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PROGRAM OUTLINE

Instrumentation and Control Technician

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INSTRUMENTATION AND CONTROL TECHNICIAN PROGRAM OUTLINE

APPROVED BY INDUSTRY

MAY 2020

BASED ON

RSOS 2020

Developed by
Industry Training Authority
Province of British Columbia

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Section 1

INTRODUCTION

Instrumentation and Control Technician

Foreword

This Program Outline is for use in the Instrumentation and Control Technician apprenticeship training classes as sponsored by the Industry Training Authority and will be used as a curriculum planning guide for instructors in the formal classroom portions of apprenticeship training.

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 WorkSafe BC 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

In 2019/2020, Subject Matter Experts were convened to review the BC Program Outline with respect to the Pan-Canadian Harmonization Initiative changes. The following are the Subject Matter Experts who participated in this review:

- Aron Reid, Howe Sound Pulp and Paper Corportation
- Shane Stirling, Epscan
- Leo Paradis, Catalyst Paper
- Jim Armstrong, BC Institute of Technology
- Charles Maxwell, BC Institute of Technology

Facilitators:

- Angela Caughy, ITA (Industry Training Authority)

The Industry Training Authority would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Instrumentation and Control Technician occupation.

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.

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Program Credentialing Model	Communicates program length and structure, and all pathways to completion	Illustrates the length and structure of the program	Illustrates the length and structure of the program, and pathway to completion	Illustrates the challenger pathway to Certificate of Qualification
OAC	Communicates the competencies that industry has defined as representing the scope of the occupation	Displays the competencies that an apprentice is expected to demonstrate in order to achieve certification	Displays the competencies apprentices will achieve as a result of program completion	Displays the competencies challengers must demonstrate in order to challenge the program
Training Topics and Suggested Time Allocation	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	Shows 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	Shows 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	Shows the relative weightings of various competencies of the occupation on which assessment is based
Program Content	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	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	Provides detailed information on program content and performance expectations for demonstrating competency	Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Training Provider Standards	Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program	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	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	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
Appendix – Glossary of Acronyms			Defines program specific acronyms	

Section 2

PROGRAM OVERVIEW

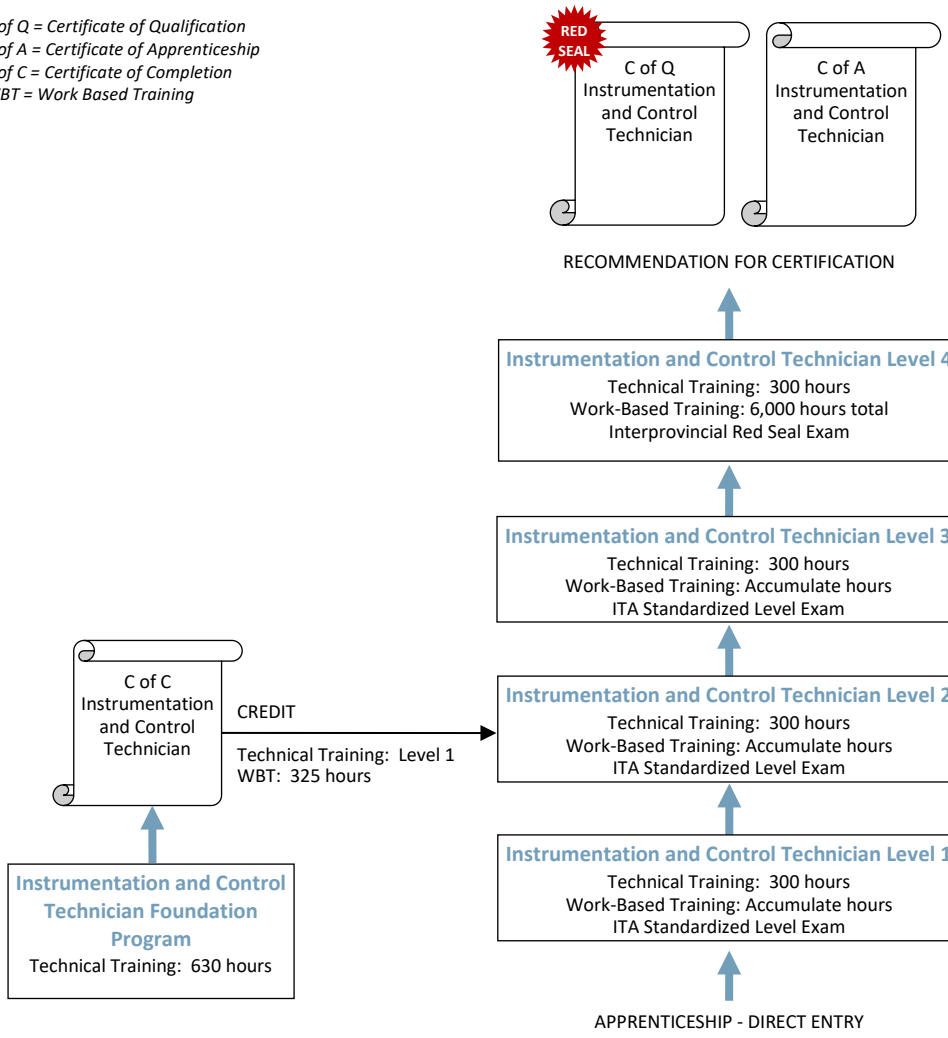
Instrumentation and Control Technician

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

Occupational Analysis Chart

Occupation Description:

"Instrumentation and Control Technician" means a person who installs, repairs, maintains, replaces, calibrates, programs and services all 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.

PERFORM SAFETY RELATED FUNCTIONS **A**	Maintain safe work environment A1	Use personal protective equipment (PPE) and safety equipment A2	Perform lock-out and tag-out procedures A3	Service and calibrate personal safety systems A4	
	1	1	1	1 2	
USE TOOLS AND EQUIPMENT **B**	Use hand and power tools B1	Use test equipment B2	Use access equipment B3	Use rigging, hoisting and lifting equipment B4	
	1	1	1	1	
ORGANIZE WORK **C**	Plan work and maintain records C1	Use computers and related applications C2	Apply codes, standards and regulations C3	Use trade related diagrams, drawings and Schematics C4	
	3	1 2 3 4	1	1 2 3 4	
USE COMMUNICATION AND MENTORING TECHNIQUES **D**	Use communication techniques D1	Use mentoring techniques D2			
	1	4			
INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES **E**	Calibrate and service indicating and recording devices E1	Install and service pressure measuring devices E2	Install and service temperature measuring devices E3	Install and service level measuring devices E4	Install and service flow measuring devices (*volumetric and mass flow*) E5	Install and service signal transducers E6
	1	1	2	2	2	2

Install and service mass measuring devices E7	Install and service density measuring devices E8	Install and service consistency measuring devices E9	Install and service vibration measuring devices E10	Install and service speed measuring devices E11	Install and service position measuring devices E12
2	2	3	3	3	3
Install and service motion measuring devices E13	Install and service process analyzers (Liquids and Solids – 3) (Gas – 4) E14	Install and service multiple variable computing devices E15			
3	3 4	2 4			
INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT F	Apply the principles of air supply F1	Install tubing and fittings F2	Install and service pneumatic systems F3	Install and service hydraulic systems F4	
	1	1	1 2 3	2	
INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT G	Apply the principles of electrical theory G1	Perform wiring installations using the Canadian Electrical Code (CEC) G2	Apply the principles of DC electricity G3	Apply the principles of AC electricity G4	Apply Boolean logic and principles of digital electronics G5	Apply the principles of electronics G6
	1	1	1	1	1 2	2
	Install and service electronic equipment G7					
	2					
INSTALL AND SERVICE FINAL CONTROL ELEMENTS H	Install and service regulators and relief valves H1	Install and service control valves and actuators H2	Install and service valve positioners H3	Install and service variable speed drive (VSD) and variable frequency drive (VFD) H4		
	1	1 2	1 2	3		

INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES **I**	Install and service control network systems I1		3	4	
	Install and service signal converters I2			4	
	Install and service gateways, bridges and media converters I3		3	4	

INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL **J**	Establish and optimize process control strategies J1		3	4	
	Install and service stand-alone controllers (SAC) J2		3	4	
	Install and service programmable logic controllers (PLC) J3	1	3	4	
	Install and service human machine interface (HMI) J4		3	4	
	Install and service distributed control systems (DCS) J5			4	
	Install and service supervisory control and data acquisition (SCADA) J6			4	
	Install and optimize advanced supervisory control systems J7		3	4	

INSTALL AND SERVICE SAFETY SYSTEMS AND DEVICES **K**	Install and service safety systems and devices K1			4	
	Install and service safety instrumented systems (SIS) K2			4	
	Install and service environmental monitoring devices K3			4	

