gate

2. Examine digital signal processing
   • Analog to digital conversion
   • Digital to analog conversion
   • Signal to noise ratio
     o Analog and digital filters
   • Signals transformation
   • Magnitude
   • Phase
   • Karnaugh Maps
Line (GAC): G FINAL CONTROL ELEMENTS
Competency: G1 Service regulators and examine relief valves

Objectives
To be competent in this area, the individual must be able to:
• Service regulators.
• Explain the operation of relief valves.

LEARNING TASKS
1. Examine regulators
   • Purpose
   • Pressure drops
   • Types
     o Relieving
     o Non- relieving
     o Pilot operated
   • Definitions
     o Droop
     o Turndown
   • Applications
     o Pressure reducing
     o Pressure relieving

2. Examine operation and applications of regulators
   • Air
   • Water
   • Steam
   • Oil
   • Gas
   • Differential

3. Service and maintain regulators
   • Components
     o Diaphragms
     o Bolts
     o Springs
     o Seats
     o Gaskets
   • Disassembling
     o Spring compression
   • Inspect
   • Reassemble
   • Test
LEARNING TASKS
4. Examine relief valves

CONTENT
  • Applications
    o Safety device
  • Reset differential
  • Certification and testing

Achievement Criteria
Performance The learner will be evaluated on the ability to:
  • Service regulators
Conditions As part of practical lab tasks, given the required tools and materials
Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Objectives
To be competent in this area, the individual must be able to:
• Service control valves.
• Install and service actuators.

LEARNING TASKS

1. Examine actuators

CONTENT
- Types
  o Pneumatic
  o Hydraulic
  o Electric
- Applications
  o Fail open
  o Fail close
  o Fail last
- Actions
  o Spring return
  o Double-acting
- Components
  o Diaphragms
  o Plates
  o Stem connector (coupling)
  o Bushings
  o O-rings
  o Pistons
  o Motors
  o Springs
- Required Operating Environment
- Process applications
  o Metallurgy
  o Seal/shut off requirements
- Flow Characteristics
  o Quick opening
  o Linear
  o Equal percentage

2. Examine control valves
LEARNING TASKS

CONTENT

- **Body Types**
  - Sliding stem
    - Globe
    - Bar stock
    - Pinch valve
  - Rotary
    - Butterfly
    - E-Disc
    - Segmented ball
    - Through-bore ball
    - Restricted trim

- **Components**
  - Cages
  - Plugs
  - Seats
  - Stems
  - Packing

- **Types and applications of valve packing**
  - Teflon
  - Graphite
  - Rope

3. **Service control valves**

- Gaskets
- Sealants
- Positioning valve in process
- Securing valve using appropriate process
  - Flanged
  - Screwed
  - Wafered/flangeless
- Isolation of valve from process
- Testing procedures
  - Stroke to ensure proper operation
  - Leak testing
- Possible faults
  - Leaking packing
  - Valve passing
  - Damaged parts
  - Incorrect travel
- Cleaning/lubricating
- Repairing/rebuilding
LEARNING TASKS

4. Install and service actuators

CONTENT

• Matching to valve
• Connecting to valve
  o Lifting procedures
• Valve travel
• Bench set
• Verifying operation
  o Correct air supply pressure
• Function testing
• Possible faults
  o Leaking diaphragms
  o Broken springs
  o Damaged/worn O-rings
• Removing/replacing components
• Cleaning/lubricating components
• Assembling/disassembling
  o Spring compression
  o Loading on stem connector
• Returning to service

Achievement Criteria:

Performance  The learner will be evaluated on the ability to:
  • Service control valves
  • Remove, service and install actuators on control valves

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Program Content
Level 1

Line (GAC): G FINAL CONTROL ELEMENTS
Competency: G3 Install and service valve positioners (includes advanced diagnostics)

Objectives
To be competent in this area, the individual must be able to:
• Install and service valve positioners on final control elements.

LEARNING TASKS
1. Examine valve positioners

CONTENT
- Types
  - Pneumatic
  - Electronic
  - Digital
  - Electro hydraulic
  - Electro mechanical
- Applications
  - Sliding stem/rotary
  - Piston/diaphragm
- Components
  - Levers
  - Nozzles
  - Flappers
  - Relays
- Auxiliaries
  - Locks
  - Boosters
  - Speed controls
- Parameters
- Relation to actuator type/application
LEARNING TASKS
2. Install and service valve positioners

CONTENT
- Mounting
- Connecting to actuator
- Connecting to process control system
- Configuring
  - Set stroke
  - Set pressures
  - Match to actuator
- Calibrating
  - Connecting calibration instruments
  - Interpretation of calibration results
  - Cause/ effect of calibration errors
- Component maintenance
  - Remove
  - Replace
  - Repair
  - Clean
- Returning to service

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
- Install and service valve positioners

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): H COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H2 Install wiring in accordance with CEC

Objectives
To be competent in this area, the individual must be able to:
• Examine wiring installations in accordance with CEC requirements.

LEARNING TASKS
1. Examine wiring installation requirements

CONTENT
• Materials
• Connections
  o Crimping
  o Terminal blocks
  o Marrettes
  o Soldering
  o Protection (heat shrink, taping etc.)
• Shielding
• Grounding
• Grounding loops
• CEC requirements
• Sizing wire
• Routing of wiring runs
• Stripping wire
• Labeling/colour-coding wire
• Connecting wire
Line (GAC): I CONTROL SYSTEMS
Competency: I7 Install, configure, maintain and service programmable logic controllers (PLCs)

Objectives
To be competent in this area, the individual must be able to:
• Explain the basics of programmable logic controllers (PLCs), given introductory materials on PLCs.

LEARNING TASKS
1. Examine types of PLCs
   • Hardware architecture
   • Control capabilities
     o Discrete control
     o Analog control
   • Compatibility with other process systems
   • Networks
   • Protocols

2. Examine PLC languages and symbols
   • Structured text
   • Instruction list
   • Ladder logic
   • Function block
   • Sequential function chart

3. Examine PLC components
   • CPU
   • Memory organization
   • Input interface
   • Output interface
   • Power supply
   • Programming/monitoring interface
   • Data table
   • User program
Level 2

Industrial Instrument Mechanic
Line (GAC): A OCCUPATIONAL SKILLS
Competency: A3 Use computers and related applications

Objectives
To be competent in this area, the individual must be able to:
• Configure and program Level 2 instrumentation devices to manufacturers’ specifications given related hardware, software and firmware.

LEARNING TASKS
1. Examines diagnostic and configuration software, hardware and firmware
   • Configuration and programming software used in Level 2
     o Flow element sizing programs
     o Temperature and density signal linearization
2. Uses diagnostic and configuration software, hardware and firmware
   • Configuration and programming software used in Level 2
     o Flow element sizing programs
     o AGA Mass flow computers

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Perform computerized flow calculations
• Program an AGA mass flow computer

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): A OCCUPATIONAL SKILLS
Competency: A6 Use trade related schematics and drawings

Objectives
To be competent in this area, the individual must be able to:
• Use schematics and drawings related to instrumentation.

LEARNING TASKS
1. Examine types of schematics and drawings
   • P&ID, SAMA, isometric, orthographic and loop drawings
2. Examine symbols and conventions
   • ISA and SAMA symbols
3. Use and modify basic schematics and drawings
   • P&ID / P&C / loop drawings

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Use and modify Level 2 drawings and schematics
Conditions As part of practical lab tasks, given the required tools and materials
Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): B MEASURING AND INDICATING DEVICES
Competency: B3 Measure temperature

Objectives
To be competent in this area, the individual must be able to:
• Install, calibrate and service temperature measuring devices.

LEARNING TASKS
1. Examine temperature scales

2. Examine temperature measuring devices and their operation

3. Examine temperature calibrating instruments

CONTENT
• Fahrenheit
• Celsius
• Kelvin
• Conversions between scales

• Thermometer
• Thermocouple
  o Thermocouple tables
• Resistive Thermal Device (RTD)
  o RTD tables
• Thermistor
• Filled thermal system
• Pyrometer
• Semi-conductor mechanical thermal system
• Infrared radiation
• Fibre Optic

• Thermometers
• Multimeters
  o Millivolt source
  o Resistance source
• Temperature baths
• Dry block calibrators
• Thermocouple simulators
• Decade box – electronic and analog
• Accuracy
• Calibration parameters of temperature measuring devices
LEARNING TASKS
4. Installs, calibrates and services temperature measuring devices

CONTENT
- Manufacturers’ specifications
- Best Practices for selection/location of measuring device
  - Response time
  - Temperature ranges
  - Resolution
- Thermowell selection and installation
  - Metallurgy
  - Heat transfer
- Thermocouples
  - Grounding
  - Cold junction compensation
  - Types (J, K…T)
  - Extension wires
  - Colour codes (note: North American and European colour codes are different)
    - North American
    - European
- RTDs
  - Alpha and DIN standards
  - 2, 3 and 4 wire
  - 100, 200…1000 ohm
- Device check/calibration
  - Wheatstone bridge
  - Simulators
  - Decade box
- Interpretation of calibration results
- Cause/effect of calibration error
- Device adjustments
- Repairing/replacing device components
- Verification of operation
- Returning device to service
- Documenting calibration

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
- Assess temperature installations to confirm best practices
- Calibrate and service temperature measuring devices

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): B MEASURING AND INDICATING DEVICES
Competency: B4 Measure level

Learning Objectives
To be competent in this area, the individual must be able to:
• Install, calibrate and service level measuring devices.

LEARNING TASKS
1. Examine level measuring devices and their operation
   • Point level
     o Capacitance
     o Float switches
     o Tuning fork
     o Indicating device
     o Microwave
     o Ultrasonic
     o Nuclear
   • Continuous level
     o Hydrostatic head
     o Laser
     o Ultrasonic
     o Radar
     o Sight glass
     o Bubble pipe
     o Resistance tape
     o Magnetic float
     o Load cell
     o Displacement
     o Capacitance
   • Drum level

2. Examine calibration instruments used on level measuring devices
   • Pressure calibrator
   • Laptop/software
   • Handheld programmer (configurator)
LEARNING TASKS
3. Install, calibrate and service level measuring devices

CONTENT
- Manufacturers’ specifications
- Selection/location of measuring device
  - Process application
  - Process medium
  - Price
  - Best practices
- Verify operation
- Device check/calibration
- Interpretation of calibration results
- Cause/effect of calibration error
- Device adjustments
- Repairing/replacing device components
- Verification of operation
- Returning device to service
- Documenting calibration

Achievement Criteria

Performance
The learner will be evaluated on the ability to:
- Assess level installations to confirm best practices
- Calibrate and service level measuring devices

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Program Content
Level 2

Line (GAC): B  MEASURING AND INDICATING DEVICES
Competency: B5  Measure density

Objectives
To be competent in this area, the individual must be able to:
• Install, calibrate and service density measuring devices.

