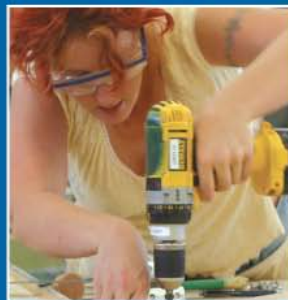
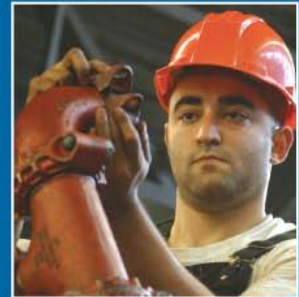


Instrumentation and Control Technician (Industrial Instrument Mechanic) Program Outline



To order additional copies please contact:

Government Publications Services

PO Box 9452 Stn Prov Govt

Victoria, BC V8W 9V7

Phone: 250 387-6409 or

Toll Free: 1 800 663-6105

Fax: 250 387-1120

www.publications.gov.bc.ca

Copyright © 2008 Industry Training Authority

This publication may not be reproduced in any form without permission by the
Industry Training Authority

Contact Director, Government Publications Services at 250 356-6876

**INSTRUMENTATION AND CONTROL TECHNICIAN
(INDUSTRIAL INSTRUMENT MECHANIC)**

PROGRAM OUTLINE

May, 2008

**Developed By
Industry Training Authority
Province of British Columbia**

SECTION 3 TRAINING PROVIDER STANDARDS	91
Recommended Reference Materials	92
Online Resources	95
TRAINING PROVIDER STANDARDS	100
Equipment and Tools	102
Electronic Tools and Test Equipment	103
Personal Protective Equipment and Safety Equipment	104
Trade Glossary and Acronyms.....	106

FOREWORD

This Program Outline is for use in the Instrumentation and Control Technician (Industrial Instrument Mechanic) apprenticeship training classes as sponsored by the Industry Training Authority and will be used as a guide for instructors in the formal classroom portions of apprenticeship training. The 2007 NOA and Alberta curriculum for this trade were examined by provincial Subject Matter Experts in the process of creating the BC 2008 Program Outline.

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

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

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

This Program Outline includes a list of recommended reference textbooks that are available to support the learning objectives and the minimum shop requirements needed to support instruction. Appendix 3 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

The Program Outline for the Instrumentation and Control Technician (Industrial Instrument Mechanic) trade in British Columbia is being prepared by Vanier Training Consultants Ltd. (VTC) in collaboration with Human Capital Strategies (HCS) under the direction of an Industry Steering Committee convened by the Resource Training Organization with funding support from the Industry Training Authority. VTC gratefully acknowledges the contributions of the members of this committee:

Curt Cain	RTO
Lindsay Langill	ITA
Danny Della Maestra	IBEW 258
Bob Hughf	CEP Western Region
Jeff Lekstrom	Northern Lights College
Doug MacLaren	RTO
Andrew McLaren	CAW 2301
Ron Merkel	Pyramid Oil and Gas Corporation
Joe Rea	Canfor Pulp and Paper Northwood Pulp Mill
Robert Zwick	Teck Cominco Metals

The Resource Training Organization and the Industry Training Authority would like to acknowledge the dedication and hard work of the Subject Matter Experts appointed to identify the training requirements of the Instrumentation and Control Technician (Industrial Instrument Mechanic) trade:

Jim Armstrong	BCIT
Julie Umberger	BCIT
Wes Babcock	Taylor Gas Liquids
John Beaumont	Teck Cominco Metals
John Bradbury	Pulp, Paper and Woodworkers of Canada (PPWC) Local 2
Mike Hamilton	Catalyst Paper
Dave Luszc	Domtar Pulp Ltd. Kamloops
Trevor O'Rourke	Northern Lights College
Joe Rea	Canfor Pulp and Paper Northwood Pulp Mill
Shane Stirling	Epscan
Robert Zwick	Teck Cominco Metals

Facilitators:

Dick Vanier	President, Vanier Training Consultants Ltd.
Kerry Jothen	CEO, Human Capital Strategies
Kathleen O'Neil	Technical Writer, Vanier Training Consultants Ltd.