Training Topics and Suggested Time Allocation – Level 1

INSTRUMENTATION AND CONTROL TECHNICIAN

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**PERFORM SAFETY RELATED FUNCTIONS**	**3%**	**80%**	**20%**	**100%**
A1	Maintain safe work environment		✓		
A2	Use personal protective equipment (PPE) and safety equipment		✓		
A3	Perform lock-out and tag-out procedures		✓	✓	
A4	Service and calibrate personal safety systems		✓		
Line B	**USE TOOLS AND EQUIPMENT**	**3%**	**80%**	**20%**	**100%**
B1	Use hand and power tools		✓		
B2	Use test equipment		✓	✓	
B3	Use access equipment		✓		
B4	Use rigging, hoisting and lifting equipment		✓		
Line C	**ORGANIZE WORK**	**5%**	**80%**	**20%**	**100%**
C2	Use computers and related applications		✓	✓	
C3	Apply codes, standards and regulations		✓		
C4	Use trade related diagrams, drawings and schematics		✓	✓	
Line D	**USE COMMUNICATION AND MENTORING TECHNIQUES**	**2%**	**60%**	**40%**	**100%**
D1	Use communication techniques		✓		
Line E	**INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES**	**15%**	**40%**	**60%**	**100%**
E1	Calibrate and service indicating and recording devices		✓	✓	
E2	Install and service pressure measuring devices		✓	✓	
Line F	**INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT**	**8%**	**40%**	**60%**	**100%**
F1	Apply the principles of air supply		✓	✓	
F2	Install tubing and fittings		✓	✓	
F3	Install and service pneumatic systems		✓	✓	
Line G	**INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT**	**30%**	**40%**	**60%**	**100%**
G1	Apply the principles of electrical theory		✓		
G2	Perform wiring installations using the Canadian Electrical Code (CEC)		✓		
G3	Apply the principles of DC electricity		✓	✓	
G4	Apply the principles of AC electricity		✓	✓	
G5	Apply Boolean logic and principles of digital electronics		✓	✓	

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line H	**INSTALL AND SERVICE FINAL CONTROL ELEMENTS**	**28%**	**40%**	**60%**	**100%**
H1	Install and service regulators and relief valves		✓	✓	
H2	Install and service control valves and actuators		✓	✓	
H3	Install and service valve positioners		✓	✓	
Line J	**INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL**	**6%**	**40%**	**60%**	**100%**
J3	Install and service programmable logic controllers (PLC)		✓	✓	
	Total Percentage for Instrumentation and Control Technician Level 1	**100%**			

Training Topics and Suggested Time Allocation – Level 2

INSTRUMENTATION AND CONTROL TECHNICIAN

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**PERFORM SAFETY RELATED FUNCTIONS**	**1%**	**50%**	**50%**	**100%**
A4	Service and calibrate personal safety systems		✓	✓	
Line C	**ORGANIZE WORK**	**5%**	**80%**	**20%**	**100%**
C2	Use computers and related applications		✓	✓	
C4	Use trade related diagrams, drawings and schematics		✓	✓	
Line E	**INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES**	**44%**	**50%**	**50%**	**100%**
E3	Install and service temperature measuring devices		✓	✓	
E4	Install and service level measuring devices		✓	✓	
E5	Install and service flow measuring devices (*volumetric and mass flow*)		✓	✓	
E6	Install and service signal transducers		✓	✓	
E7	Install and service mass measuring devices		✓	✓	
E8	Install and service density measuring devices		✓	✓	
E15	Install and service multiple variable computing devices		✓	✓	
Line F	**INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT**	**10%**	**40%**	**60%**	**100%**
F3	Install and service pneumatic systems		✓	✓	
F4	Install and service hydraulic systems		✓	✓	
Line G	**INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT**	**30%**	**50%**	**50%**	**100%**
G5	Apply Boolean logic and principles of digital electronics (*advanced*)		✓	✓	
G6	Apply the principles of electronics		✓	✓	
G7	Install and service electronic equipment		✓	✓	
Line H	**INSTALL AND SERVICE FINAL CONTROL ELEMENTS**	**10%**	**60%**	**40%**	**100%**
H2	Install and service control valves and actuators *(application)*		✓	✓	
H3	Install and service valve positioners *(application)*		✓	✓	
	Total Percentage for Instrumentation and Control Technician Level 2	**100%**			

Training Topics and Suggested Time Allocation – Level 3

INSTRUMENTATION AND CONTROL TECHNICIAN

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line C	**ORGANIZE WORK**	**5%**	**80%**	**20%**	**100%**
C1	Plan work and maintain records		✓	✓	
C2	Use computers and related applications		✓	✓	
C4	Use trade related diagrams, drawings and schematics		✓	✓	
Line E	**INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES**	**35%**	**50%**	**50%**	**100%**
E9	Install and service consistency measuring devices		✓	✓	
E10	Install and service vibration measuring devices		✓	✓	
E11	Install and service speed measuring devices		✓		
E12	Install and service position measuring Devices		✓		
E13	Install and service motion measuring Devices		✓		
E14	Install and service process analyzers *(liquids and solids)*		✓	✓	
Line F	**INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT**	**2%**	**50%**	**50%**	**100%**
F3	Install and service pneumatic systems		✓	✓	
Line H	**INSTALL AND SERVICE FINAL CONTROL ELEMENTS**	**5%**	**40%**	**60%**	**100%**
H4	Install and service variable speed drive (VSD) and variable frequency drive (VFD)		✓	✓	
Line I	**INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES**	**10%**	**80%**	**20%**	**100%**
I1	Install and service control network systems		✓	✓	
I3	Install and service gateways, bridges and media converters		✓		
Line J	**INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL**	**43%**	**40%**	**60%**	**100%**
J1	Establish and optimize process control strategies		✓	✓	
J2	Install and service stand-alone controllers (SAC)		✓		
J3	Install and service programmable logic controllers (PLC)		✓	✓	
J4	Install and service human machine interface (HMI)		✓	✓	
J7	Install and optimize advanced supervisory control systems		✓		
	Total Percentage for Instrumentation and Control Technician Level 3	**100%**			

Training Topics and Suggested Time Allocation – Level 4

INSTRUMENTATION AND CONTROL TECHNICIAN

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line C	**ORGANIZE WORK**	**2%**	**60%**	**40%**	**100%**
C2	Use computers and related applications		✓	✓	
C4	Use trade related diagrams, drawings and schematics		✓	✓	
Line D	**USE COMMUNICATION AND MENTORING TECHNIQUES**	**3%**	**40%**	**60%**	**100%**
D2	Use mentoring techniques		✓		
Line E	**INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES**	**10%**	**50%**	**50%**	**100%**
E14	Install and service process analyzers *(gas)*		✓	✓	
E15	Install and service multiple variable computing devices		✓	✓	
Line I	**INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES**	**10%**	**80%**	**20%**	**100%**
I1	Install and service control network systems		✓	✓	
I2	Install and service signal converters		✓	✓	
I3	Install and service gateways, bridges and media converters		✓	✓	
Line J	**INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL**	**60%**	**40%**	**60%**	**100%**
J1	Establish and optimize process control strategies		✓	✓	
J2	Install and service stand-alone controllers (SAC)		✓	✓	
J3	Install and service programmable logic controllers (PLC)		✓	✓	
J4	Install and service human machine interface (HMI)		✓	✓	
J5	Install and service distributed control systems (DCS)		✓	✓	
J6	Install and service supervisory control and data acquisition (SCADA)		✓	✓	
J7	Install and optimize advanced supervisory control systems		✓	✓	
Line K	**INSTALL AND SERVICE SAFETY SYSTEMS AND DEVICES**	**15%**	**60%**	**40%**	**100%**
K1	Install and service safety systems and devices		✓	✓	
K2	Install and service safety instrumented systems (SIS)		✓	✓	
K3	Install and service environmental monitoring devices		✓	✓	
	Total Percentage for Instrumentation and Control Technician Level 4	**100%**			

Section 3

PROGRAM CONTENT

Instrumentation and Control Technician

Level 1

Instrumentation and Control Technician

Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS

Competency: A1 Maintain safe work environment

Objectives

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

- Assess and manage workplace hazards.

LEARNING TASKS	CONTENT

1. Describe common workplace hazards	• Short term hazards
	  o Confined space
	  o Elevations
	  o Electrical
	  o Compressed gas
	  o Explosive material (dust)
	  o Air quality
	• Long term hazards
	  o Respiratory disease
	  o Repetitive strain injuries
	  o Hearing loss
	  o Chemical exposure
	• Workspace awareness
	  o Safe attitude
	  o Safe housekeeping
	  o Site conditions
	  o Recycling and disposal procedures

2. Manage workplace hazards	• WHMIS
	• Safety Data Sheets (SDS)
	• TDG
	• OHS regulations
	• WorkSafeBC standards
	• Emergency shutoffs
	• Fire prevention
	• Chemical hazard response
	  o Eye wash facilities
	  o Emergency shower
	• Evacuation plan
	  o Marshalling/mustering areas
	  o Emergency exits
	  o Emergency contact/phone numbers

Achievement Criteria – (Workplace)

Performance	The learner is aware of WHMIS and that it is a required certification.
Conditions	To be assessed in the workplace.
Criteria	Tasks must be performed within specification and time frames acceptable to industry.

Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS

Competency: A2 Use personal protective equipment (PPE) and safety equipment

Objectives

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

- Describe personal protective equipment (PPE) and safety equipment.
- Apply personal safety precautions and procedures.

LEARNING TASKS	CONTENT
1. Describe personal protective equipment (PPE)	• Head protection • Eye protection • Hearing protection • Hand protection • Clothing (FR rated) • Foot protection • Personal breathing apparatus

2. Describe safety equipment	• Types
	  o Fire extinguishers
	  o First-aid
	  o Ventilation
	  o Screens
	• Procedures
	• Storage
	• Limitations
	• Standards, acts and regulations

Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS

Competency: A3 Perform lock-out and tag-out procedures

Objectives

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

- Describe lock-out requirements.
- Perform lock-out and tag-out procedures.
- Explain standards and safe practices when working with AC and DC electrical circuits and devices.