LEARNING TASKS

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<th>LEARNING TASKS</th>
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<td>Effect of temperature on density</td>
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<td>Pressure calibrator</td>
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<td>Laptop/software</td>
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<td>Handheld programmer (configurator)</td>
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<td>Manufacturers’ specifications</td>
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<td>Returning device to service</td>
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<td>Documenting calibration</td>
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<td>Radiation source regulatory safety test</td>
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</table>

2. Examine calibration instruments used on density measuring devices

3. Install, calibrate and service density measuring devices
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Assess density installations to confirm best practices
  • Calibrate and service density measuring devices
  • Perform safety tests on a radiation source

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): B  MEASURING AND INDICATING DEVICES
Competency: B6  Measure weight

Objectives
To be competent in this area, the individual must be able to:
• Install, calibrate and service weight measuring devices.

LEARNING TASKS

1. Examine weight measuring devices and their operation
   • Load cells
   • Scales
   • Strain gauges

2. Examine calibration instruments used on weight measuring devices
   • Test weights
   • Calibration chains
   • Wheatstone bridge
   • Laptop/software
   • Handheld programmer (configurator)

3. Install, calibrate and service weight measuring devices
   • Manufacturers’ specifications
   • Selection/location of measuring device
     o Process application
     o Cost
     o Best practices
   • Verify operation
   • Device check/calibration
   • Interpretation of calibration results
   • Cause/effect of calibration error
   • Device adjustments
   • Repair/replace device components
   • Returning device to service
   • Documenting calibration

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
• Assess weight installations to confirm best practices
• Calibrate and service weight measuring devices

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): B MEASURING AND INDICATING DEVICES
Competency: B7 Measure flow (volumetric and mass flow)

Objectives
To be competent in this area, the individual must be able to:
• Install, calibrate and service flow measuring devices to process requirements.

LEARNING TASKS
1. Examine flow measuring devices and their operation
   • Bernoulli’s Theorem
   • Differential pressure
     o Orifice plate
     o Flumes/weirs
     o Annubar
     o Pitot tube
     o Target meter
     o Elbow meter
     o Venturi
     o Wedge
     o Flow nozzle
     o Multi-variable mass flow
     o Variable area flow meters
   • Velocity
     o Turbine
     o Vortex
     o Ultrasonic
     o Magnetic flow meter
   • Mass flow
     o Coriolis
     o Thermal
   • Positive displacement meter
   • Other flow measurement devices
2. Examine calibration instruments used on flow measuring devices
   • Pressure calibrators
   • Flow simulators
   • Temperature calibrator
   • Frequency generator
   • Laptop/software
   • Handheld programmer (configurator)
LEARNING TASKS
3. Install, calibrate and service flow measuring devices

CONTENT
- Manufacturers’ specifications
- Selection/location factors
  - Straight pipe requirements
  - Accuracy requirements
  - Process application
  - Process medium
  - Cost
  - Best practices
- Verify operation
- Device check/calibration
- Interpretation of calibration results
- Cause/effect of calibration error
- Device adjustments
- Repair/replace device components
- Returning device to service
- Documenting calibration

Achievement Criteria
Performance: The learner will be evaluated on the ability to:
  - Assess flow installations to confirm best practices
  - Calibrate and service flow measuring devices

Conditions: As part of practical lab tasks, given the required tools and materials

Criteria: Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): E  PNEUMATIC AND HYDRAULIC SYSTEMS
Competency: E4  Install and maintain signal conditioners

Objectives
To be competent in this area, the individual must be able to:
• Calibrate and service signal conditioners to process requirements.

LEARNING TASKS
1. Examine signal conditioners and their operation
   • Pneumatic relays
     o Signal converters
     o Volume boosters
   • I/P, P/I transducers
   • Hardware and software
     o E.g., high select, function block
   • Square root extraction
   • Integrators

2. Calibrate and service signal conditioners
   • Manufacturers’ specifications for installation
     o E.g., Moore Industries, Fisher 846, Rosemount

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
• Calibrate and service signal conditioners
Conditions     As part of practical lab tasks, given the required tools and materials
Criteria      Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): E  PNEUMATIC AND HYDRAULIC SYSTEMS
Competency: E5  Install and service control devices for hydraulic systems

Objectives
To be competent in this area, the individual must be able to:
• Explain the types of hydraulic equipment, its specifications and hazards
• Diagnose control devices for different types of hydraulic equipment

LEARNING TASKS
1. Examine hydraulic specifications and hazards
   • Contamination
     o Types
     o Sources
   • Fluid cleanliness standards
   • Filter media
     o Types
     o Ratings
     o Selection
     o Lifespan
     o Housing selection
   • Filter location
   • Fluid analysis

2. Examine different types of hydraulic equipment
   • Types
     o Pumps
     o Relays
     o Regulators
   • Components
     o Seals
     o Spring
     o Pistons

3. Diagnose control devices for hydraulic systems
   • Cleaning
     o Solvents
     o Brushes
   • Connections
     o To system
     o Defective
   • Repair
   • Valves
   • Pumps
   • Sensors
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Diagnose hydraulic control systems

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): F ELECTRICAL AND ELECTRONIC SYSTEMS
Competency: F4 Apply principles of electronics

Objectives
To be competent in this area, the individual must be able to:
• Install and service electronic equipment to manufacturers’ specifications.

LEARNING TASKS
1. Examine electronic equipment and its operation
   • Analog and digital
   • Discrete components and their operation
     o Transistors
     o Op amps
     o Diodes
     o Zener diodes
   • Power supplies
     o Half and full wave rectified
     o Switching
     o Bridges
     o Filtering
     o UPS systems

2. Install and troubleshoot electronic equipment
   • Select equipment
     o Application
     o Components
   • Select/install wiring
     o Current loops
     o Wiring – 2, 3 and 4 wire transmitters
     o I/I
     o Ground loops
     o Manufacturer’s specifications
   • Connect to system
   • Adjust settings
   • Creating and updating loop drawings and documentation
3. Service electronic equipment

**CONTENT**

- Isolate equipment
- Repair/replacement methods and equipment
  - Oscilloscope (Scope meter)
  - Multimeter
  - Logic probe
- Electronic assemblies
  - Troubleshooting to board level
    - Power supply
    - Input conditioning
    - Signal manipulation
    - Output circuit
    - Back plane
  - Board replacement procedures
    - Ground strap
    - Power down and Power Up
- Cleaning methods

**Achievement Criteria**

**Performance** The learner will be evaluated on the ability to:
- Troubleshoot electronic equipment to board level

**Conditions** As part of practical lab tasks, given the required tools and materials

**Criteria** Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): G FINAL CONTROL ELEMENTS
Competency: G2 Service, size and install control valves and actuators

Objectives
To be competent in this area, the individual must be able to:
• Determine the sizing and selection of control valves and actuators.

LEARNING TASKS
1. Examine sizing and selection of actuators
   • Size and force required by process conditions
2. Examine sizing and selection of control valves
   • Defining Cv
   • Flow characteristics
     o Quick opening
     o Equal percentage
     o Linear
   • Process requirements
     o Medium (Liquid/ gas/steam)
     o Pressure
     o Flow
     o Temperature
     o Viscosity
     o TDH (Total Dynamic Head) and NPSH (Net Positive Suction Head)
       – Correlating pump curve
   • Flashing/Cavitation
   • Noise suppression
   • Sizing for maximum ∆P allowable
3. Select the correct valve type and size for given process applications
   • Perform sizing calculations (Liquid/ gas/steam)
     o Manual (nomograph)
   • Valve sizing software

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Select correct valve type and size for given process applications
Conditions As part of practical lab tasks, given the required tools and materials
Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC):  G  FINAL CONTROL ELEMENTS  
Competency:  G3  Install and service valve positioners (includes advanced diagnostics)  

Objectives  
To be competent in this area, the individual must be able to:  
• Explain the advanced diagnostics and operational capabilities of Smart Positioners.  
• Install, configure and service smart valve positioners.  

LEARNING TASKS  
1. Examine advanced diagnostics and operational capabilities of Smart positioners  
   • Determining valve and actuator health  
     o Stiction  
     o Friction  
     o Hysteresis  
     o Duty cycles  
     o Strokes  
     o Travel  
     o Time near closed  
     o Time near open  
     • History  
     • Alarming  
     • Control system interface  
     • Offline diagnostic testing  
   2. Install and service smart valve positioners  
   • Mounting  
   • Connecting to actuator  
   • Connecting to process control system  
   • Configuring  
     o Set stroke  
     o Set pressures  
     o Match to actuator  
     o Autotune  
   • Calibrating  
     o Connecting calibration and configuration instruments  
     o Calibration parameters  
     o Interpretation of calibration results  
     o Cause/effect of calibration errors
LEARNING TASKS

CONTENT
- Component maintenance
  - Remove
  - Replace
  - Repair
  - Clean
- Returning to service

Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  - Install, configure and service smart valve positioners

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Level 3

Industrial Instrument Mechanic
Line (GAC): A  OCCUPATIONAL SKILLS
Competency: A2  Organize work and maintain records

Objectives
To be competent in this area, the individual must be able to:
• Estimate labour and material and complete work-related documentation.

LEARNING TASKS
1. Examine and determine standard work requirements
   • Materials
   • Equipment and tools
   • Personnel
   • Task planning
     o Hazard assessment
   • Work scheduling

2. Examine and apply related skills
   • Estimating
     o Time
     o Cost
     o Materials
     o Manpower needed
   • Identifying/organizing
     o Tools
     o Equipment

3. Examine, maintain and update types of trade related documentation
   • Calibration sheets
   • Data sheets
   • Work orders
   • Log entries
   • Permits
   • SOP (Standard Operating Procedure)
   • Management of Change Documentation
     o Instrument change
     o Range change
     o Process change
   • Maintenance schedules
     o Preventative
     o Predictive
     o Reliability centered
   • Related software
     o Spreadsheets
     o Databases
   • Word processing
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Estimate labour and material requirements and complete work-related documentation

Conditions   As part of practical lab tasks, given the required tools and materials

Criteria     Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): A OCCUPATIONAL SKILLS
Competency: A3 Use computers and related applications

Objectives
To be competent in this area, the individual must be able to:
- Configure and program Level 3 instrumentation devices to manufacturers’ specifications given related hardware, software and firmware.