SECTION 1

OCCUPATION ANALYSIS

OCCUPATION ANALYSIS CHART

INSTRUMENTATION AND CONTROL TECHNICIAN (INDUSTRIAL INSTRUMENT MECHANIC)

APPLIES OCCUPATIONAL SKILLS A	Plan and perform routine trade activities A-1	Organize work and maintain records A-2	Use computers and related applications A-3	Explain codes, standards and regulations A-4	Identify electrical hazards and apply safe work practices (includes CEC) A-5	Use trade related schematics and drawings A-6	
	1	3	1 2 3 4	1	1	1 2 3 4	
	INSTALLS AND MAINTAINS MEASURING AND INDICATING DEVICES B	Calibrate and service indicating and recording instruments B-1	Measure pressure B-2	Measure temperature B-3	Measure level B-4	Measure density B-5	Measure weight B-6
		1	1	2	2	2	2
		Measure flow (volumetric, mass flow) B-7	Measure consistency and viscosity B-8	Measure and service environmental monitoring devices B-9	Measure vibration B-10	Measure speed B-11	Measure position B-12
		2	3	3	4	4	4
Measure motion B-13							
4							
INSTALLS AND MAINTAINS ANALYTICAL INSTRUMENTATION C	Measure analytical properties of process gases C-1	Measure analytical properties of process liquids C-2	Measure analytical properties of process solids C-3	Install, calibrate and maintain process analyzers C-4			
	3 4	3	3	3			

INSTALLS AND MAINTAINS SAFETY AND PROCESS MONITORING SYSTEMS

Service and test flame safety systems

D-1

			4
--	--	--	---

Install and service process cameras

D-2

			4
--	--	--	---

Service ESD (emergency shutdown devices)

D-3

1			4
---	--	--	---

Service and calibrate personal safety systems

D-4

1			
---	--	--	--

INSTALLS AND MAINTAINS PNEUMATIC AND HYDRAULIC SYSTEMS

Examine air supply systems

E-1

1			
---	--	--	--

Install tubing and fittings

E-2

1			
---	--	--	--

Install and service pneumatic instruments

E-3

1	2		
---	---	--	--

Install and maintain signal conditioners

E-4

	2		
--	---	--	--

Install and service hydraulic systems

E-5

	2		
--	---	--	--

INSTALLS AND MAINTAINS ELECTRICAL AND ELECTRONIC SYSTEMS

Examine electrical theory

F-1

1			
---	--	--	--

Apply basic principles of DC electricity

F-2

1			
---	--	--	--

Apply basic principles of AC electricity

F-3

1			
---	--	--	--

Apply principles of electronics

F-4

	2		
--	---	--	--

Apply Boolean logic and principles of digital electronics

F-5

	2		
--	---	--	--

INSTALLS AND MAINTAINS FINAL CONTROL ELEMENTS

Service regulators and examine relief valves

G-1

1			
---	--	--	--

Service, size and install control valves and actuators

G-2

1		3	
---	--	---	--

Install and service valve positioners (includes advanced diagnostics)

G-3

1		3	
---	--	---	--

Configure variable speed drive (VSD) and variable frequency drive (VFD)

G-4

			4
--	--	--	---

INSTALLS AND MAINTAINS COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION SYSTEMS
H

Examine communication systems

H-1

		3		
--	--	---	--	--

Install wiring in accordance with CEC

H-2

1				
---	--	--	--	--

Examine communication network structures and components

H-3

		3		
--	--	---	--	--

Troubleshoot signal transmission systems

H-4

			4	
--	--	--	---	--

Service supervisory control and data acquisition (SCADA) systems

H-5

	2	3		
--	---	---	--	--

INSTALLS AND MAINTAINS CONTROL SYSTEMS
I

Examine fundamental theories of process operation and equipment

I-1

	2			
--	---	--	--	--

Examine control theory

I-2

		3		
--	--	---	--	--

Examine process control techniques and strategies

I-3

		3		
--	--	---	--	--

Implement process control strategies

I-4

		3	4	
--	--	---	---	--

Service stand alone controllers

I-5

			4	
--	--	--	---	--

Install, configure, maintain and service distributed control systems (DCS)