LEARNING TASKS	CONTENT
1. Describe 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. Describe OHS guide to electrical hazards	• Reference WorkSafeBC Publications o Working Safely Around Electricity
3. Describe lock-out requirements for various sources of energy	• Electrical • Hazardous energy o Mechanical o Gravity o Pressure o Static • Hydraulic o Steam o Pneumatic.vacuum • Hazardous gases o Toxic o Flammable
4. Perform lock-out and tag-out	• Procedures o Identify o Isolate o De-energize o Verify – Test for zero energy o Documentation • Plant requirements

LEARNING TASKS

CONTENT

- Use of locks
  - Scissors
  - Breaker locks
  - Cord locks
- Lock-out board
- Tags
- Cables
- Key-box system
- Blinding
- Standby person
- Isolation of vessels
- Matching of the lock-out to the vessel being worked on

Achievement Criteria

Performance — The learner will be able to perform electrical lock-out including verification.

Conditions — To be assessed during technical training.
The learner will be given:

- Lock-out equipment
- Isolation devices
- Multi-meter
- Lock and key
- Tag
- Personal protective equipment (PPE)

Criteria — The learner will be evaluated on:

- Safety
- Completion and verification of electrical lock-out procedures

Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS

Competency: A4 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.
- Explain personal safety system applications.

LEARNING TASKS	CONTENT
1. Describe personal gas monitors and standard calibration routines	• Portable personal gas monitor (Cl, SO_2, H_2S, O_2, LEL, CO) • Pull tube (Draeger)

Line (GAC): B USE TOOLS AND EQUIPMENT

Competency: B1 Use hand and power tools

Objectives

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

- Use and maintain hand and power tools.

LEARNING TASKS	CONTENT
1. Use hand tools	• Types o See Section 4 – Tools and Equipment • Maintenence
2. Use power tools	• Types o See Section 4 – Tools and Equipment • Maintenence

Line (GAC): B USE TOOLS AND EQUIPMENT

Competency: B2 Use test equipment

Objectives

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

- Use test equipment.
- Mount and install devices.

LEARNING TASKS	CONTENT
1. Confirm and maintain integrity of test equipment	• Test gauge • Multimeter • Manometer • Dead weight tester • Digital test equipment • Portable personal gas monitors

2. Describe mounting and installation hardware and installation practices	• Manufacturers' instructions
	• Types of mounting hardware
	  o Uni-strut
	  o Clamps
	  o U-bolts
	• Installation locations

Achievement Criteria

Performance	The learner will be able to: • Use test equipment • Mount and install 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 USE TOOLS AND EQUIPMENT

Competency: B3 Use access equipment

Objectives

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

- Describe the safe use of access equipment.

LEARNING TASKS	CONTENT

1. Describe the safe use of access equipment	• Types
	  o Ladders
	  o Platforms
	  o Lifts
	• WorkSafeBC regulations

Line (GAC): B USE TOOLS AND EQUIPMENT

Competency: B4 Use rigging, hoisting and lifting equipment

Objectives

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

- Describe the use of rigging, hoisting and lifting equipment.

LEARNING TASKS	CONTENT

1. Describe the use of rigging, hoisting and lifting equipment.	• Types
	  o Tirfors (come-along)
	  o Aerial lift platform
	  o Slings
	  o Shackles
	  o Hoists
	  o Cranes
	• WorkSafeBC regulations

Line (GAC): C ORGANIZE WORK

Competency: C2 Use computers and related applications

Objectives

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

- Configure and program instrumentation devices to manufacturers' specifications.

LEARNING TASKS	CONTENT
1. Examines diagnostic and configuration software, hardware and firmware	• Types o SMART calibrators o HART communicators • Configuration and programming software, hardware and firmware used in Level 1
2. Uses diagnostic and configuration software, hardware and firmware	• Configuration and programming software, hardware and firmware used in Level 1
3. Maintains back-up data and documentation	• Configuration and applicable programming software

Achievement Criteria

Performance	The learner will be able 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): C ORGANIZE WORK

Competency: C3 Apply codes, standards and regulations

Objectives

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

- Explain the purpose and applications of standards, codes and regulations.
- Access work-related safety regulations and publications.

LEARNING TASKS	CONTENT

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

LEARNING TASKS	CONTENT
2. Examine safety and certification bodies related to this trade	o Hazard Alerts • Purpose and intent of codes / regulations/standards o WHMIS/GHS and use of SDS o CSA certification standards o ISA documentation o CEC (Canadian Electrical Code) o Boiler and Pressure Vessel Code o CNSC (Canadian Nuclear Safety Commission) o National Energy Board Regulations for Custody Transfer o Oil and Gas Commission Accepted Practices for Measurement o Transportation of Dangerous Goods Act o BC Mines Act o BC Environmental Regulations • Other related codes and standards, as needed

Line (GAC): C ORGANIZE WORK

Competency: C4 Use trade related diagrams, drawings and schematics

Objectives

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

- Describe drawings and schematics.
- Describe symbols.
- Use P&ID/P&C drawings.

LEARNING TASKS	CONTENT
1. Describe types of schematics and drawings	• P&ID • SAMA • Isometric • Orthographic
2. Describe symbols and conventions	• ISA • SAMA
3. Use basic schematics and drawings	• P&ID • P&C

Achievement Criteria

Performance	The learner will be able 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 of 70%

Line (GAC): D USE COMMUNICATION AND MENTORING TECHNIQUES

Competency: D1 Use communication techniques

Objectives

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

- Communicate with others.

LEARNING TASKS	CONTENT
1. Communicate with others	• Trade terminology • Effective verbal communication skills • Effective written communication skills • Consulting to solve problems

Line (GAC): E INSTALL AND SERVICE PROCESS MEASURING DEVICES

Competency: E1 Calibrate and service indicating and recording devices

Objectives

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

- Calibrate and service chart recorders and gauges using principles of links and levers.

LEARNING TASKS	CONTENT

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

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

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

LEARNING TASKS	CONTENT
	o Duplex o Differential o Draft o Oxygen service o 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 able to:

- Calibrate pressure gauges
  - Draft gauge
  - Bourdon gauge
- Calibrate mechanical, 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): E INSTALL AND SERVICE PROCESS MEASURING DEVICES

Competency: E2 Install and service pressure measuring devices

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.

LEARNING TASKS	CONTENT

1. Examine types of pressure	• Absolute
	• Differential
	• Gauge
	• 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

4. Configure / calibrate pressure measuring devices	• Device operation
	• Primary calibration standards
	  o Manometer types
	  ▪ Well
	  ▪ Raised Well
	  ▪ Dual tube
	  ▪ Incline
	  ▪ U-tube
	  ▪ Slack tube
	  o Manometer fluids
	  ▪ Mercury
	  ▪ Unity oil

LEARNING TASKS	CONTENT
	▪ Water ▪ Red oil ▪ Meriam #3 ▪ Fluoroscien o 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	• Manufacturers' recommended maintenance procedures

Achievement Criteria

Performance	The learner will be able 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): F INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT

Competency: F1 Apply the principles of air supply

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	CONTENT
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 able 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%

Line (GAC): F INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT

Competency: F2 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	CONTENT

1. Examine types of tubing and installation procedures	• Plastic
	• Stainless steel
	• Copper
	• Rubber
	• Process and pressure requirements
	  o Sizes
	  o Pressure and temperature ratings

2. Examine types of fittings and installation procedures	• Types of fittings
	  o Unions
	  o Elbows
	  o Tees
	  o Couplings
	  o Bushings
	  o Reducers
	  o Caps
	  o Plugs
	  o Bulkhead fittings
	  o Others
	• Tube fittings
	  o Compression
	  o Flared
	  o Hydraulic
	• Process and pressure requirements
	  o Sizes
	  o Pressure and temperature ratings
	• Pipe fittings
	  o Ratings

3. Examine tube bending techniques	• Calculating dimensions • Manual tube benders • Hydraulic tube benders

LEARNING TASKS	CONTENT
4. Install tubing and fittings	• Ferrule construction and location • Tightening fittings • Follow P&ID drawings • Select appropriate tubing and fittings

Achievement Criteria

Performance	The learner will be able 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%

Line (GAC): F INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT

Competency: F3 Install and service pneumatic systems

Objectives

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

- Calibrate pneumatic instruments to required specifications.

LEARNING TASKS	CONTENT
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 fundamental operating principles of pneumatic equipment	• Force balance • Motion balance

4. Examine fundamental 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 able 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): G INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT

Competency: G1 Apply the principles of 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	CONTENT

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 Alternating current (AC)
	  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	CONTENT
4. Explain Ohm's law	• Relationship between voltage (E), current (I) and resistance (R) in an electrical circuit o E= I x R

Line (GAC): G INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT

Competency: G2 Perform wiring installations using the Canadian Electrical Code (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
  - Crimping
  - Terminal blocks
  - Marrettes
  - Soldering
  - Protection (heat shrink, taping etc.)
- Shielding
- Grounding
- Grounding loops
- CEC requirements
- Wire sizing
- Routing of wiring runs
- Stripping wire
- Labeling/colour-coding wire
- Connecting wire

Line (GAC): G INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT

Competency: G3 Apply the principles of DC electricity

Objectives

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

- Apply the basic principles of DC electricity.
- Use DC electrical equipment and instruments.

LEARNING TASKS	CONTENT
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 x 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 x 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 able 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): G INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT

Competency: G4 Apply the principles of AC electricity

Objectives

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

- Apply the basic principles of AC electricity.
- Use AC circuits.