LEARNING TASKS

1. Examines diagnostic and configuration software, hardware and firmware
   - Configuration and programming software used in Level 3
     - E.g., Autocad, valve sizing software, HMI

2. Uses diagnostic and configuration software, hardware and firmware
   - Configuration and programming software used in Level 3
     - E.g., Autocad, valve sizing software, HMI

3. Maintains back-up data and documentation
   - Configuration and programming software used in Level 3
     - E.g., Autocad, valve sizing software, HMI

Achievement Criteria
Performance The learner will be evaluated on the ability to:
- Use Level 3 configuration and programming software, hardware and firmware

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Program Content
Level 3

Line (GAC): A OCCUPATIONAL SKILLS
Competency: A6 Use trade related schematics and drawings

Objectives
To be competent in this area, the individual must be able to:
• Use schematics and drawings related to instrumentation.

LEARNING TASKS
1. Examine types of schematics and drawings
   • P&ID, SAMA, isometric and orthographic drawings
   • Loop drawings

2. Examine symbols and conventions
   • P&ID, SAMA, isometric and orthographic drawings
   • Loop drawings

3. Use and develop schematics and drawings
   • P&ID/P&C drawings
   • Loop drawings

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Use applicable Level 3 drawings and schematics

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
**Line (GAC):** B  MEASURING AND INDICATING DEVICES

**Competency:** B8  Measure consistency and viscosity

**Objectives**
To be competent in this area, the individual must be able to:
- Confirm installation, calibrate and service consistency and viscosity measuring devices to process requirements.

**LEARNING TASKS**

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>LEARNING TASKS</th>
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</table>
| 1. Examine consistency and viscosity measuring devices and their operation | • Types (analog and Smart)  
  - Optical  
  - Rotary  
  - Blade  
  - Microwave  
  - Nuclear  
  - Viscometer  
| | • Factors affecting system performance  
  - Temperature  
  - Flow  
  - Vibration  
  - Pressure  
  - Process considerations |
| 2. Examine instruments and techniques used to calibrate consistency and viscosity measuring devices | • Multimeters  
| | • Calibrated weights  
| | • Sampling/lab tests  
| | • Manufacturers’ specifications  
| | • Selection/location factors  
  - Accuracy requirements  
  - Process application  
  - Process medium  
  - Cost  
  - Best practices  
| 3. Calibrate and service consistency measuring devices | • Verify operation  
| | • Calibration parameters  
| | • Device check/calibration  
| | • Interpretation of calibration results  
| | • Cause/effect of calibration error  
| | • Device adjustments  
| | • Repair/replace device components  
| | • Returning device to service  
| | • Documenting calibration |
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Assess consistency measuring installations to confirm best practices
  • Calibrate and service consistency and viscosity measuring devices

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): B MEASURING AND INDICATING DEVICES
Competency: B10 Measure vibration

Objectives
To be competent in this area, the individual must be able to:
• Calibrate and service vibration measuring devices using a vibration monitoring system.

LEARNING TASKS

1. Examine vibration measuring devices
   • Probes
   • Proximitors
   • Transmitters

2. Examine the installation, calibration and servicing requirements of vibration measuring devices
   • Manufacturers’ recommended maintenance procedures
   • Maintenance actions
   • Identifying cause of calibration errors
   • Repair and cleaning of device

3. Service vibration monitoring system
   • Test and set up vibration monitoring system on operating process equipment

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Calibrate and service vibration measuring devices

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): B MEASURING AND INDICATING DEVICES
Competency: B11 Measure speed

Objectives
To be competent in this area, the individual must be able to:
• Explain the servicing requirements of speed measuring devices.

LEARNING TASKS
1. Examine relevant laws & principles of physics
2. Examine speed measuring devices and their applications
3. Examine the installation, calibration and servicing requirements of speed measuring devices

CONTENT
• Speed
• Velocity
• Speed measuring devices
  o Tachometers
  o Probes
  o Proximitors
  o RPM counters
  o Strobe lights
• Applications
  o Belt weightometers
  o Belt slippage
  o Governors
  o Radar gun
  o Interlock
  o Overspeed trips
• Manufacturers’ recommended maintenance procedures
• Maintenance actions
• Identifying cause of calibration errors
• Repair and cleaning of device
Line (GAC): B  MEASURING AND INDICATING DEVICES
Competency: B12  Measure position

Objectives
To be competent in this area, the individual must be able to:
• Explain the servicing requirements of position measuring devices.

LEARNING TASKS
1. Examine position measuring devices and their applications

CONTENT
• Analog position sensors
  o LVDT
    ▪ E.g. Temposonic rods
  o Proximity switches
  o Proximity probes
  o Analog position sensors
  o Lasers
  o GPS

• Examples of industrial applications
  o Pulp and paper
  o Oil and gas
  o Mining
  o Food Industry

2. Examine the installation, calibration and servicing requirements of position measuring devices

CONTENT
• Manufacturers’ recommended maintenance procedures
• Maintenance actions
• Identifying cause of calibration errors
• Bringing device within calibration parameters
• Repair and cleaning of device
Line (GAC): B MEASURING AND INDICATING DEVICES
Competency: B13 Measure motion

Objectives
To be competent in this area, the individual must be able to:
• Explain the servicing requirements of motion measuring devices.

LEARNING TASKS
1. Examine motion measuring devices and their applications

   • Types
     o Torque switches
     o Proximity switches
     o Proximity probes
     o Analog position sensors
     o Camera

   • Applications
     o Security
     o Safety
     o Monitoring rig torque

2. Examine the installation, calibration and servicing requirements of motion measuring devices

   • Manufacturers’ recommended maintenance procedures
   • Maintenance actions
   • Identifying cause of calibration errors
   • Bringing device within calibration parameters
   • Repair and cleaning of device
Line (GAC): C ANALYTICAL INSTRUMENTATION
Competency: C2 Measure analytical properties of process liquids

Objectives
To be competent in this area, the individual must be able to:
• Calibrate and service process liquid analyzers to process requirements.

LEARNING TASKS
1. Examine process liquid analyzers
   • pH
     o Measuring electrode
     o Reference electrode
     o FET
   • Conductivity
     o 2 electrode
     o 4 electrode
     o Torroidal
   • ORP
   • Specific ion
   • Dissolved oxygen
   • Turbidity
   • Water/effluent treatment
     o BOD (Biological Oxygen Demand)
     o COD (Chemical Oxygen Demand)
     o Silica
     o Sodium
     o Residual Chlorine
   • X-ray Fluorescence
2. Examine process liquid analyzer operational theory and operating parameters
   • Non-linear scale
   • Temperature effects/compensation
   • Accuracy
   • Repeatability
   • Interaction with process
   • Sources of contamination
   • Sampling systems
   • Conditions required
LEARNING TASKS
3. Calibrate and service process liquid analyzers

CONTENT
- Manufacturers’ specifications
- Selection/location factors
  - Measurement delays
  - Chemical mixing
  - Temperature requirements
- Connection to control system or indicator
- Configuration of devices
- Calibration of devices
  - Buffering solutions
  - Calibration standards

Achievement Criteria
Performance The learner will be evaluated on the ability to:
- Calibrate and service process liquid analyzers

Conditions As part of practical lab tasks, given the required tools, materials and live process equipment

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): C  ANALYTICAL INSTRUMENTATION
Competency: C3  Measure analytical properties of process solids

Objectives
To be competent in this area, the individual must be able to:
• Explain the theory and operating parameters of process solids analyzers.

LEARNING TASKS

1. Examine types of process solids analyzers
   • Nuclear devices
   • Assays
   • Moisture content
   • X-ray devices
   • Near infra-red

2. Examine methods used by process solids analyzer
   • Online
     o Material handling considerations
     o Interface with system
   • Offline/lab Test
     o Sample/weigh/dry/weigh
     o Chemical theory
   • Standards
     o ASTM

3. Examine operating parameters of process solids analyzers
   • Accuracy
   • Repeatability
   • Interaction with process
   • Sources of contamination
   • Sampling systems
   • Conditions required
   • Method used

4. Examine other process analyzers
   • Brightness
   • Paper sheet scanners
   • Kappa (K#) analyzers
   • Sulfidity
   • Crossbelt analyzers
     o E.g., Gamma matrix
Line (GAC): E PNEUMATIC AND HYDRAULIC SYSTEMS

Competency: E3 Install and Service Pneumatic Instruments

Objectives
To be competent in this area, the individual must be able to:
• Align pneumatic controllers.

LEARNING TASKS
1. Examine pneumatic controllers
   • Force balance
   • Motion balance

2. Align pneumatic controllers
   • Input/output calibration
   • Temperature and pressure inputs
   • Indication calibration
   • Controller alignment and service
   • Auto/manual transfer stations

Achievement Criteria:
Performance The learner will be evaluated on the ability to:
• Align pneumatic controllers

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Objectives
To be competent in this area, the individual must be able to:
• Configure and test VSD and VFD.

LEARNING TASKS
1. Examine basic operation of VSD and VFD
   • Operation
     o Tuning parameter identification
     o Signal isolation DCS/VFD
   • Control of speed
     o ECC (Eddy Current Coupling)
     o Hydraulic speed control
     o Input signals (digital and analog)

2. Test operation of a VSD/VFD
   • Set up and test a VSD/VFD

3. Examine interaction of PID tuning and VSD configuration
   • PID control in PLC/DCS with configuration parameters in VSD

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Configure and test VSD and VFD

Conditions As part of practical lab tasks, given the required tools, materials and load

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry and the learner must achieve a minimum grade of 70%
Line (GAC): H  COMMUNICATIONS NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H1 Examine communication systems

Objectives
To be competent in this area, the individual must be able to:
• Explain the features and limitations on specified communication protocols.

LEARNING TASKS
1. Examine types of signal transmission systems
   - Fibre optics
     • Armoured cable
     • Non armoured cable
     • Multimode/single mode transmission
   - Wired
     • Coax
     • UTP
   - Wireless
     • Satellite
     • Cellular
     • Blue tooth
     • RF
     • IR
     • IEEE standards

2. Examine features and limitations of communication protocols
   • Types of protocols
     • RS232
     • RS422/485
     • MODBUS
     • MODBUS+
     • ASi BUS
     • Device Net
     • Profibus
     • Highway Addressable Remote Transducer (HART)
     • FSK (Frequency Shift Keying)
     • Foundation Fieldbus
     • Spread spectrum
     • Ethernet TCP/IP
   • Addressing methods and components
   • Potential sources of interference
   • Related standards, codes, licenses
Line (GAC): H COMMUNICATIONS NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H3 Examine communication network structures and components

Objectives
To be competent in this area, the individual must be able to:
• Explain the basic structures and components of communication networks.