I-6

			4	
--	--	--	---	--

Service programmable logic controllers (PLCs)

I-7

1		3	4	
---	--	---	---	--

Service human machine interface (HMI)

I-8

			4	
--	--	--	---	--

Install and demonstrate knowledge of advanced supervisory control systems

I-9

			4	
--	--	--	---	--

SECTION 2

PROGRAM OUTLINE

SUGGESTED SCHEDULE OF TIME ALLOTMENT FOR LEVEL 1

LEVEL ONE		% OF TIME	Theory	Practical	Page
Line A	Applies Occupational Skills	(5%)			
A-1	Plan and perform routine trade activities		✓	✓	11
A-3	Use computers and related applications		✓	✓	12
A-4	Explain codes, standards and regulations		✓		13
A-5	Identify electrical hazards and apply safe work practices (includes CEC)		✓	✓	15
A-6	Use trade related schematics and drawings		✓	✓	16
Line B	Installs and Maintains Measuring and Indicating Devices	(15%)			
B-1	Calibrate and service indicating and recording instruments		✓	✓	17
B-2	Measure pressure		✓	✓	19
Line D	Installs & Maintains Safety and Process Monitoring Systems	(5%)			
D-3	Service ESD (emergency shutdown devices)		✓	✓	21
D-4	Service and calibrate personal safety systems		✓	✓	22
Line E	Installs and Maintains Pneumatic and Hydraulic Systems	(7%)			
E-1	Examine air supply systems		✓	✓	23
E-2	Install tubing and fittings		✓	✓	24
E-3	Install and service pneumatic instruments		✓	✓	25
Line F	Installs and Maintains Electrical and Electronic Systems	(30%)			
F-1	Examine Electrical Theory		✓		26
F-2	Apply basic principles of DC electricity		✓	✓	27
F-3	Apply basic principles of AC electricity		✓	✓	28
Line G	Installs and Maintains Final Control Elements	(25%)			
G-1	Service regulators and examine relief valves		✓	✓	29
G-2	Service, size and install control valves and actuators		✓	✓	30
G-3	Install and service valve positioners (includes advanced diagnostics)		✓	✓	32
Line H	Installs and Maintains Communications, Networking and Signal Transmission Systems	(3%)			
H-2	Install wiring in accordance with CEC		✓	✓	34
Line I	Installs and Maintains Control Systems	(10%)			
I-7	Service Programmable Logic Controllers (PLCs)		✓		35
Level One, Total Number of Competencies = 20		(100%)	20	17	

SUGGESTED SCHEDULE OF TIME ALLOTMENT FOR LEVEL 2

LEVEL TWO		% OF TIME	Theory	Practical	Page
Line A	Applies Occupational Skills	(5%)			
A-3	Use computers and related applications		✓	✓	37
A-6	Use trade related schematics and drawings		✓	✓	38
Line B	Installs and Maintains Measuring and Indicating Devices	(50%)			
B-3	Measure temperature		✓	✓	39
B-4	Measure level		✓	✓	41
B-5	Measure density		✓	✓	42
B-6	Measure weight		✓	✓	43
B-7	Measure flow (volumetric, mass flow)		✓	✓	44
Line E	Installs and Maintains Pneumatic and Hydraulic Systems	(20%)			
E-3	Install and service pneumatic instruments		✓	✓	46
E-4	Install and maintain signal conditioners		✓	✓	47
E-5	Install and service hydraulic systems		✓	✓	48
Line F	Installs and Maintains Electrical and Electronic Systems	(21%)			
F-4	Apply principles of electronics		✓	✓	49
F-5	Apply Boolean logic and principles of digital electronics		✓	✓	51
Line H	Installs and Maintains Communications, Networking and Signal Transmission Systems	(2%)			
H-5	Service supervisory control and data acquisition (SCADA) systems		✓	✓	52
Line I	Installs and Maintains Control Systems	(2%)			
I-1	Examine fundamental theories of process operation and equipment		✓	✓	53
Level Two, Total Number of Competencies = 14		(100%)	14	14	