LEARNING TASKS	CONTENT
1. Describe AC electricity	• Generation • Polarity and waveform analysis
2. Examine various types of transformers	• Step up • Step down • Automatic • SOLA • Isolation
3. Examine the use of capacitors and inductors in AC circuits	• Applications • Filtering • Regulating voltage • Power factor correction
4. Size electrical components for various circuits	• Capacitors • Inductors • Resistors • Wire • Fuses
5. Build and test circuits	• Demonstrate use of various AC components in circuits • Measuring techniques and equipment • Sizing components
6. Types of AC circuits	• Class 1 • Class 2 • Section 16 CEC
7. Examine installation procedures for AC equipment	• Wiring methods (Section 12 CEC) • Support • Grounding • Shielding
8. Apply proper circuit connection techniques	• Soldering • Crimping • Printed circuit board repair

Achievement Criteria

Performance	The learner will be able 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%

Line (GAC): G INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT

Competency: G5 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	CONTENT

1. Examine basic 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 Negation and polarity indicators
	  o NOT gate
	  o AND gate
	  o OR gate
	  o NAND gate
	  o NOR gate
	  o XOR gate
	  o XNOR gate

Achievement Criteria

Performance	The learner will be able to apply principles of digital logic in Instruction List (IL) programming
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 INSTALL AND SERVICE FINAL CONTROL ELEMENTS

Competency: H1 Install and service regulators and relief valves

Objectives

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

- Service regulators.
- Explain the operation of relief valves.
- Service basic emergency shutdown devices (ESDs).

LEARNING TASKS	CONTENT

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

4. Examine relief valves	• Applications

LEARNING TASKS	CONTENT
	○ Safety device • Reset differential • Certification and testing
5. Service basic ESDs	• Manipulate process to allow for servicing ○ Alerting operations ○ Awareness of impact on process • Test ESD components • Alarming ○ Audible alarms ○ Visible alarms ○ Response to alarm ○ Notificatons

Achievement Criteria

Performance	The learner will be able to: • Service regulators • Service basic 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): H INSTALL AND SERVICE FINAL CONTROL ELEMENTS

Competency: H2 Install and service control valves and actuators

Objectives

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

- Service control valves.
- Install and service actuators.

LEARNING TASKS	CONTENT
1. Examine actuators	• 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
2. Examine control valves	• Process applications o Metallurgy o Seal/shut off requirements • Flow Characteristics o Quick opening o Linear o Equal percentage • Body Types o Sliding stem – Globe – Bar stock – Pinch valve

LEARNING TASKS	CONTENT
	o Rotary – Butterfly – E-Disc – Segmented ball – Through-bore ball – Restricted trim • Components o Cages o Plugs o Seats o Stems o Packing • Types and applications of valve packing o Teflon o Graphite o Rope
3. Service control valves	• Gaskets • Sealants • Positioning valve in process • Securing valve using appropriate process o Flanged o Screwed o Wafered/flangeless • Isolation of valve from process • Testing procedures o Stroke to ensure proper operation o Leak testing • Possible faults o Leaking packing o Valve passing o Damaged parts o Incorrect travel • Cleaning/lubricating • Repairing/rebuilding
4. Install and service actuators	• Matching to valve • Connecting to valve o Lifting procedures • Valve travel • Bench set

LEARNING TASKS

CONTENT

- Verifying operation
  - Correct air supply pressure
- Function testing
- Possible faults
  - Leaking diaphragms
  - Broken springs
  - Damaged/worn O-rings
- Removing/replacing components
- Cleaning/lubricating components
- Assembling/disassembling
  - Spring compression
  - Loading on stem connector
  - Returning to service

Achievement Criteria

Performance	The learner will be able 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%

Line (GAC): H INSTALL AND SERVICE FINAL CONTROL ELEMENTS

Competency: H3 Install and service valve positioners

Objectives

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

- Install and service valve positioners on final control elements.

LEARNING TASKS	CONTENT

1. Examine valve positioners	• Types
	  o Pneumatic
	  o Electronic
	  o Digital
	  o Electro hydraulic
	  o Electro mechanical
	• Applications
	  o Sliding stem/rotary
	  o Piston/diaphragm
	• Components
	  o Levers
	  o Nozzles
	  o Flappers
	  o Relays
	• Auxiliaries
	  o Locks
	  o Boosters
	  o Speed controls
	• Parameters
	• Relation to actuator type/application

2. Install and service valve positioners	• Mounting
	• Connecting to actuator
	• Connecting to process control system
	• Configuring
	  o Set stroke
	  o Set pressures
	  o Match to actuator
	• Calibrating
	  o Connecting calibration instruments
	  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 able 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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J3 Install and service programmable logic controllers (PLC)

Objectives

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

- Explain basic programmable logic controllers (PLCs) from introductory materials on PLCs
- Create a simple PLC program using instruction list (IL) language

LEARNING TASKS	CONTENT

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

2. Identify the five IEC 61131-3 PLC programming languages	• 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

4. Create a simple PLC program using the Instruction List (IL) programming language	• IL operators in the program
	  o LD, ST, S, R, AND, OR, XOR, ADD, SUB, MUL, DIV, GT, GE, EQ, NE, LE, LT
	• Subroutine commands
	  o JMP, CAL, RET
	• Timer and Counter commands
	  o TON, CD

Achievement Criteria

Performance	The learner will be able to create a simple PLC program using the Instruction List (IL) programming language
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 2

Instrumentation and Control Technician

Line (GAC): A PERFORM SAFETY RELATED FUNCTIONS

Competency: A4 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.
- Explain personal safety system applications.

LEARNING TASKS	CONTENT
1. Describe radiation safety devices	• Radiation (gamma) survey meter • Personal dosimeter

Line (GAC): C ORGANIZE WORK

Competency: C2 Use computers and related applications

Objectives

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

- Configure and program instrumentation devices to manufacturers' specifications.

LEARNING TASKS	CONTENT
1. Examine diagnostic and configuration software, hardware and firmware	• Types o PC software o SMART calibrators o HART communicators • Configuration and programming software used in Level 2 o Flow element sizing programs o Temperature and density signal linearization o Control valve sizing
2. Use diagnostic and configuration software, hardware and firmware	• Configuration and programming software used in Level 2 o Primary flow element sizing programs o AGA Mass flow computers o Control valve sizing programs

Achievement Criteria

Performance	The learner will be able to: • Perform computerized flow calculations • Program an AGA mass flow computer • Size a control valve given the process application parameters
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 ORGANIZE WORK

Competency: C4 Use trade related diagrams, drawings and schematics

Objectives

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

- Describe drawings and schematics.
- Describe symbols.
- Use P&ID/P&C/loop drawings.

LEARNING TASKS	CONTENT
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 able to use and modify 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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E3 Install and service temperature measuring devices

Objectives

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

LEARNING TASKS	CONTENT
1. Examine temperature scales	• Fahrenheit • Celsius • Kelvin • Conversions between scales

2. Examine temperature measuring devices and their operation	• 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

3. Examine temperature calibrating instruments	• 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

4. Install, calibrate and service temperature measuring devices	• Manufacturers' specifications
	• Best Practices for selection/location of measuring device
	  o Response time
	  o Temperature ranges

LEARNING TASKS

CONTENT

- 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
  - Callendar Van Dusen
- 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 able 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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E4 Install and service level measuring devices

Objectives

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

- Install, calibrate and service level measuring devices.

LEARNING TASKS	CONTENT

1. Examine level measuring devices and their operation	• Point level
	  o Capacitance
	  o Float switches
	  o Tuning fork
	  o Bindicator
	  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
	• Boiler drum level

2. Examine calibration instruments used on level measuring devices	• Pressure calibrator • Laptop/software • Handheld programmer (configurator)

3. Install, calibrate and service level measuring devices	• Manufacturers' specifications
	• Selection/location of measuring device
	  o Process application
	  o Process medium
	  o Price
	  o Best practices
	• Verify operation
	• Device check/calibration

LEARNING TASKS	CONTENT
	• 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 able 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%

Line (GAC): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E5 Install and service flow measuring devices (*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	CONTENT

1. Examine flow measuring devices and their operation	• Bernoulli's Theorem
	• Differential pressure sensors
	  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 Variable area flow meters
	• Velocity
	  o Turbine
	  o Vortex
	  o Ultrasonic
	  o Magnetic flow meter
	• Mass flow
	  o Coriolis
	  o Multi-variable mass flow
	  o Thermal
	  o Weightometer fundamentals (conveyors)
	• 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)
3. Install, calibrate and service flow measuring	• Manufacturers' specifications

LEARNING TASKS	CONTENT

devices	• Selection/location factors
	  o Straight pipe requirements
	  o Accuracy requirements
	  o Process application
	  o Process medium
	  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 able to: • Assess flow installations to confirm best practices • Calibrate and service flow measuring devices • Program and calibrate multivariable mass flow 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 INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E6 Install and service signal transducers

Objectives

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

- Calibrate and service signal conditioners to process requirements.

LEARNING TASKS	CONTENT

1. Examine signal conditioners and their operation	• Pneumatic relays
	  o Signal converters
	  o Volume boosters
	• I/P, P/I transducers
	• Hardware and software
	  o High select
	  o Function block
	• Square root extraction
	• Integrators

2. Calibrate and service signal conditioners	• Manufacturers' specifications for installation
	  o Moore Industries
	  o Fisher 846
	  o Rosemount

Achievement Criteria

Performance	The learner will be able 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 INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E7 Install and service mass measuring devices

Objectives

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

- Install, calibrate and service mass measuring devices.