LEARNING TASKS
1. Examine hardware layers

CONTENT
• Network switches (routers)
  o Configurable
  o Nonconfigurable
  o Firewalls
  o Hubs

• Gateways
  o Protocol interface
  o Media interface
  o Network isolation

• Hardware topologies
  o Rapid spanning tree
  o Self-healing rings
  o Star

2. Examine network connectors

CONTENT
• Types of connectors
  o USB
  o Firewire
  o 9 pin, 25 pin serial port
  o RJ45
  o RJ11
  o M12
  o M10
  o BNC
  o Cannon plugs

• Resistance and Environmental Standards
  o IP standards (IP67)
Line (GAC): H COMMUNICATIONS NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H4 Troubleshoot signal transmission systems

Objectives
To be competent in this area, the individual must be able to:
• Troubleshoot malfunctioning signal transmission systems to operational requirements.

LEARNING TASKS

1. Troubleshoot wired signal transmission systems

   • Current loops
     o 4-20 mA loops (HART)
   • Digital buses (at least one of the following):
     o Foundation Fieldbus
     o Profibus
     o Device net
   • Software configuration
     o FDT (Field Device Tool)
   • Performing system diagnostics
   • Troubleshooting installation problems/deficiencies
     o Testing cable
     o Manipulating process to allow for servicing
     o Removing/replacing components
   • Upgrading software and firmware
   • Signal strength requirements
     o Batteries
   • Potential causes of interference
   • Performing system diagnostics
   • Troubleshooting installation problems/deficiencies
     o Manipulating process to allow for servicing
     o Removing/replacing components
   • Networks
     o Line of sight
     o Spanning tree
     o Interface to DCS

2. Troubleshoot wireless signal transmission systems

   • Signal strength requirements
     o Batteries
   • Potential causes of interference
   • Performing system diagnostics
   • Troubleshooting installation problems/deficiencies
     o Manipulating process to allow for servicing
     o Removing/replacing components
   • Upgrading software and firmware
   • Networks
     o Line of sight
     o Spanning tree
     o Interface to DCS
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
   • Troubleshoot wired and wireless signal transmission systems

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): I CONTROL SYSTEMS
Competency: I1 Examine fundamental theories of process operation and equipment

Objectives
To be competent in this area, the individual must be able to:
• Explain the basic operation of common industrial processes.
• Calibrate and tune industrial control loops.
• Diagnose process control problems on a live process.

LEARNING TASKS
1. Examine common industrial processes
   • Basic oil & gas field processes
     o Raw gas processing
     o Compression
     o Dehydration
   • Material handling/quality control
     o Pulp consistency control process
   • Separation
     o Magnets
     o Screening
     o Centrifugal
     o Electrostatic
   • Concrete plant
   • Food
   • Pharmaceuticals
   • Chemical reaction
     o pH
     o Electrolytic
     o Water and waste water treatment
   • Evaporation
   • Flotation

2. Calibrate and tune industrial instrumentation for common industrial processes
   • Multiple effect evaporation
   • Material handling/quality control
     o Pulp consistency control process
   • Chemical reaction
     o E.g. pH
     o E.g. Conductivity
LEARNING TASKS
3. Operate processes and troubleshoot control problems.

CONTENT
- Multiple effect evaporation
- Material handling/quality control
  - Pulp consistency control process
- Chemical reaction
  - E.g., pH
  - E.g., Conductivity

Achievement Criteria

Performance  The learner will be evaluated on the ability to:
- Calibrate and tune industrial control loops
- Diagnose process control problems on a live process

Conditions  As part of practical lab tasks, given the required tools, materials and live process equipment

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC):  I CONTROL SYSTEMS
Competency:  I2 Examine control theory

Objectives
To be competent in this area, the individual must be able to:
• Explain basic control theory, actions and operational modes.

LEARNING TASKS

1. Examine basic control theory
   • Set point/process variable/manipulated variable
   • Relation of output to input
   • Steady state value and dynamic component
   • Control loop gains/loop stability

2. Examine control modes
   • On/Off control
   • Differential Gap
   • Proportional only
   • Integral only
   • Proportional plus Integral
   • PID-Proportional, Integral, Derivative
     o Reset rate/reset time
     o Series/parallel
     o Interactive/non-interactive/rate
       on PV

3. Examine controller action
   • Direct acting
   • Reverse acting

4. Examine controller operating modes
   • Automatic
   • Manual
   • Remote
   • Local
   • Supervisory
Line (GAC): I CONTROL SYSTEMS  
Competency: I3 Examine process control techniques and strategies

Objectives
To be competent in this area, the individual must be able to:
- Explain control techniques and strategy applications to different processes.

**LEARNING TASKS** | **CONTENT**
---|---
1. Examine control techniques | • Loop tuning  
  o Zeigler Nicholls  
  o Lambda  
  o Tuning from manual output changes  
2. Examine basic control strategies | • Feedback control  
  • Feedforward indexed control  
  • Cascade control  
  • Gap action control  
  • Duplex control  
  • Auto select control
### Objectives
To be competent in this area, the individual must be able to:
- Implement process control strategies.

### LEARNING TASKS

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<th>CONTENT</th>
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<tbody>
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<td>o 2 mode</td>
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<td>o 3 mode</td>
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<tr>
<td>• Implementation on live processes</td>
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<tr>
<td>• Upset recovery</td>
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</table>

### Achievement Criteria

**Performance**
The learner will be evaluated on the ability to:
- Configure and tune industrial control loops
- Diagnose process control problems on a live process

**Conditions**
As part of practical lab tasks, given the required tools, materials and live process equipment

**Criteria**
Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
**Program Content**  
**Level 3**

**Line (GAC):**  I  
**Competency:**  I7  
**Install, configure, maintain and service programmable logic controllers (PLCs)**

**Objectives**

To be competent in this area, the individual must be able to:
- Program PLC in ladder logic.
- Troubleshoot various PLCs, given appropriate instructional materials.

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<thead>
<tr>
<th>LEARNING TASKS</th>
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<tr>
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<td>IEC Standard 1131-3 Programming Languages</td>
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<td>o Structured Text (ST)</td>
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<td>o Ladder Diagram (LD)</td>
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<td>o Function Block Diagram (FBD)</td>
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<td>o Sequential Function Chart (SFC)</td>
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</tbody>
</table>

2. Examine and troubleshoot industrial PLC installations

3. Examine and troubleshoot PLC components

4. Back up and document PLC data for future recovery

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<tbody>
<tr>
<td></td>
<td>Hardware</td>
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<td>Assembly</td>
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<td>Programming</td>
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<td>CPU</td>
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<td>Memory organization</td>
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<td>Input interface</td>
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<td></td>
<td>Output interface</td>
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<td></td>
<td>Power supply</td>
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<td></td>
<td>Programming/monitoring interface</td>
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<td>Network communication module</td>
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<td>Back up and document programming</td>
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<td></td>
<td>- Configuration</td>
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<tr>
<td></td>
<td>- Settings</td>
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<td></td>
<td>- Parameters</td>
</tr>
</tbody>
</table>
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
- Program PLC in ladder logic
- Troubleshoot PLC industrial installations and components

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): I  CONTROL SYSTEMS
Competency: I8  Install, configure, maintain and service human machine interface (HMI)

Objectives
To be competent in this area, the individual must be able to:
• Program HMI software to communicate with a PLC or DCS.

LEARNING TASKS

1. Examine HMI
   • Software/hardware design and capability
   • Compatibility with other process control systems
   • Communication networks and protocols
   • Tag descriptors and addressing
   • Consistency issues in programming
   • Alarm priorities
   • Read/write issues
   • Access/security issues
   • Communications systems used
   • Interaction with PLC, DCS

2. Program HMI software
   • Program graphical representation of a process
   • Program HMI software to communicate with a PLC
   • Build HMI software to interface with PID control and motor control in PLC

3. Back up and document HMI data for future recovery
   • Back up and document programming
     o Configuration
   • Communication settings

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
• Program HMI software to communicate with a PLC or DCS

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Level 4

Industrial Instrument Mechanic
Line (GAC): A OCCUPATIONAL SKILLS
Competency: A3 Use computers and related applications

Objectives
To be competent in this area, the individual must be able to:
• Configure and program Level 4 instrumentation devices to manufacturers’ specifications given related hardware, software and firmware.

LEARNING TASKS
ACTION
1. Examines diagnostic and configuration software, hardware and firmware
2. Uses diagnostic and configuration software, hardware and firmware

CONTENT
• Configuration and programming software used in Level 4
• Configuration and programming software used in Level 4

Achievement Criteria
Performance
The learner will be evaluated on the ability to:
• Use software to configure and program hardware and firmware used in Level 4

Conditions
As part of practical lab tasks, given the required tools and materials

Criteria
Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Objectives
To be competent in this area, the individual must be able to:
• Create basic schematics and drawings.

LEARNING TASKS
1. Create and modify basic drawings

CONTENT
• Electronic drawing
  o E.g., Autocad
• P&ID and SAMA drawings
• Loop drawings

Achievement Criteria:
Performance The learner will be evaluated on the ability to:
• Produce a loop sheet drawing
Conditions As part of practical lab tasks, given the required tools and materials
Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Objectives
To be competent in this area, the individual must be able to:
• Install, configure and calibrate monitoring devices to process safety requirements.

LEARNING TASKS
1. Examine types of hazardous gases and particulates to be monitored
   • Classes and groups of gases
   • Terms and definitions for hazardous gases
     o LEL/HEL (Low/High Explosive Limit)
     o PEL (Personnel Exposure Limit)
   • Monitored Gases
     o H2S
     o CO
     o Cl2
     o SOX
     o NOX
     o TRS (Total Reduced Sulphur)
   • Particulates
   • Protection
     o Personnel
     o Equipment
     o Environment

2. Examine types of detection equipment for hazardous gases
   • Infrared
   • Catalytic bead
   • Electro-chemical cell
   • Lead acid strip
   • Other technologies

3. Examine operation of monitoring systems
   • Acceptable limits
   • Accuracy limitations
   • Shut down
     o Procedures
     o Actions
     o Implications
LEARNING TASKS

4. Install, configure and calibrate monitoring devices

CONTENT

- Manufacturers’ specifications
- Selection/location factors
- Connection to control system or indicator
- Configuration of devices
- Alarming methods
- Calibration of devices
  - Laptop/software
  - Test gas selection and storage
- Documenting calibration

Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  - Calibrate and service environmental monitoring devices

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Objective
To be competent in this area, the individual must be able to:
• Explain, calibrate and service gas chromatographs.

LEARNING TASKS

1. Examine gas chromatographs
   - Gas analysis
   - Methane, Ethane, Propane, Butane, etc.
   - Sulfur species

2. Examine gas chromatograph operational theory
   - Chromatography
   - FID (Flame Ionization detector)
   - PID (Photo Ionization detector)
   - Thermal Conductivity detector

3. Examine operating parameters of gas chromatographs
   - Accuracy
   - Repeatability
   - Interaction with process
   - Sources of contamination
   - Sampling systems
   - In situ
   - Extractive
   - Conditions required

4. Examine the installation, calibration and servicing of process gas chromatographs
   - Manufacturers’ specifications
   - Selection/location factors
   - Connection to control system or indicator
   - Configuration of devices
   - Alarming methods
   - Calibration of devices
   - Laptop/software
   - Test gas selection and storage
### LEARNING TASKS

5. Calibrate and service gas chromatographs

### CONTENT

- Manufacturers’ specifications
- Selection/location factors
- Connection to control system or indicator
- Configuration of devices
- Alarming methods
- Calibration of devices
  - Laptop/software
- Test gas selection and storage

### Achievement Criteria

**Performance**  The learner will be evaluated on the ability to:
- Calibrate and service a process gas chromatograph

**Conditions**  As part of practical lab tasks, given the required tools and materials

**Criteria**  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): C  ANALYTICAL INSTRUMENTATION
Competency: C4  Measure analytical properties of flue gases

Objectives
To be competent in this area, the individual must be able to:
- Explain, calibrate and service flue gas analyzers.

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<td>1. Examine flue gas analyzers</td>
<td>• Online flue gas analyzers</td>
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<td>o Excess oxygen</td>
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<td>o CO</td>
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<td>o Particulate/opacity</td>
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<td>o TRS</td>
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<td>o NOX</td>
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<td>o SOX</td>
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<td>• Lab tests</td>
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<td>o Orsat</td>
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<td>o Fyrite</td>
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<td>2. Examine flue gas analyzer operational theory</td>
<td>• Thermo-paramagnetic</td>
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<td>• Zirconium oxide</td>
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<td>• Catalytic combustibles detector</td>
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<td>• Infrared laser</td>
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<td>3. Examine operating parameters of flue gas analyzers</td>
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<td>o Close-coupled extractive</td>
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<td>4. Calibrate and service process flue gas analyzers</td>
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<td>• Test gas selection and storage</td>
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</table>
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Calibrate and service flue gas analyzers

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC):        D SAFETY AND PROCESS MONITORING SYSTEMS
Competency:       D1 Service and test flame safety systems

Objectives
To be competent in this area, the individual must be able to:
• Troubleshoot flame detection equipment.
• Service flame safety systems.

LEARNING TASKS

1. Examine flame detection equipment
   • Ultraviolet
   • Infrared
   • Magnetic
   • Rate of rise
   • Heat sensors (thermopile)
   • Ionic

2. Examine operation of flame safety systems
   • Acceptable limits
     o BC Safety Authority regulatory requirements
   • Accuracy
   • Shut down
     o Procedures
     o Actions
     o Implications
   • Applications
     o BMS
     o Flare stacks

3. Troubleshoot flame detection equipment
   • Manufacturers’ specifications and recommendations
   • Selecting required equipment
   • Connecting to process/indicator
   • Configuring
   • Calibrating
   • Alarming

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Troubleshoot flame detection equipment
• Troubleshoot Burner Management Systems (BMS)

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): D  SAFETY AND PROCESS MONITORING SYSTEMS
Competency: D2  Install and service process cameras

Objectives
To be competent in this area, the individual must be able to:
• Explain the operation of process cameras and their applications.

LEARNING TASKS
1. Examine process camera applications

   • Leak monitoring
   • Fire monitoring
   • Intruder alert
   • Remote monitoring
     o Process control
     o Quality control
   • Safety
   • Analog and Digital
   • Manufacturers’ specifications and recommendations
   • Selecting required equipment
   • Connecting to process/indicator
   • Configuring
   • Calibrating
   • Alarming

2. Examine the operation of process cameras
Line (GAC): D  SAFETY AND PROCESS MONITORING SYSTEMS
Competency: D3  Service ESD (emergency shutdown devices)

Objectives
To be competent in this area, the individual must be able to:
• Explain the types of Emergency Shutdown Devices (ESD), their purposes and testing procedures.

LEARNING TASKS
1. Examine types of ESD control systems
   • Levels of shutdown
     o Equipment shutdown
     o Area shutdown
     o Total/Plant shutdown
   • Types of ESD
     o Electric
     o Pneumatic
     o Hydraulic
     o Mechanical

2. Examine purposes of different types of ESD
   • Personnel protection
   • Environmental protection
   • Equipment protection

3. Examine ESD testing procedures
   • Partial Stroke test
   • Time test
   • Valve integrity
   • Interlock checks (system shut down check)
Line (GAC): H COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H5 Install, Configure, Maintain and Service Supervisory Control and Data Acquisition (SCADA) systems

Objectives
To be competent in this area, the individual must be able to:
• Explain SCADA protocols, configurations, equipment and servers.
• Program and service SCADA systems.

LEARNING TASKS
1. Examine types of SCADA protocols and configurations
   • Applications
     o Custody transfer
       - AGA/API calculations
   • Online history
   • Remote equipment operation
   • Time synchronization and time stamping
   • Network layout
     o Protocols
     o Host
     o Field
   • Addressing methods
   • Configuration licensing

2. Examine types of SCADA equipment and servers for data acquisition and storage
   • Radio Telemetry Units (RTU)
   • Wireless communications systems
     o Cellular
     o Satellite
     o Radio

3. Service SCADA systems
   • Manipulating process to allow for servicing
   • Alerting operations
   • Transferring from automatic to manual
   • Awareness of impact on process
   • Maintaining on site software/firmware revisions and data backups
   • Performing system diagnostics
   • Testing SCADA components
   • Maintaining host integrity
   • Installation problems and deficiencies
   • Develop logic strategies
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  • Program and service SCADA systems

Conditions   As part of practical lab tasks, given the required tools and materials

Criteria    Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): I CONTROL SYSTEMS
Competency: I1 Examine fundamental theories of process operation and equipment

Objectives
To be competent in this area, the individual must be able to:
- Explain the operation of common industrial processes using advanced control strategies.
- Calibrate and tune industrial control loops.
- Diagnose process control problems on a live process.

LEARNING TASKS

1. Examine industrial instrumentation for advanced control systems with industrial processes
   - Steam generation (boilers)
   - Batch process
     - Digester
   - Distillation
     - Fractionation
     - Binary tower
     - Cryogenic
     - LNG

2. Calibrate and tune industrial instrumentation for advanced control systems with industrial processes
   - Steam generation (boilers)
   - Batch process
     - Digester
   - Distillation
     - Fractionation
   - Binary tower

3. Operate processes and troubleshoot advanced control systems
   - Steam generation (boilers)
   - Batch process
     - Digester
   - Distillation
     - Fractionation
   - Binary tower

Achievement Criteria
Performance The learner will be evaluated on the ability to:
- Calibrate and tune industrial control loops
- Diagnose process control problems on a live process

Conditions As part of practical lab tasks, given the required tools, materials and live process equipment

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
**Program Content**

**Level 4**

**Line (GAC):**  I  **CONTROL SYSTEMS**

**Competency:**  I4  Implement process control strategies

**Objectives**

To be competent in this area, the individual must be able to:
- Implement advanced process control strategies.

**LEARNING TASKS**

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</table>

**Achievement Criteria**

**Performance**
The learner will be evaluated on the ability to:
- Implement and tune advanced process control strategies

**Conditions**
As part of practical lab tasks, given the required tools, materials and live process equipment

**Criteria**
Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): I CONTROL SYSTEMS
Competency: I5 Install and service stand-alone controllers

Objectives
To be competent in this area, the individual must be able to:
• Install, configure and service stand-alone controllers for various control strategies.

LEARNING TASKS

1. Examine stand-alone controllers
   • Microprocessor
     o Single loop
     o Cascade loop
   • I/O
     o HART
     o Electronic
   • Installation requirements
     o Ambient temperature
     o Area classification

2. Configure stand-alone controller
   • Maintenance
   • Configuration
     o Techniques
     o Tools
     − Hand held programmers
     − Software

Achievement Criteria
Performance The learner will be evaluated on the ability to:
• Configure stand alone controllers for various control strategies

Conditions As part of practical lab tasks, given the required tools and materials

Criteria Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC):  I  CONTROL SYSTEMS
Competency:  I6  Install, configure, maintain and service Distributed Control Systems (DCS)

Objectives
To be competent in this area, the individual must be able to:
• Configure DCS equipment.

LEARNING TASKS
1. Examine DCS
   • DCS
     o E.g., Emerson, Schnieder, Honeywell
     • System configuration
     • LAN communication protocols
     • Hardware components
     • Configuration software
     • Troubleshooting
     • Operator console and diagnostic tools
       o Analog and discrete input and output signals
       o Tunable parameters in software blocks
     • SIS systems

2. Configure DCS
   • Build and troubleshoot a cascade control system (including operator interface graphics)
   • Configure and troubleshoot analog inputs, analog outputs, control loops and pump stop/start

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
• Configure and troubleshoot a DCS

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): I  CONTROL SYSTEMS
Competency: I7 Install, configure, maintain and service programmable logic controllers (PLCs)

Objectives
To be competent in this area, the individual must be able to:
• Configure and troubleshoot PLCs.

LEARNING TASKS
1. Configure PLC
   • Configuration of analog control strategies using a minimum of two of the following IEC 1131 standard protocols:
     - FBD
     - ST
     - IS
     - SFC
   • Software interface
   • Operation
   • Troubleshooting
   • SIS systems

2. Back up and document PLC data for future recovery
   • Back up and document programming
     - Configuration
     - Settings
     - Parameters

Achievement Criteria
Performance  The learner will be evaluated on the ability to:
• Configure a PLC

Conditions  As part of practical lab tasks, given the required tools and materials

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Line (GAC): I CONTROL SYSTEMS
Competency: I9 Install and demonstrate knowledge of advanced supervisory control systems

Objectives
To be competent in this area, the individual must be able to:
• Explain and demonstrate process optimization for an advanced supervisory control system.

LEARNING TASKS
1. Examine batch process control

2. Examine Batch Process Control and compare to other control applications and strategies

3. Examine batch process control software in use

4. Examine and tune boiler control systems

5. Examine other advanced supervisory control systems

6. Examine and diagnose safety instrumented systems (SIS)

CONTENT
• Operation and application of Batch Process Control
• Continuous
• Discontinuous
• DCS and PLC
• Applications (examples)
  o Batch pulp digester process
  o Concrete plant
  o Oil pipeline transmission
  o Chemical industry
  o Food plant

• Combustion control systems
  o Parallel open/closed loop
  o Cross limited
    – Application of excess oxygen trim control
• Plant master VS boiler master controls
• Application of feedforward control indexing to plant master pressure controller
• Steam temperature attemporator
• Conventional desuperheater control
• 2,3 and 5 element drum level control
• Balanced draft furnace pressure control
  o FD and ID fans

• Predictive control techniques
  o Smith Predictors
  o MPC

• SIL levels
• Voting structures
• Documentation
Achievement Criteria

Performance  The learner will be evaluated on the ability to:
  •  Tune boiler control systems

Conditions  As part of practical lab tasks, given the required instrumentation, tools, materials and live process equipment

Criteria  Tasks must be performed within specifications, safety standards and time frames acceptable to industry, and the learner must achieve a minimum grade of 70%
Section 4

TRAINING PROVIDER STANDARDS
Instructor Requirements

Occupation Qualification
The instructor must possess:

- Red Seal Qualification as an Instrumentation and Control Technician (Industrial Instrument Mechanic)

Work Experience
A minimum of 5-years’ experience working in the industry as a Journeyperson.