LEARNING TASKS	CONTENT
1. Examine mass (weight) measuring devices and their operation	• Load cells • Scales • Strain gauges
2. Examine calibration instruments used on mass (weight) measuring devices	• Test weights • Calibration chains • Wheatstone bridge • Laptop/software • Handheld programmer (configurator)

3. Install, calibrate and service mass (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 able to: • Assess mass (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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E8 Install and service density measuring devices

Objectives

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

LEARNING TASKS	CONTENT

1. Examine density measuring devices and their operation	• Types
	  o Hydrometer
	  o Hydrostatic head
	  o Displacers
	  o Nuclear
	  o Refractometer
	  o Boiling Point Rise (BPR)
	  o Coriolis meters
	• Effect of temperature on density

2. Examine calibration instruments used on density measuring devices	• Pressure calibrator • Laptop/software • Handheld programmer (configurator)

3. Install, calibrate and service density measuring devices	• Manufacturers' specifications
	• Selection/location of measuring device
	  o Process application
	  o Process medium
	  o Price
	  o 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
	• Radiation source regulatory safety test

Achievement Criteria

Performance	The learner will be able 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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E15 Install and service multiple variable computing devices

Objectives

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

- Configure a multivariable steam or natural gas flow metering system.
- Explain the purpose and application of a temperature compensated vortex steam flow meter.

LEARNING TASKS	CONTENT
1. Examine multivariable flow meters	• Operation of multivariable flow meters o Mass steam flow o Mass air flow o Temperature compensated vortex steam flow (volumetric to mass) o Floboss meters for natural gas custody transfer o Pressure and temperature compensated natural gas turbine flow measurement
2. Configure (calibrate) multivariable flow meters	• Calibration / certification of multivariable transmitters o Mass steam flow o Mass air flow o Temperature compensated vortex steam flow (volumetric to mass) o Floboss meters for natural gas custody transfer o Pressure and temperature compensated natural gas turbine flow measurement

Achievement Criteria

Performance	The learner will be able to program and calibrate a multivariable flow transmitter
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 INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT

Competency: F3 Install and service pneumatic systems

Objectives

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

- Explain the installation and servicing of pneumatic systems

LEARNING TASKS	CONTENT
1. Examine operating principles of pneumatic equipment	• Force balance • Motion balance

2. 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

Achievement Criteria

Performance	The learner will be able to: • Troubleshoot a pneumatic transmitter • Service and maintain a pneumatic transmitter
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 INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT

Competency: F4 Install and service 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	CONTENT

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 able 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): G INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT

Competency: G5 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	CONTENT

1. Review basic 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 Negation and polarity indicators
	  o NOT gate
	  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

Achievement Criteria

Performance	The learner will be able to: • Interpret digital logic circuits • Build and test a basic digital logic circuit
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 INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT

Competency: G6 Apply the principles of electronics

Objectives

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

- Explain electronic equipment and its operation.

LEARNING TASKS	CONTENT

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 Bridge rectifier
	  o Filtering
	  o UPS system
	  ▪ Online (Double conversion)
	  ▪ Line-interactive

Achievement Criteria

Performance	The learner will be able 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 INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT

Competency: G7 Install and service electronic equipment

Objectives

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

- Install and service electronic equipment to manufacturers' specifications.

LEARNING TASKS	CONTENT

1. 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

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

Achievement Criteria

Performance	The learner will be able 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): H INSTALL AND SERVICE FINAL CONTROL ELEMENTS

Competency: H2 Install and service control valves and actuators

Objectives

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

- Size and select control valves and actuators.

LEARNING TASKS	CONTENT
1. Examine sizing and selection of actuators	• Size and force required by process conditions

2. Examine sizing and selection of control valves	• Defining C_v
	• 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 ΔP 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 able to select the correct valve type and size for process given 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): H INSTALL AND SERVICE FINAL CONTROL ELEMENTS

Competency: H3 Install and service valve positioners

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	CONTENT

1. Examine advanced diagnostics and operational capabilities of SMART positioners	• Determining valve and actuator health
	  o Stiction
	  o Friction
	  o Hysterisis
	  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 Calibraton parameters
	  o Interpretation of calibration results
	  o Cause/effect of calibration errors
	• Component maintenance
	  o Remove
	  o Replace
	  o Repair
	  o Clean
	• Returning to service

Achievement Criteria

Performance	The learner will be able 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

Instrumentation and Control Technician

Line (GAC): C ORGANIZE WORK

Competency: C1 Plan 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	CONTENT

1. Examine and determine standard work requirements	• Materials
	• Equipment and tools
	• Personnel
	• Task planning
	  o Hazard assessment
	  o Process hazards
	  ▪ Pressure
	  ▪ Temperature
	  ▪ Chemical
	• Work scheduling

2. Examine and apply related skills	• Estimating
	  o Time
	  o Cost
	  o Materials
	  o Manpower
	• 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
	• Standard Operating Procedure (SOP)
	• Management of Change Documentation
	  o Instrument change
	  o Range change
	  o Process change
	• Maintenance schedules
	  o Preventative
	  o Predictive
	  o Reliability centered

LEARNING TASKS

CONTENT

- Related software
  - Spreadsheets
  - Databases
- Word processing

Achievement Criteria

Performance	The learner will be able to: • Estimate labour and material requirements • 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): C ORGANIZE WORK

Competency: C2 Use computers and related applications

Objectives

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

- Configure and program instrumentation devices to manufacturers' specifications given related hardware, software and firmware.

LEARNING TASKS	CONTENT
1. Use diagnostic and configuration software, hardware and firmware	• Configuration and programming software o AutoCAD o Fieldcare o Pactware o Valve sizing o HMI ▪ Vijeo ▪ Wonderware
2. Maintain back-up data and documentation	• Configuration and programming software o AutoCAD o Fieldcare o Pactware o Valve sizing o HMI ▪ Vijeo ▪ Wonderware

Achievement Criteria

Performance	The learner will be able to configure and program 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%

Line (GAC): C ORGANIZE WORK

Competency: C4 Use trade related diagrams, drawings and schematics

Objectives

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

- Develop drawings and schematics.
- Describe symbols.
- Use P&ID/P&C/loop drawings.

LEARNING TASKS	CONTENT
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 able to use and develop 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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E9 Install and service consistency measuring devices

Objectives

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

- Install, calibrate and service consistency and viscosity measuring devices.

LEARNING TASKS	CONTENT

1. Examine consistency and viscosity measuring devices and their operation	• Types (analog and SMART)
	  o Optical
	  o Rotary
	  o Blade
	  o Microwave
	  o Nuclear
	  o Viscometer
	• Factors affecting system performance
	  o Temperature
	  o Flow
	  o Vibration
	  o Pressure
	  o Process considerations

2. Examine instruments and techniques used to calibrate consistency and viscosity measuring devices	• Multimeters • Calibrated weights • Sampling and lab tests

3. Calibrate and service consistency measuring devices	• Manufacturers' specifications
	• Selection/location factors
	  o Accuracy requirements
	  o Process application
	  o Process medium
	  o Cost
	  o Best practices
	• 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 able 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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E10 Install and service vibration measuring devices

Objectives

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

- Calibrate and service vibration measuring devices using a vibration measuring system.

LEARNING TASKS	CONTENT
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 able 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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E11 Install and service speed measuring devices

Objectives

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

- Explain the servicing requirements of speed measuring devices.

LEARNING TASKS	CONTENT
1. Examine relevant laws & principles of physics	• Speed • Velocity

2. Examine speed measuring devices and their applications	• 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

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

Line (GAC): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E12 Install and service position measuring devices

Objectives

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

- Explain the servicing requirements of position measuring devices.

LEARNING TASKS	CONTENT

1. Examine position measuring devices and their applications	• Analog position sensors
	  o Linear variable differential transformer (LVDT)
	  ▪ Temposonic rods
	  o Proximity switches
	  o Proximity probes
	  o Analog position sensors
	  o Lasers
	  o Global positioning system (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	• Manufacturers' recommended maintenance procedures • Maintenance actions • Identifying cause of calibration errors • Bringing device within calibration parameters • Repair and cleaning of device

Line (GAC): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E13 Install and service motion measuring devices

Objectives

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

- Explain the servicing requirements of motion measuring devices.

LEARNING TASKS	CONTENT

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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E14 Install and service process analyzers *(liquids and solids)*

Objectives

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

- Calibrate and service process liquid analyzers to process requirements.
- Explain the theory and operating parameters of process solids analyzers.