Instructional Experience and Education
It is preferred that the instructor also possesses one of the following:

- Instructors Certificate (minimum 30 hr course)
- Registered in an Instructor's Diploma Program (to be completed within a five year period)
- Bachelor's or Master's degree in Education
- Power Engineering Certificate (4th Class or higher)
- Red Seal qualification as an Industrial or Construction Electrician
Training Provider Standards

Facility Requirements

General Areas
- Cleaning supplies
- Compliance with all local and national fire code and occupational safety requirements
- Adequate lighting
- Heating/air conditioning for comfort all year round
- 120 volt AC

Classroom Area (General Area requirements plus the following)
- Comfortable seating and tables suitable for training, teaching, and lecturing
- Lighting controls to allow easy visibility of projection screen while also allowing students to take notes
- Windows must have shades or blinds to adjust sunlight
- Heating/air conditioning for comfort all year round with room-specific control
- Acoustics in the room must allow audibility of the instructor
- White marking board with pens and eraser
- Projection screen or projection area at front of classroom
- Document camera and/or multi-media projector

Shop Area (General Area requirements plus the following)
- Lifting devices
  - E.g., overhead cranes
- Workbenches with 6" vices
- Instrument air supply

Lab Requirements

All Levels
- Communication and Signal transmission instrumentation and final control equipment
- Measurement recorders and indicators including motion, speed, vibration, position, mass flow, pH, temperature, pressure, weight, level
- Multiple computer stations with interfacing options
- Resource computer with internet access
- Instrument air supply

Level 1
- Shoebox Programmable Logic Controllers (e.g., Omron, Westinghouse, Schneider)

Level 2
- Shoebox Programmable Logic Controllers (e.g., Omron, Westinghouse, Schneider)
- Access to a radiation source that may be used for level or density measurement
Training Provider Standards

Level 3

- Fully operational, representative process-equipment with supporting instrumentation and control equipment (e.g., distillation column, evaporator and power boiler, pulp stock digester, mineralization)
- Installed control system (e.g., Fisher Delta V)
- Stand alone controllers, pneumatic
- Software-loadable Programmable Logic Controllers (e.g., Schneider, GE/Fanuc, AB)
- Distributed Control Systems (e.g., Schneider Foxboro IA, Delta V, ABB)
- Access to a radiation source that may be used for level or density measurement

Level 4

- Fully operational, representative process-equipment with supporting instrumentation and control equipment (e.g., distillation column, evaporator and power boiler, pulp stock digester, mineralization)
- Installed control system (e.g., Fisher Delta V)
- Stand alone controllers, electronic (e.g., F&P MC-5000)
- PC-based advanced control software (e.g., Brainwave)
- Software-loadable Programmable Logic Controllers (e.g., Schneider, GE/Fanuc, AB)
- Distributed Control Systems (e.g., Schneider Foxboro IA, Delta V, ABB)
- SCADA systems (e.g., Bristol, Fisher, Schneider)
- Access to a radiation source that may be used for level or density measurement

Student Facilities

- Adequate lunch room as per WorkSafeBC requirements
- Adequate washroom facilities as per WorkSafeBC requirements
- Personal storage lockers

Instructor’s Office Space

- Private seating space sufficient for 3 people (separate from training space)

Other

- Not applicable
Tools and Equipment

Shop Equipment

Power Tools

Required
- Air compressor
- Drill press
- Grinders
- Heat gun
- Portable electric drill
- Pressure and vacuum pumps
- Soldering iron with appropriate ventilation

Recommended
- Cutoff saw
- High pressure grease gun
- Hydraulic press
- Impact wrench
- Pipe threader
- Powder actuated tools (hilti, ramset, etc.)
- Pneumatic tools

Electronic Tools and Test Equipment

Required
- Amp probe
- Analog multimeter
- Flue gas analyzers (complete with Ringelmann chart)
- Gas chromatograph
- Barometer
- Bridges
- Calibrated oven
- Capacitance simulator
- Current calibrator
- Data logger
- Deadweight tester (hydraulic and pneumatic)
- Decade resistance box
- Deflectional-type strain indicator
- Dew point tester
- Digital multimeter
- Dry block calibrator
- Electromagnetic flowmeter
- Electrostatic voltmeter
- Ethernet network kit
- Frequency counter
- Frequency generator
- Gauge blocks
- Hand held programmer (configurator)
- Millivoltmeter calibrator
- Modem
- Null balance strain indicator
- Optical pyrometer
- Oscilloscope
- pH simulator/buffers
- Pneumatic test stand
- Portable sound level meter
- Portable voltage tester
- Potentiometer
- Power supplies
- Pressure/vacuum calibrator
- Printers
- Protocol analyzer
- Radiation meter
- Regulator
- Rpm tester/tachometer
- Rtd/thermocouple calibrator
- Signal generator
- Signal analyzer
- Sling psychrometer
- Software
- Tachometer generator
Training Provider Standards

- Hand held pyrometer
- Hydrometer
- Infrared thermometer
- Lab scales
- Label maker
- Laptop computer
- Logic testers
- Loop calibrator/simulator
- Manometer (well and incline)

Recommended
- Eddy current tachometer
- Laser strength meter
- Microwave leakage meter

Shop (Facility) Tools

Required Hand Tools
- Calipers (assorted)
- Crowbar
- Diagonal cutter
- Drill bits
- Easy-out (extractor)
- Portable vices
- Flaring tool
- Flashlight
- Fuse puller
- Gauge pointer puller
- Gasket cutter
- Grease gun
- Hammers (assorted)
- Hand files (assorted)
- Hex keys (Imperial/Metric)
- Knockout punch
- Level
- Magnet
- Measuring tape
- Micrometers (assorted)
- Mirrors
- Heat shrink labeller
- Nut drivers (assorted)
- Packing puller
- Pinch bar
- Pipe threader
- Pliers (assorted)
- Punches (assorted)
- Reamer
- Rubber mallet
- Saws (assorted)
- Screw starter
- Screwdrivers (assorted)
- Scribe
- Sockets (imperial/metric)
- Square
- Steel rule
- Strap wrench
- Tap and die set
- Pipe wrench
- Torque wrench
- Tube benders
- Tube cutter
- Tweezer
- Wire brushes
- Wire crimpers
- Wire cutter
- Wire labeller
- Wire stripper
- Wrenches
- Toolbox
Personal Protective Equipment and Safety Equipment (provided by TP)

**Required**
- Ear protection (muffs and plugs)
- Eye wash bottle
- Face shield
- Fire extinguisher
- First aid kit
- Gloves
- Grounding mat
- Hard hat
- Mask
- Personal dosimeter
- Personal monitor (gas)
- Radiation survey meter
- Respirators
- Rubber safety boots
- Rubber suits
- Safety glasses
- Safety harnesses with lanyard
- Splash goggles

**Recommended**
- Apron
- Cap lamp
- Personal locks for lockout
- Scissor clamps for lockout

**Specialty Tools (required)**
- Lifting and rigging equipment
- Ventilated fume hood

**Student Tools (supplied by student)**

**NOTE: check with training provider for student equipment and tools**

**Required**
- Steel-toed boots

**Recommended**
- Coveralls
- Fluke 789 process calibrator or equivalent
- Powered breadboard with lead kit (e.g., MB-800 project board)
Reference Materials

Introduction

The amount of technical data and the rate of technological innovation confronting workers in this trade are extremely high. Manufacturers who formerly maintained in-house publishing operations (due to the sheer quantity of specialized technical information associated with their products) have now moved to providing technical information in on-line and/or CD formats, in order to reduce costs associated with frequent revisions and updates to technical materials. The implications for the development of trade training materials are clear: there is potential for rapid redundancy of information and a need for constant Subject Matter Expert-led evaluation of curriculum.

As well, there are almost infinite variations in the technologies of industrial instrumentation. The focus of BC IIM training is on the technologies most prevalent in the industries of this province. This approach has served industry well. Apprentices are prepared to work with the most current BC technologies and also capable of dealing with the older systems sometimes encountered in the oil and gas fields. Training materials should support a “BC first” focus, while enabling apprentices to successfully challenge the IP exam for this trade.

MATERIALS IN PRINT

- McMillan, Gregory K. Advanced temperature measurement and control
- Vickers, Incorporated Training Center Closed loop electrohydraulic systems manual
- Warren, John E. Control instrument mechanisms
- Coggan, Donald A. Fundamentals of industrial control
- Parr, E.A. Hydraulics and Pneumatics
- Eaton Corporation Industrial Hydraulics manual
- Eaton Corporation Industrial Hydraulics answer book
- Liptak, Bela G. Instrument Engineers Handbook. Process Control and Optimization
- Eaton Fluid Power Training Introduction to Hydraulics Technology
- Nyce, David S. Linear Position Sensors
- Park, John Practical Data Communication for Instrumentation and Control
- Mackay, Steve Practical Industrial Data Networks
- Terrel, David L. Fundamentals of Electronics DC/AC Circuits
- Cooke and Adams Basic Math for Electronics
- Ptec Instrumentation
- Kirk, Franklin & Philip, Weeder, Thomas A. Instrumentation
- Murrill, Paul W. Fundamentals of Process Control Theory
- Buchla, David Experiments of Digital Fundamentals
- Floyd, Thomas L. Principals of Electric Circuits

---

1 When asked about the technical information resources they use in their trade, about 2/3 of the SME’s, identified the “Help Menus” of the products they configure and install as a significant source of up-to-date technical information.
Training Provider Standards

- Bartlet, Terry
  Instrumentation and Process Control
- Patrick, Dale R. & Steven R.
  Pneumatic Instrumentation
- Faulk, Sutko
  Industrial Instrumentation
- Thomson, Delmar Learning
  Fundamentals of Instrumentation
- Price, Winston T. & Miller, Merlin
  Elements of Data Processing Math
- Alerich, Walter N. & Keljik, Jeff
  Electricity 3
- Considine, Douglas M.
  Process Industrial Instrumentation and Control
- Anderson, Norman A.
  Instruments for Process Measurement and Control
- Bell, David A.
  Fundamentals of Electric Circuits
- Rease, Dudley A.
  Basic Fluid Power
- Skoog, Douglas A. & West, Donald M.
  Fundamentals of Analytical Chemistry
- Shortley and Williams
  Elements of Physics
- Wildi, Theodore
  Electrical Machines, Drives and Power Systems
- Johnston, Curtis D.
  Process Control Instrument Technologies
- Steinigress, Frederick M.
  Low Pressure Boilers
- Heath, Macnaughton and Martindale
  Fundamentals of Physics
- Kuphaldt, Tony R.
  Lessons in Industrial Instrumentation
- Floyd, Thomas L.
  Digital Fundamentals, 8th edition. Prentice-Hall, 2005
- Spitzer, David W.
- Trevathan, Vernon L.
- Eren, Halit
  Paperback, 384 pages, publication date: NOV-2003
- Macdonald, Dave
ONLINE RESOURCES
(AS OF JULY 2014)

- www.abb.com ABB
- www.boschrexroth.ca Bosch Rexroth Canada is the Canadian partner of Bosch Rexroth, an international company specializing in “Drive and Control.” Some technical information on hydraulics, including course outlines for introduction and maintenance.
- www.control.com “Control.com,” an online global community of automation professionals. Webpage includes a forum for questions, list of topic threads, opportunity for exchange of ideas and information with other instrumentation professionals.
- www.controlglobal.com/whitepapers/
- http://www.controlsweekly.com – Controls Weekly Review – weekly reviews of manufactured systems used in process control; archive; topics list. Information updated weekly.
- www.cpecn.com/
- www.cvs-controls.com CVS Controls is a manufacturer and supplier of products for the process control industry. Select “literature”: free instruction manuals available.
- www.cyberlaboratory.com/ -- Information on density.
- www.documentation.emersonprocess.com/ Click on “Emerson Process Management Documentation Library” for free downloads, including a 297 page Control Valve handbook.
- www.emersonprocess.com Emerson.
- www.emersonprocess.com/university - PlantWeb University has 11 courses (free download when registered – no cost to register) on Safety Instrumented Systems (SIS) and 21 courses on wireless technologies.
- www.fisherregulators.com (requires registration to access technology literature).
- www.flowcontrolnetwork.com
- www.foxboro.com Foxboro
- www.galvanic.com Galvanic Applied Sciences Ltd. (see “suspended solids” under the “liquid measurement” heading for product notes).
- www.honeywell.com Honeywell.
- www.invensys.com Invensys.
- www.joliettech.com Joliet Technologies, producer of variable speed drive systems and controls. Product material has good information on VSD and VFD.
- www.metsoautomation.com Metso.
Training Provider Standards

- [http://www.modelingandcontrol.com/](http://www.modelingandcontrol.com/) Modeling and Control: the Dynamic World of Process Control is a blog written by two men with a “broad range of experience in the design and commissioning of batch and continuous process control systems and the development and application of process simulation for operator training and control study.” They write with the intent that readers will find the information posted interesting and helpful in work situations.


- [http://www.multimediahrd.com/](http://www.multimediahrd.com/) Multi media offers DVD and video materials on 10 topics related to hydraulics training. Click on “DVD and video” on webpage sidebar, scroll down to “technical” on new page shown, select “hydraulics” to view topics covered.

- [www.omega.com](http://www.omega.com) – Information on basic process measurements like flow, temperature, pressure, pH, conductivity, level, etc.

- [www.ohsonline.com](http://www.ohsonline.com) – National US website on employment safety issues; use Search button to get information on personal gas detectors.

- [www.processingtalk.com/guides/](http://www.processingtalk.com/guides/) News and information site for Process Engineers, updated daily. Select “Emergency Shutdown” from list of common terms – or browse through for information on other topics.

- [www.raesystems.com](http://www.raesystems.com) Rae Systems. See technical and application notes for information on hand held and portable sensors (personal safety systems).

- [www.scadalink.com](http://www.scadalink.com) Bentek Systems. See Tech notes for information on wireless SCADA systems.


- [www.smar.com/PDFs/Catalogues/HARTTUTCE.PDF](http://www.smar.com/PDFs/Catalogues/HARTTUTCE.PDF) – a good tutorial on HART communication.

- [www.spitzerandboyes.com](http://www.spitzerandboyes.com)

- [www.vegacontrols.co.uk/vega_downloads_open.htm](http://www.vegacontrols.co.uk/vega_downloads_open.htm) – Radar and ultrasonic level measurements.

- [www.worksafebc.com](http://www.worksafebc.com) -- WorkSafeBC’s webpage – view the provincial OHS regulation, which explains employer/employee responsibilities, get access to WorkSafeBC publications on specific issues (young worker safety, accident reports…etc.)

- [www.yokogawa.com](http://www.yokogawa.com) Yokogawa.

- [www.zoneni.com](http://www.zoneni.com) National Instruments – see the NI developer zone.


## Grading Sheet: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>LINE</th>
<th>SUBJECT COMPETENCIES</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Applies Occupational Skills</td>
<td>9%</td>
<td>2%</td>
</tr>
<tr>
<td>B</td>
<td>Installs and Maintains Measuring and Indicating Devices</td>
<td>13%</td>
<td>17%</td>
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<tr>
<td>D</td>
<td>Installs and Maintains Safety and Process Monitoring Systems</td>
<td>8%</td>
<td>2%</td>
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<td>E</td>
<td>Installs and Maintains Pneumatic and Hydraulic Systems</td>
<td>9%</td>
<td>5%</td>
</tr>
<tr>
<td>F</td>
<td>Installs and Maintains Electrical and Electronic Systems</td>
<td>26%</td>
<td>33%</td>
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<tr>
<td>G</td>
<td>Installs and Maintains Final Control Elements</td>
<td>21%</td>
<td>28%</td>
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<tr>
<td>H</td>
<td>Installs and Maintains Communications, Networking and Signal Transmission</td>
<td>7%</td>
<td>0%</td>
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<tr>
<td>I</td>
<td>Installs and Maintains Control Systems</td>
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<td>13%</td>
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<td></td>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
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</tbody>
</table>

**In-school theory / practical subject competency weighting**

| In-school theory / practical subject competency weighting | 70% | 30% |

**Final in-school percentage score**

| IN-SCHOOL % |

**In-school Percentage Score**

Combined theory and practical subject competency multiplied by

| 80% |

**Standard Level Exam Percentage Score**

The exam score is multiplied by

| 20% |

**Final Percentage Score**

| FINAL% |
### Appendix A
### Assessment Guidelines

<table>
<thead>
<tr>
<th>LINE</th>
<th>SUBJECT COMPETENCIES</th>
<th>THEORY WEIGHTING</th>
<th>PRACTICAL WEIGHTING</th>
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<tbody>
<tr>
<td>A</td>
<td>Applies Occupational Skills</td>
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<td>46%</td>
<td>49%</td>
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<td>Installs and Maintains Pneumatic and Hydraulic Systems</td>
<td>11%</td>
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<td>F</td>
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<td>25%</td>
<td>29%</td>
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<td>G</td>
<td>Installs and Maintains Final Control Elements</td>
<td>12%</td>
<td>8%</td>
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<td><strong>Total</strong></td>
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In-school theory / practical subject competency weighting

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<tr>
<th></th>
<th>THEORY</th>
<th>PRACTICAL</th>
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<tr>
<td></td>
<td>70%</td>
<td>30%</td>
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Final in-school percentage score

<table>
<thead>
<tr>
<th></th>
<th>IN-SCHOOL %</th>
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<tr>
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<tr>
<td>In-school Percentage Score</td>
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<td>80%</td>
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<td>Combined theory and practical subject competency multiplied by</td>
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<tr>
<td>Standard Level Exam Percentage Score</td>
<td>20%</td>
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</tr>
<tr>
<td>The exam score is multiplied by</td>
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</table>

Final Percentage Score

<table>
<thead>
<tr>
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<th>FINAL%</th>
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---

**PROGRAM:**
**IN-SCHOOL TRAINING:**
**INDUSTRIAL INSTRUMENT MECHANIC LEVEL 2**

**ITA DIRECT ACCESS CODE:**
## Appendix A
### Assessment Guidelines

**Program:**
**In-School Training:**
**ITA Direct Access Code:**

### Industrial Instrument Mechanic Level 3

<table>
<thead>
<tr>
<th>Line</th>
<th>Subject Competencies</th>
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<th>Practical Weighting</th>
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<tr>
<td>A</td>
<td>Applies Occupational Skills</td>
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<td>B</td>
<td>Installs and Maintains Measuring and Indicating Devices</td>
<td>21%</td>
<td>10%</td>
</tr>
<tr>
<td>C</td>
<td>Installs and Maintains Analytical Instrumentation</td>
<td>21%</td>
<td>28%</td>
</tr>
<tr>
<td>E</td>
<td>Installs and Maintains Pneumatic and Hydraulic Systems</td>
<td>11%</td>
<td>9%</td>
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<td>G</td>
<td>Installs and Maintains Final Control Elements</td>
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<td>I</td>
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<td>26%</td>
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<td></td>
<td><strong>Total</strong></td>
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</table>

### In-school theory / practical subject competency weighting

- 70%
- 30%

### Final in-school percentage score

IN-SCHOOL %

### In-school Percentage Score

Combined theory and practical subject competency multiplied by 80%

### Standard Level Exam Percentage Score

The exam score is multiplied by 20%

### Final Percentage Score

FINAL%
## Appendix A

### Assessment Guidelines

**PROGRAM:**

**IN-SCHOOL TRAINING:**

**ITA DIRECT ACCESS CODE:**

<table>
<thead>
<tr>
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<th>SUBJECT COMPETENCIES</th>
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<td>Installs and Maintains Measuring and Indicating Devices</td>
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<td>4%</td>
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<td>C</td>
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<tr>
<td>D</td>
<td>Installs and Maintains Safety and Process Monitoring Systems</td>
<td>16%</td>
<td>14%</td>
</tr>
<tr>
<td>H</td>
<td>Installs and Maintains Communications, Networking and Signal Transmission Systems</td>
<td>11%</td>
<td>15%</td>
</tr>
<tr>
<td>I</td>
<td>Installs and Maintains Controls Systems</td>
<td>41%</td>
<td>52%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**In-school theory / practical subject competency weighting**

<table>
<thead>
<tr>
<th>IN-SCHOOL %</th>
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</table>

Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal or ITA CofQ exam.

All apprentices who complete Level 4 of the Instrumentation and Control Technician (Industrial Instrument Mechanic) program with a FINAL level percentage score of 70% or greater will write the Interprovincial Red Seal examination as their final assessment.

ITA will enter the apprentices’ Instrumentation and Control Technician Interprovincial Red Seal examination percentage score in ITA Direct Access.