LEARNING TASKS	CONTENT

1. Examine process liquid analyzers	• pH
	  o Measuring electrode
	  o Reference electrode
	  o FET electrode
	• Conductivity
	  o 2 electrode
	  o 4 electrode
	  o Torroidal
	• Oxidation Reduction Potential (ORP)
	• Specific ion
	• Dissolved oxygen
	• Turbidity
	• Water/effluent treatment
	  o Biological Oxygen Demand (BOD)
	  o Chemical Oxygen Demand (COD)
	  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
3. Calibrate and service process liquid analyzers	• Manufacturers' specifications • Selection/location factors

LEARNING TASKS	CONTENT
	o Measurement delays o Chemical mixing o Temperature requirements • Connection to control system or indicator • Configuration of devices • Calibration of devices o Buffering solutions o Calibration standards
4. Examine types of process solids analyzers	• Nuclear devices • Assays • Moisture content • X-ray devices • Near infra-red
5. Examine methods used by process solids analyzers	• Online o Material handling considerations o Interface with system • Offline/lab test o Sample/weigh/dry/weigh o Chemical theory • Standards o ASTM
6. Examine operating parameters of process solids analyzers	• Accuracy • Repeatability • Interaction with process • Sources of contamination • Sampling systems • Conditions required • Method used
7. Examine other process analyzers	• Brightness • Paper sheet scanners • Kappa (K#) analyzers • Sulfidity • Crossbelt analyzers o Gamma matrix

Achievement Criteria

Performance	The learner will be able to calibrate and service process liquid 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): F INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT

Competency: F3 Install and service pneumatic systems

Objectives

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

LEARNING TASKS	CONTENT
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 able 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%

Line (GAC): H INSTALL AND SERVICE FINAL CONTROL ELEMENTS

Competency: H4 Install and service variable speed drive (VSD) and variable frequency drive (VFD)

Objectives

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

- Configure and test VSD and VFD.

LEARNING TASKS	CONTENT

1. Examine basic operation of VSD and VFD	• Operation
	  o Tuning parameter identification
	  o Signal isolation DCS/VFD
	• Control of speed
	  o Eddy Current Coupling (ECC)
	  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 able to configure and test VSD and VFD
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 INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES

Competency: I1 Install and service control network systems

Objectives

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

- Explain the basic structures and components of communication networks.

LEARNING TASKS	CONTENT
1. Examine hardware layers	• 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	• 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)
3. 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

LEARNING TASKS	CONTENT
	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
4. 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 able 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 INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES

Competency: I3 Install and service gateways, bridges and media converters

Objectives

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

- Explain the features and limitations on specified communication protocols.

LEARNING TASKS	CONTENT

1. Examine types of signal transmission systems	• Fibre optics
	  o Armoured cable
	  o Non-armoured cable
	  o Multimode/single mode transmission
	• Wired
	  o Coax
	  o Unshielded Twisted Pair (UTP)

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

Line (GAC): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J1 Establish and optimize process control strategies

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	CONTENT

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 pH
	  o Conductivity

3. Operate processes and troubleshoot control problems.	• Multiple effect evaporation

LEARNING TASKS

CONTENT

- Material handling/quality control
  - Pulp consistency control process
- Chemical reaction
  - pH
  - Conductivity

Achievement Criteria

Performance	The learner will be able 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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J2 Install and service stand-alone controllers (SAC)

Objectives

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

- Explain basic control theory, actions and operational modes.

LEARNING TASKS	CONTENT
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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J3 Install and service programmable logic controllers (PLC)

Objectives

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

- Program PLC in ladder logic.
- Troubleshoot various PLC, given appropriate instructional materials.

LEARNING TASKS	CONTENT

1. Review PLC languages and symbols	• IEC Standard 61131-3 Programming Languages
	  o Instruction List (IL)
	  o Structured Text (ST)
	  o Ladder Diagram (LD)
	  o Function Block Diagram (FBD)
	  o Sequential Function Chart (SFC)

2. Examine, create and troubleshoot industrial PLC installations	• Hardware • Assembly • Configuration • I/O addressing • Programming o Ladder logic • Data Tables • User Programs
3. Examine and troubleshoot PLC components	• CPU • Memory organization • Input interface • Output interface • Power supply • Programming/monitoring interface • Network communication module

4. Back up and document PLC data for future recovery	• Back up and document programming
	  o Configuration
	  o Settings
	  o Parameters

Achievement Criteria

Performance	The learner will be able 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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J4 Install 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	CONTENT
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 able 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%

Line (GAC): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J7 Install and optimize advanced supervisory control systems

Objectives

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

- Perform process optimization for an advanced supervisory control system.

LEARNING TASKS	CONTENT
1. Examine and diagnose safety instrumented systems (SIS)	• SIL levels • Voting structures • Documentation

Level 4

Instrumentation and Control Technician

Line (GAC): C ORGANIZE WORK

Competency: C2 Use computers and related applications

Objectives

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

- Configure and program instrumentation devices to manufacturers' specifications given related hardware, software and firmware.

LEARNING TASKS	CONTENT
1. Examine diagnostic and configuration software, hardware and firmware	• Types o SMART communicators o SMART calibrators o Various PC programs • Configuration and programming software o IACC (Foxboro) o Unity (Schneider) o Control Logix (Allen Bradley) o Delta V (Emerson)
2. Use diagnostic and configuration software, hardware and firmware	• Configuration and programming software o IACC o Unity o Control Logix o Delta V

Achievement Criteria

Performance	The learner will be able to configure and program 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%

Line (GAC): C ORGANIZE WORK

Competency: C4 Use trade related diagrams, drawings and schematics

Objectives

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

- Create basic schematics and drawings.

LEARNING TASKS	CONTENT
1. Create and modify basic drawings	• Electronic drawing o AutoCAD • P&ID and SAMA drawings • Loop drawings

Achievement Criteria

Performance	The learner will be able 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%

Line (GAC): D USE COMMUNICATION AND MENTORING TECHNIQUES

Competency: D2 Use mentoring techniques

Objectives

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

- Explain mentoring techniques.

LEARNING TASKS	CONTENT

1. Describe effective mentoring techniques	• Verbal
	• Non-verbal
	  o Body language
	  o Signals
	• Active listening
	  o Hearing
	  o Interpreting
	  o Reflecting
	  o Responding
	  o Paraphrasing
	• Personal responsibilities
	  o Attitude
	  o Harassment
	  o Descrimination

2. Describe learning strategies	• Coaching
	• Practice
	• Assessing
	  o Feedback
	  o Correcting
	• Reinforcement

3. Describe outcomes of effective coaching	• Responsibilites • Punctuality • Safety • Collaboration

Line (GAC): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E14 Install and service process analyzers *(Gas)*

Objectives

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

- Calibrate and service gas chromatographs.
- Calibrate and service flue gas analyzers.

LEARNING TASKS	CONTENT
1. Examine gas chromatographs	• Gas analysis • Methane, Ethane, Propane, Butane, etc. • Sulfur species
2. Examine gas chromatograph operational theory	• Chromatography • Flame Ionization detector (FID) • Photo Ionization detector (PID) • Thermal Conductivity detector

3. Examine operating parameters of gas chromatographs	• Accuracy
	• Repeatability
	• Interaction with process
	• Sources of contamination
	• Sampling systems
	  o In situ
	  o 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
5. Calibrate and service gas chromatographs	• Manufacturers' specifications • Selection/location factors • Connection to control system or indicator • Configuration of devices

LEARNING TASKS	CONTENT
	• Alarming methods • Calibration of devices o Laptop/software Test gas selection and storage

6. Examine flue gas analyzers	• Online
	  o Excess oxygen
	  o CO
	  o Particulate/opacity
	  o TRS
	  o NOX
	  o SOX
	• Offline
	  o Orsat
	  o Fyrite

7. Examine flue gas analyzer operational theory	• Thermo-paramagnetic • Zirconium oxide • Catalytic combustibles detector • Infrared laser

8. Examine operating parameters of flue gas analyzers	• Accuracy
	• Repeatability
	• Interaction with process
	• Sources of contamination
	• Sampling systems
	  o In situ
	  o Convective
	  o Close-coupled extractive
	  o Extractive

9. Calibrate and service process flue gas analyzers	• Manufacturers' specifications • Selection/location factors • Connection to control system or indicator • Configuration of devices • Alarming methods • Calibration of devices o Laptop/software • Test gas selection and storage

Achievement Criteria

Performance	The learner will be able to calibrate and service: • Process gas chromatographs • 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): E INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES

Competency: E15 Install and service multiple variable computing devices

Objectives

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

- Configure a multivariable steam or natural gas flow metering system.
- Explain the purpose and application of a temperature compensated vortex steam flow meter.

LEARNING TASKS	CONTENT
1. Examine multivariable flow meters	• Operation of multivariable flow meters o Mass steam flow o Mass air flow o Temperature compensated vortex steam flow (volumetric to mass) o Floboss meters for natural gas custody transfer o Pressure and temperature compensated natural gas turbine flow measurement
2. Configure (calibrate) multivariable flow meters	• Calibration/certification of multivariable transmitters o Mass steam flow o Mass air flow o Temperature compensated vortex steam flow (volumetric to mass) o Floboss meters for natural gas custody transfer o Pressure and temperature compensated natural gas turbine flow measurement

Achievement Criteria

Performance	The learner will be able to: • Configure (program) multivariable transmitters • Certify the accuracy of a multivariable transmitter
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 INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES

Competency: I1 Install and service control network systems

Objectives

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

- Explain the basic structures and components of communication networks.

LEARNING TASKS	CONTENT
1. Explain types of networking	• Serial networks • Ethernet • Wireless networks
2. Configure network addressing	• Serial • Ethernet • Wireless
3. Test network communications	• Send and receive data o Protocols ▪ Serial ▪ Ethernet ▪ Wireless
4. Install and configure wireless systems	• Satellite • Cellular • Bluetooth • RF • IR • IEEE standards

Achievement Criteria

Performance	The learner will be able 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 INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES

Competency: I2 Install and service signal converters

Objectives

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

- Calibrate and service signal conditioners (A/D and D/A) to process requirements.

LEARNING TASKS	CONTENT
1. Explain the operations of signal conversion	• Digital to analog converters • Analog to digital converters
2. Test and certify the operation	• Test the operation of a D/A converter • Test the operation of an A/D converter

Achievement Criteria

Performance	The learner will be able 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): I INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES

Competency: I3 Install and service gateways, bridges and media converters

Objectives

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

- Explain the features and limitations on specified communication protocols.
- Configure and test communication protocols.

LEARNING TASKS	CONTENT
1. Explain the operation of gateways, bridges, media converters, routers and switches	• Ethernet connections • Serial connections
2. Configure switches and routers as required; connect and test connections to and from hosts and slaves	• Test and confirm network • Test and confirm communications

Achievement Criteria

Performance	The learner will be able to configure and test communication protocols
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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J1 Establish and optimize process control strategies

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	CONTENT

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

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

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

Achievement Criteria

Performance	The learner will be able 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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J2 Install and service stand-alone controllers (SAC)

Objectives

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

- Explain advanced control theory, actions and operational modes.
- Apply advanced control applications using microprocessor-based controllers.

LEARNING TASKS	CONTENT

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
	  ▪ Handheld programmers
	  ▪ Software

Achievement Criteria

Performance	The learner will be able 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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J3 Install and service programmable logic controllers (PLC)

Objectives

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

- Program PLC in FBD.
- Program PLC in SFC.
- Troubleshoot PLC.

LEARNING TASKS	CONTENT
1. Configure PLC	• Configuration of analog plus discrete logic control strategies using both of the following IEC 61131-3 standard programming languages: o FBD o SFC • Software interface • Operation • Troubleshooting • SIS systems
2. Back up and document PLC data for future recovery	• Back up and document programming o Configuration o Settings o Parameters

Achievement Criteria

Performance	The learner will be able to: • Configure a PLC • Program in FBD and SFC languages
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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J4 Install and service human machine interface (HMI)

Objectives

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

- Configure HMI operator graphics.
- Program HMI software to communicate with a PLC or DCS.

LEARNING TASKS	CONTENT
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 configuration • Communication settings

Achievement Criteria

Performance	The learner will be able to: • Create HMI operator graphics • 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%

Line (GAC): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J5 Install and service distributed control systems (DCS)

Objectives

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

- Configure DCS equipment.

LEARNING TASKS	CONTENT

1. Examine DCS	• DCS
	  o Emerson
	  o Schneider (Foxboro)
	  o 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 able 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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J6 Install and service supervisory control and data acquisition (SCADA)

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	CONTENT

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 able 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): J INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL

Competency: J7 Install and optimize advanced supervisory control systems

Objectives

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

- Perform process optimization for an advanced supervisory control system.

LEARNING TASKS	CONTENT
1. Examine Batch Process Control	• Operation and application of Batch Process Control
2. Examine Batch Process Control and compare to other control applications and strategies	• Continuous • Discontinuous
3. Examine Batch Process Control software in use	• DCS and PLC • Applications (examples) o Batch pulp digester process o Cement plant o Oil pipeline transmission o Chemical industry o Food plant
4. Examine and tune boiler control systems	• 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
5. Examine other advanced supervisory control systems	• Predictive control techniques o Smith Predictors o Model Predictive Control (MPC) o Horizon Predictive Control

Achievement Criteria

Performance	The learner will be able to tune boiler 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): K INSTALL AND SERVICE SAFETY SYSTEMS AND DEVICES

Competency: K1 Install and service safety systems and devices

Objectives

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

- Troubleshoot flame detection equipment.
- Service flame safety systems.
- Explain the operation of process cameras and their applications.
- Explain the types of Emergency Shutdown Devices (ESD), their purposes and testing procedures.

LEARNING TASKS	CONTENT
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 Technical Safety BC 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
4. Examine process camera applications	• Leak monitoring • Fire monitoring • Intruder alert • Remote monitoring o Process control

LEARNING TASKS	CONTENT
	○ Quality control • Safety
5. Examine the operation of process cameras	• Analog and Digital • Manufacturers' specifications and recommendations • Selecting required equipment • Connecting to process/indicator • Configuring • Calibrating • Alarming
6. Examine types of ESD control systems	• Levels of shutdown ○ Equipment shutdown ○ Area shutdown ○ Total/Plant shutdown • Types of ESD ○ Electric ○ Pneumatic ○ Hydraulic ○ Mechanical
7. Examine purposes of different types of ESD	• Personnel protection • Environmental protection • Equipment protection
8. Examine ESD testing procedures	• Partial stroke test • Time test • Valve integrity • Interlock checks (system shut down check)

Achievement Criteria

Performance — The learner will be able 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): K INSTALL AND SERVICE SAFETY SYSTEMS AND DEVICES

Competency: K2 Install and service safety instrumented systems (SIS)

Objectives

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

- Diagnose Safety Instrumented Systems (SIS)

LEARNING TASKS	CONTENT
1. Review, examine and diagnose safety instrumented systems (SIS)	• SIL levels • Voting structures • Documentation
2. Examine Fire & Gas (F&G) safety systems	• Functionality tests o Calibrate sensors o Test safety functions

Achievement Criteria

Performance — The learner will be able to:

- Diagnose F&G safety systems and sensors
- Troubleshoot F&G safety systems and sensors

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): K INSTALL AND SERVICE SAFETY SYSTEMS AND DEVICES

Competency: K3 Install and service environmental monitoring devices

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	CONTENT

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

4. Install, configure and calibrate monitoring devices	• Manufacturers' specifications • Selection/location factors

LEARNING TASKS	CONTENT

	• Connection to control system or indicator
	• Configuration of devices
	• Alarming methods
	• Calibration of devices
	  o Laptop/software
	  o Test gas selection and storage
	• Documenting calibration

Achievement Criteria

Performance	The learner will be able 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%

Section 4

ASSESSEMENT GUIDELINES

Assessment Guidelines – Level 1

Level 1 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	INSTRUMENTATION AND CONTROL TECHNICIAN LEVEL 1		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	PERFORM SAFETY RELATED FUNCTIONS	3%	3%
B	USE TOOLS AND EQUIPMENT	3%	3%
C	ORGANIZE WORK	5%	5%
D	USE COMMUNICATION AND MENTORING TECHNIQUES	2%	2%
E	INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES	15%	15%
F	INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT	8%	8%
G	INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT	30%	30%
H	INSTALL AND SERVICE FINAL CONTROL ELEMENTS	28%	28%
J	INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL	6%	6%
	Total	100%	100%
In-school theory / practical subject competency weighting		65%	35%
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%

Assessment Guidelines – Level 2

Level 2 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	INSTRUMENTATION AND CONTROL TECHNICIAN LEVEL 2		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	PERFORM SAFETY RELATED FUNCTIONS	1%	1%
C	ORGANIZE WORK	5%	5%
E	INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES	44%	44%
F	INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT	10%	10%
G	INSTALL AND SERVICE ELECTRICAL AND ELECTRONIC EQUIPMENT	30%	30%
H	INSTALL AND SERVICE FINAL CONTROL ELEMENTS	10%	10%
	Total	100%	100%
In-school theory / practical subject competency weighting		65%	35%
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%

Assessment Guidelines – Level 3

Level 3 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	INSTRUMENTATION AND CONTROL TECHNICIAN LEVEL 3		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
C	ORGANIZE WORK	5%	5%
E	INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES	35%	35%
F	INSTALL AND SERVICE PNEUMATIC AND HYDRAULIC EQUIPMENT	2%	2%
H	INSTALL AND SERVICE FINAL CONTROL ELEMENTS	5%	5%
I	INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES	10%	10%
J	INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL	43%	43%
	Total	100%	100%
In-school theory / practical subject competency weighting		65%	35%
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%

Assessment Guidelines – Level 4

Level 4 Grading Sheet: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	INSTRUMENTATION AND CONTROL TECHNICIAN LEVEL 4		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
C	ORGANIZE WORK	2%	2%
D	USE COMMUNICATION AND MENTORING TECHNIQUES	3%	3%
E	INSTALL AND SERVICE PROCESS MEASURING AND INDICATING DEVICES	10%	10%
I	INSTALL AND SERVICE COMMUNICATION SYSTEMS AND DEVICES	10%	10%
J	INSTALL AND SERVICE CONTROL SYSTEMS AND PROCESS CONTROL	60%	60%
K	INSTALL AND SERVICE SAFETY SYSTEMS AND DEVICES	15%	15%
	Total	100%	100%
In-school theory / practical subject competency weighting		57%	43%
Final in-school percentage score Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal exam.		IN-SCHOOL %	

All apprentices who complete Level 4 of the Instrumentation and Control Technician 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 into ITA Direct Access.

A minimum percentage score of 70% on the examination is required for a pass.