A minimum percentage score of 70% on the examination is required for a pass.
Appendix B
Glossary and Acronyms
GLOSSARY

**Actuator** – a controlled hardware device used to implement change in a process

**Adapter** – a device used to make electrical or mechanical connections between items not originally intended for use together

**Align** – to bring within required specifications

**Amplifier** – a device that enables an input signal to control power from a source independent of the signal and thus be capable of delivering an output that bears some relationship to, and is generally greater than, the input signal

**Analog signal** – any variable signal continuous in both time and amplitude rather than of a pulsed or discrete nature

**Apply** – to put to use especially for some practical purpose

**Back-up** – to save configuration, current data or status in recoverable media

**Bellows** – a mechanical element of generally cylindrical shape with cylindrical walls containing deep convolutions

**Benchtest** – removing a piece of equipment and testing it at the shop; a static setup as opposed to a dynamic setup

**Calibrate** – to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device

**Cascade control** – a type of controller set-up in which the output of one controller acts as the set point or controlling signal of another controller

**Configure** – to set up a program or computer system for a particular application

**Control mode** – a specific type of control action such as proportional, integral or derivative

**Control variable** – measured variables that can be manipulated by the control system, such as flow, level, pressure and temperature

**Describe** – to give a detailed or graphic account of a process or procedure

**Determine** – to arrive at, or locate, information by a process

**Distributed Control System (DCS)** – a system of dividing plant or process control into several areas of responsibility, each managed by its own controller (processor), with the whole interconnected to form a single entity usually by communication buses of various kinds

**Document** – to provide proof or evidence

**Examine** – to investigate critically; scrutinize; test; question

**Feed forward** – an industry standard process control strategy, in which mathematically predicted errors are corrected before they occur

**Fieldbus** – a digital, two-way, multi-drop communication link among intelligent measurement and control devices which serves as a Local Area Network (LAN) for advanced process control, remote input/output and high speed factory automation applications; a communication protocol

**Firmware** – software (programs or data) that has been written onto read-only memory chips; firmware is a combination of software and hardware

**Flume** – a device that measures large flow rates in open channels

**Frequency** – the number of cycles completed by a periodic quantity on a unit time
Highway Addressable Remote Terminal (HART) – provides digital communication to microprocessor-based (smart) analog process control instruments; a communication protocol

Human Machine Interface (HMI) – the graphical display and control interface between a process & a human operator

Implement – to make active or effective

Input/Output (I/O) – all equipment and activity that transfers information into or out of a computer

Install – to set up for use or service

Instrumentation – a collection of instruments or their application for the purpose of observation, measurement or control

Instrumentation, Systems and Automation Society (ISA) – an engineering society that develops and maintains defined standards for both scientific and technical areas of process control and automation

Interface – the place at which systems, such as a computer and a peripheral, meet and interact with each other

Kinetic – the energy that a body possesses as a result of its motion

Maintain – to keep in good condition; to keep functional and in good repair

Management of change (facility change management) – proper management of change to industrial facilities and processes is recognized as critical to even small changes; the main requirement is that a thorough review of a proposed change be performed by a multidisciplinary team to ensure that as many possible viewpoints as possible are used to minimize the chances of missing a hazard

Module – an assembly of interconnected components which constitutes an identifiable device, instrument or piece of equipment — can be removed, tested as a unit and replaced with a spare

Network – the interconnection of devices sharing a communications protocol

Operate – to perform a function; exert power or influence

Port – a signal input (access) or output (egress) point

Power supply – a device that produces one or more voltages for the operation of electronic and logic devices

Process – physical or chemical change of matter or conversion of energy such as change in pressure, temperature, speed, electrical potential, etc.

Profibus – a communication protocol

Program – a list of instructions that a computer will execute to perform a certain task

Programmable Logic Controller (PLC) a control device, normally used in industrial control applications, that employs the hardware architecture of a computer and a relay ladder diagram language

Proportional, Integral, Derivative (PID) proportional gain, integral action time and derivative action time. PID software, for example, compares an analog input value with a set point and if there's a discrepancy outputs an appropriate analog or digital control value, according the PID calculations

Range – the region between the limits within which a quantity is measured, received or transmitted; expressed by stating the lower and upper range values

Remote – a device allowing the set point to be altered by a signal from a physical location away from the controller — necessary for cascade operation

Safety Integrity Level (SIL) – Safety Instrument System (SIS)/Process Safety System (PSS)
Sensing element – the element directly responsive to the value of the measured variable

Service – to remove, maintain, repair, or replace items and/or components

Signal – a form of energy that quantitatively represents a variable

Strain gauge – a device that uses the change of electrical resistance of a wire under strain to measure applied force

Supervisory Control and Data Acquisition (SCADA) – a control package used to monitor and control a remote process; also includes hardware such as modems, telemetry, servers and control systems

Telemetry – transmitting the readings of instruments to a remote location via wires, radio waves or other means

Temperature bath – a volume of a substance held at constant temperature, so that an object placed in thermal contact with it is maintained at the same temperature

Terminal – a peripheral device used by the operator to communicate with the computer

Test – to methodically assess against criterion or standard

Thermocouple – devices that convert heat energy into electrical energy consisting of two dissimilar metal strips fused together at one end

Transducer – an element or device that receives energy in one form and converts to another form

Transmitter – a transducer which responds to a measured variable by means of a sensing element, and converts it to a standardized transmission signal that is proportional to the measured variable

Troubleshoot – to investigate critically and methodically the causes of abnormal conditions

Tuning – adjustment of parameters to optimize a particular process

Uninterruptible Power Supply (UPS) used to keep critical equipment, including computers, running in the event of a power failure

Update – to record current data or status

Use – the act or practice of employing something

Variable Frequency Drive (VFD) and Variable Speed Drive (VSD) electronic equipment that allows an electric motor to be run at varying speeds

Weir – an engineered obstruction placed in an open channel
## ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>A/D, ADC</td>
<td>Analog to Digital Converter</td>
</tr>
<tr>
<td>BMS</td>
<td>Burner Management Systems</td>
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<tr>
<td>CEC</td>
<td>Canadian Electrical Code</td>
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<tr>
<td>CEMS</td>
<td>Continuous Emissions Monitoring System</td>
</tr>
<tr>
<td>CNSC</td>
<td>Canadian Nuclear Safety Commission</td>
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<tr>
<td>CSA</td>
<td>Canadian Standards Association</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Tube</td>
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<tr>
<td>D/A, DAC</td>
<td>Digital to Analog Converter</td>
</tr>
<tr>
<td>DCS</td>
<td>Distributed Control System</td>
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<tr>
<td>DP</td>
<td>Differential Pressure</td>
</tr>
<tr>
<td>EPA</td>
<td>Environment Protection Act</td>
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<tr>
<td>ESD</td>
<td>Emergency Shutdown Device</td>
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<tr>
<td>HART</td>
<td>Highway Addressable Remote Transducer</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
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<tr>
<td>I/O</td>
<td>Input/output</td>
</tr>
<tr>
<td>ISA</td>
<td>Instrumentation, Systems and Automation Society</td>
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<tr>
<td>LNG</td>
<td>Liquefied Natural Gas</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid Crystal Display</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
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<tr>
<td>MISA</td>
<td>Municipal Industry Strategy for Abatement</td>
</tr>
<tr>
<td>MSDS</td>
<td>Material Safety Data Sheets</td>
</tr>
<tr>
<td>NIST</td>
<td>National Institute of Standards and Technology</td>
</tr>
<tr>
<td>OH&amp;S</td>
<td>Occupational Health and Safety Act</td>
</tr>
<tr>
<td>OPC</td>
<td>OLE (Object Linking Embedding) Process Control</td>
</tr>
<tr>
<td>ORP</td>
<td>Oxidation Reduction Potential</td>
</tr>
<tr>
<td>P&amp;ID</td>
<td>Piping &amp; Instrument Drawing</td>
</tr>
<tr>
<td>PID</td>
<td>Proportional, Integral, Derivative</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
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<tr>
<td>PPE</td>
<td>Personal Protection Equipment</td>
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<td>PSS</td>
<td>Process Safety Systems</td>
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<tr>
<td>RTU</td>
<td>Remote Terminal Unit</td>
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<tr>
<td>RTD</td>
<td>Resistive Temperature Device</td>
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<tr>
<td>SAC</td>
<td>Stand Alone Controller</td>
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<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
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<td>SIL</td>
<td>Safety Integrity Level</td>
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<td>SIS</td>
<td>Safety Instrument System</td>
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<tr>
<td>SOP</td>
<td>Standard Operating Procedures</td>
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<tr>
<td>TCP/IP</td>
<td>Transport Control Protocol / Internet Protocol</td>
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<tr>
<td>TDG</td>
<td>Transportation of Dangerous Goods</td>
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<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
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<tr>
<td>VFD</td>
<td>Variable Frequency Drive</td>
</tr>
<tr>
<td>VSD</td>
<td>Variable Speed Drive</td>
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<tr>
<td>WHMIS</td>
<td>Workplace Hazardous Materials Information System</td>
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Appendix C

Sample Evaluation Sheet
SAMPLE EVALUATION SHEET

INSTRUMENTATION AND CONTROL TECHNICIAN (INDUSTRIAL INSTRUMENT MECHANIC)

Date: __________

Practical Skills Assessment Form

Student ______________________________ Score: ______ %

Lab Project:______________________________________________

School/Training Institution: _________________________________

Instructor/ Assessor: ______________________________________

General Work Standard Criteria      Rate 1-10 or N/A

1. Plans Lab tasks to organize work and ensure personal safety ………. __________
2. Uses required tools safely and efficiently……………………. __________
3. Maintains orderly work area while completing Lab assignment…… __________
4. Leaves Lab work area in a clean, work-ready state ......................... __________

Lab Criteria         Rate 1-10 or N/A

1. Demonstrates knowledge of related theory and principles ………. __________
2. Interprets related schematics or drawings correctly……………………. __________
3. Demonstrates understanding of primary device or system…………. __________
4. Demonstrates understanding of secondary device or system……… __________
5. Efficiently manipulates devices or systems……………………………………. __________
6. Solution to Lab assignment is valid within stipulated parameters… __________
7. Documents calibration as required ................................. __________
8. Completes Lab assignment within time allotted ............................. __________
9. Meets other Lab criteria (Identify:___________________) …… __________
10. Meets other Lab criteria (Identify:___________________) …… __________

Scoring passing grade is 70%:

➢ Add Total scores for all criteria,
➢ divide by total number of applicable criteria,
➢ multiply by 100%

NOTE: It is recommended that at least one Practical Assessment be completed for each line on the Occupational Analysis Chart (e.g. General Area of Competency) for each term.
Appendix D
Previous Contributors
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Previous Contributors

Previous Contributors

The Program Outline was prepared under the direction of an Industry Steering Committee convened by the Resource Training Organization (RTO). Members include:

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- Robert Zwick Teck Cominco Metals