Section 5

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
    - Overhead cranes, hydraulic lifts
- Workbenches with 6” vices
- Instrument air supply
- Water supply (100 psig)

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

- “Instruction list” Programmable Logic Controllers (e.g., Omron, Westinghouse, Schneider)

Level 2

- “Instruction list
  Programmable Logic Controllers (e.g., Omron, Westinghouse, Schneider)

- Access to a radiation source that may be used for level or density measurement

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
- 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

- Hand held programmer (configurator)
- Hand held pyrometer
- Hydrometer
- Infrared thermometer
- Lab scales
- Label maker
- Laptop computer
- Logic testers
- Loop calibrator/simulator
- Manometer (well and incline)
- Tachometer generator
- Temperature bath
- Test gases
- Test gauges (pressure, vacuum)
- Thermal meter
- Thermometer
- Variable transformer
- Vibration table (wobbulator)
- Wrist ground strap

Recommended

- Eddy current tachometer
- Laser strength meter
- Microwave leakage meter
- Stroboscope
- Wireless signal strength tester

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
- Electronic kit c/w breadboard (purchase from school – has required components for labs)

Reference Materials

Introduction

The amount of technical data and the rate of technological innovation confronting workers in this trade are extremely high.[1] 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 ICT 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

- *Canadian Electrical Code, Part 1*, most current edition.
- 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 Management and Analysis**
- Liptak, Bela G. **Instrument Engineers Handbook. Process Control and Optimization**
- Liptak, Bela G. **Instrument Engineers Handbook. Process Software and Digital Networks**
- 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**

[1] When asked about the technical information resources they use in their trade, about 2/3 of the SMEs, identified the "Help Menus" of the products they configure and install as a significant source of up-to-date technical information.

- Buchla, David — **Experiments of Digital Fundamentals**
- Floyd, Thomas L. — **Principals of Electric Circuits**
- 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 Hand Book**
- 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**
- Steingress, 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. — **Industrial Flow Measurement, 3rd edition. Instrument Society Of America, 2005.**
- Trevathan, Vernon L. — **Ed. A Guide to the Automation Body of Knowledge, 2nd edition. Instrument Society of America, 2006.**
- Eren, Halit — **Wireless communication systems/ Design and construction; CRC Press, 2006. 297 pages ISBN 0849336740**
- Macdonald, Dave — **Practical Industrial Safety, Risk Assessment and Shutdown Systems, 2003.**
  Paperback, 384 pages, publication date: NOV-2003
  ISBN-13: 978-0-7506-5804-1

  ISBN-10: 0-7506-5804-5

ONLINE RESOURCES

(AS OF AUGUST 2020)

- 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.croftinst.com/home.htm Croft Instrument Systems – process instrument designers, suppliers and manufacturers. Process Solids: (see: “suspended solids” and “standard consistency” for technical/product notes).
- 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/fisher Fisher.
- 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.enmet.com Enmet Corporation. Manufactures gas and vapor detectors, stationary and portable.
- 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.gongol.net DJ Gongol and Associates, manufacturers of range of process-control related equipment. Select “Instruments” – scroll to “toxic gas detections”, see specifications for portable and hand held equipment.
- www.graceindustries.com Grace Industries manufactures industrial safety products. Information on lone worker security systems (click “industrial Safety products”).
- www.honeywell.com Honeywell.
- www.iceweb.com.au/Technical/LevelTechnologies.html
- www.invensys.com Invensys.
- www.isa.org The Instrumentation, Systems and Automation Society.
- 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.

- 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.
- www.nfpa.org/codes-and-standards/document-information-pages NFPA Codes and Standards e.g. NFPA 85 – Boiler and Combustion Systems Hazards Code.
- http://www.ca.endress.com/en Endress + Hauser.
- http://www.blrbac.org/ Black Liquor Recovery Boiler Advisory Committee.
- 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 – Information on basic process measurements like flow, temperature, pressure, pH, conductivity, level, etc.
- www.ohsonline.com --National US website on employment safety issues; use Search button to get information on personal gas detectors.
- 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 Rae Systems. See technical and application notes for information on hand held and portable sensors (personal safety systems).
- www.scadalink.com Bentek Systems. See Tech notes for information on wireless SCADA systems.
- www2.sea.siemens.com/Products/Process-Instrumentation/Support/PI-User-Manuals --advanced control strategies.
- www.smar.com/PDFs/Catalogues/FBTUTCE.pdf -- Foundation Fieldbus information.
  www.smar.com/PDFs/Catalogues/HARTTUTCE.PDF -- a good tutorial on HART communication.
- www.spitzerandboyes.com
- www.vegacontrols.co.uk/vega_downloads_open.htm --Radar and ultrasonic level measurements.
- 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 Yokogawa.
- www.zoneni.com National Instruments – see the NI developer zone.
- http://www.itabc.ca/program/instrumentation-and-control-technician-industrial-instrument-mechanic
  http://nuclearsafety.gc.ca/eng/ Canadian Nuclear Safety Commission.
- http://www.nist.gov/ - National Institute of Standards and Technology.
- The Engineering Mindset. Power factor Explained – The Basics What is Power Factor pf,
  https://www.youtube.com/watch?time_continue=2&v=Tv_7XWf96gg&feature=emb_logo
- Vesma, Vilnis, Three Phase Explained,
  https://www.youtube.com/watch?time_continue=2&v=MnH_ifcRJq4&feature=emb_logo
- Khutoryansky, Eugene. Op Amp Circuits: Analog Computers from operational amplifiers.
  https://www.youtube.com/watch?time_continue=1&v=_o4ScgRZtNI&feature=emb_logo
- Stron Medicine. Hydrostatic Pressure (Fluid Mechanics – Lesson 3).
  https://www.youtube.com/watch?time_continue=2&v=C0ujLqKPWew&feature=emb_logo
- TED – Ed. The History of the barometer (and how it works) – Asaf Bar-Yosef.
  https://www.youtube.com/watch?time_continue=1&v=EkDhlzA-lwI&feature=emb_logo

- Mensor LP. DH-Budenberg CPB5800 Deadweight Tester Overview | How Dual Piston Technology Works. https://www.youtube.com/watch?v=OH-T_CcAJj0&feature=emb_logo
- LunchBox Sessions. LunchBox Sessions Youtube Channel. https://www.youtube.com/channel/UCBX5Aj80CYu_DWmwdIZGIKQ
- Learnchannel. Learnchannel Youtube Channel. https://www.youtube.com/channel/UCy9UQv9SaA-fKpqoE1VWjCg
- The Physics Channel. The Physics Channel Youtube channel. https://www.youtube.com/channel/UCaVjLZhirwDg-D0hBcqT4Vg,
- Endress+Hauser. Endress+Hauser Youtube Channel. https://www.youtube.com/channel/UCZGXEDoheb9GkTnB4BPKoaQ
- RealPars. What is a Level Sensor?. https://www.youtube.com/watch?time_continue=3&v=EMotg3BQjlI&feature=emb_logo
- Emerson. Emerson Youtube Channel, Fisher Valves & Instruments. https://www.youtube.com/channel/UCeeaILbj7WNXOxF0bbu2HCQ
- RedVectorOnline. Three Basic Mechanisms for Pneumatic Controllers. https://www.youtube.com/watch?time_continue=1&v=8_UPBYucUM0&feature=emb_logo
- Technical Engineering School. Technical Engineering School Youtube Channel. https://www.youtube.com/channel/UCR0EfsRZIwA5TVDaQbTqwEQ
- Learn Engineering. Learn Engineering Youtube Channel. https://www.youtube.com/channel/UCqZQJ4600a9wIfMPbYc60OQ
- CrashCourse. Boolean Logic & Logic Gates: Crash Course Computer Science #3. https://www.youtube.com/channel/UCX6b17PVsYBQ0ip5gyeme-Q
- Schneider Electric. Schneider Electric Youtube Channel. https://www.youtube.com/channel/UCnpqjEw2RHDBNVGDe8pI7tw

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:

- Instructor's 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

Appendices

Appendix A
Acronyms

ASME – American Society of Mechanical Engineers

A/D, ADC – Analog to Digital Converter

BMS – Burner Management Systems

BPR – Boiling Point Rise

CEC – Canadian Electrical Code

CEMS – Continuous Emissions Monitoring System

CNSC – Canadian Nuclear Safety Commission

CSA – Canadian Standards Association

CRT – Cathode Ray Tube

D/A, DAC – Digital to Analog Converter

DCS – Distributed Control System

DP – Differential Pressure

EPA – Environment Protection Act

ESD – Emergency Shutdown Device

FD – Forced draft

GPS – Global Positioning System

HART – Highway Addressable Remote Transducer

HMI – Human Machine Interface

I/O – Input/output

ID – Induced draft

ISA – Instrumentation, Systems and Automation Society

LNG – Liquefied Natural Gas

LCD – Liquid Crystal Display

LED – Light Emitting Diode

LVDT - Linear variable differential transformer

MISA – Municipal Industry Strategy for Abatement

MPC – Model Predictive Control

MSDS – Material Safety Data Sheets

NIST – National Institute of Standards and Technology

OH&S – Occupational Health and Safety Act

OPC – OLE (Object Linking Embedding) Process Control

ORP – Oxidation Reduction Potential

P&C – Process and control

P&ID – Piping & Instrument Drawing

PID – Proportional, Integral, Derivative

PLC – Programmable Logic Controller

PPE – Personal Protection Equipment

PSS – Process Safety Systems

RTU – Remote Terminal Unit

RTD – Resistive Temperature Device

SAC – Stand Alone Controller

SAMA – Scientific Apparatus Manufacturers Association

SCADA – Supervisory Control and Data Acquisition

SIL – Safety Integrity Level

SIS – Safety Instrument System

SOP – Standard Operating Procedures

TCP/IP – Transport Control Protocol / Internet Protocol

TDG – Transportation of Dangerous Goods

UPS – Uninterruptible Power Supply

VFD – Variable Frequency Drive

VSD – Variable Speed Drive

WHMIS/GHS – Workplace Hazardous Materials Information System / Globally Harmonized System

Appendix B
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

Piping and Instrumentation Diagram (P&ID) - diagram of piping and instrumentation

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

Appendix C
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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