SUGGESTED SCHEDULE OF TIME ALLOTMENT FOR LEVEL 3

LEVEL THREE		% OF TIME	Theory	Practical	Page
Line A	Applies Occupational Skills	(5%)			
A-2	Organize work and maintain records		✓	✓	55
A-3	Use computers and related applications		✓	✓	56
A-6	Use trade related schematics and drawings		✓	✓	57
Line B	Installs and Maintains Measuring and Indicating Devices	(13%)			
B-8	Measure consistency and viscosity		✓	✓	58
B-9	Examine and service environmental monitoring devices		✓	✓	59
Line C	Installs and maintains analytical instrumentation	(25%)			
C-1	Measure analytical properties of process gases		✓	✓	60
C-2	Measure analytical properties of process liquids		✓	✓	61
C-3	Measure analytical properties of process solids		✓	✓	62
C-4	Install, calibrate and maintain process analyzers		✓	✓	63
Line G	Installs and Maintains Final Control Elements	(10%)			
G-2	Service, size and install control valves and actuators		✓	✓	64
G-3	Install and service valve positioners (includes advanced diagnostics)		✓	✓	65
Line H	Installs and Maintains Communications, Networking and Signal Transmission Systems	(20%)			
H-1	Examine communication systems		✓	✓	66
H-3	Examine communication network structures and components		✓	✓	67
H-5	Service supervisory control and data acquisition (SCADA) systems		✓	✓	68
Line I	Installs and Maintains Control Systems	(27%)			
I-2	Examine control theory		✓	✓	69
I-3	Examine process control techniques and strategies		✓	✓	70
I-4	Implement process control strategies		✓	✓	71
I-7	Service programmable logic controllers (PLCs)		✓	✓	72
Level Three, Total Number of Competencies = 18		(100%)	18	18	

SUGGESTED SCHEDULE OF TIME ALLOTMENT FOR LEVEL 4

LEVEL FOUR		% OF TIME	Theory	Practical	Page
Line A	Applies Occupational Skills	(5%)			
A-3	Use computers and related applications		✓	✓	74
A-6	Use trade related schematics and drawings		✓	✓	75
Line B	Installs and Maintains Measuring and Indicating Devices	(10%)			
B-10	Measure vibration		✓	✓	76
B-11	Measure speed		✓	✓	77
B-12	Measure position		✓	✓	78
B-13	Measure motion		✓	✓	79
Line C	Installs and maintains analytical instrumentation	(10%)			
C-1	Measure analytical properties of process gases		✓	✓	80
Line D	Installs and Maintains Safety and Process Monitoring Systems	(15%)			
D-1	Service and test flame safety systems		✓	✓	81
D-2	Install and service process cameras		✓	✓	82
D-3	Service ESD (emergency shutdown devices)			✓	83
Line G	Installs and Maintains Final Control Elements	(2%)			
G-4	Configure variable speed drive (VSD) and variable frequency drive (VFD)		✓	✓	84
Line H	Installs and Maintains Communications, Networking and Signal Transmission Systems	(13%)			
H-4	Troubleshoot signal transmission systems		✓	✓	85
Line I	Installs and Maintains Control Systems	(45%)			
I-4	Implement process control strategies		✓	✓	86
I-5	Service stand alone controllers		✓	✓	87
I-6	Install, configure, maintain and service Distributed Control Systems (DCS)		✓	✓	88
I-7	Service Programmable Logic Controllers (PLCs)		✓	✓	89
I-8	Service human machine interface (HMI)		✓	✓	90
I-9	Install and demonstrate knowledge of advanced supervisory control systems		✓	✓	91
Level Four, Total Number of Competencies = 20		(100%)	19	20	

PROGRAM OUTLINE FOR LEVEL 1

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-1 Plan and perform routine trade activities

Learning Objectives:

The learner will be able to perform routine trade activities.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Communicate with others | <ul style="list-style-type: none">• Trade terminology• Effective verbal communication skills• Effective written communication skills• Consulting to solve problems |
| 2. Examine types of trade related personal protective equipment | <ul style="list-style-type: none">• Head protection<ul style="list-style-type: none">– CSA approved hard hat• Eye protection<ul style="list-style-type: none">– CSA approved goggles and face shield• Hearing protection<ul style="list-style-type: none">– Ear plugs– Ear muffs• Hand protection<ul style="list-style-type: none">– Types of gloves and mitts• Clothing<ul style="list-style-type: none">– Types of materials suitable to work environment (FR rated)• Foot protection<ul style="list-style-type: none">– CSA approved safety boots with suitable soles |
| 3. Maintain safe work environment | <ul style="list-style-type: none">• Personal Breathing Apparatus• Safe housekeeping practices• Appropriate recycling and disposal procedures |
| 4. Use and maintain hand and power tools | <ul style="list-style-type: none">• Trade specific hand and power tools• (see tools and equipment lists in Appendix) |
| 5. Examine mounting and installation hardware and practices | <ul style="list-style-type: none">• Manufacturer instructions• Types of mounting hardware (uni-strut, clamps, u-bolts...)• Location for installation of mounting hardware |
| 6. Confirm integrity of test equipment | <ul style="list-style-type: none">• Test gauge• Multimeter• Manometer• Dead weight tester |

Achievement Criteria:

- Given a 10 question test (reviewing trade related communication, PPE, safe work practices, hand and power tools, installation hardware and the maintenance of test equipment) the learner must answer 7 or more questions correctly.
- The learner's use of safe work practices will be an assessed element of Lab assignments throughout technical training (see Appendix One: Sample Lab Assessment Tool).
- The learner's knowledge of instrumentation test equipment and device installation will be an assessed element of Lab assignments on specific instruments and devices.

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-3 Use computers and related applications

Learning Objectives:

The learner will be able to configure and program Level 1 instrumentation devices to manufacturers' specifications.

LEARNING TASKS

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

CONTENT

- Configuration and programming software, hardware and firmware used in Level One
- Configuration and programming software, hardware and firmware used in Level One

Achievement Criteria:

- Given a 10 question test on the configuration and programming software, hardware and firmware used in Level One, the learner must answer 7 or more questions correctly.
- The learner's use of Level One configuration and programming software, hardware and firmware will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-4 Explain codes, standards and regulations

Learning Objectives:

The learner will be able to access and explain the purpose and applications of these standards, codes and regulations to their trade.

LEARNING TASKS

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

CONTENT

- <http://worksafebc.com>
- OHS Regulation
- Purpose of Regulation
- General Requirements of OHS
- Right to refuse unsafe work
- Government / Employer / Employee responsibilities
- Chemical and biological agents
- Noise, vibration, radiation and temperature
- Tools machinery and equipment safety
- Ladders, scaffolds and temporary work platforms
- Rigging, cranes and hoists
- Mobile equipment
- Transportation of workers
- Traffic control
- Electrical safety
- Oil and gas industries

Free, downloadable PDF documents from WorkSafeBC website (publications):

- *Effective Safety and Health Programs*
- *Lockout*
- *Fall Protection*
- *Confined Space Hazards*
- *Confined Space Entry*
- *Working Safely Around Electricity*
- *Chlorine Safe Work Practices*
- *WHMIS manuals*
- *Hazard Symbols Key Booklet*
- *Hazard Alerts*

2. Examine safety and certification bodies related to this trade

- Purpose and intent of codes / regulations / standards
- WHMIS and use of MSDS
- CSA certification standards
- ISA documentation
- CEC (Canadian Electrical Code)
- Boiler and Pressure Vessel Code
- CNSC (Canadian Nuclear Safety Commission)
- National Energy Board Regulations for Custody Transfer
- Oil and Gas Commission Accepted Practices for Measurement
- Transportation of Dangerous Goods
- BC Mines Act
- BC Environmental Regulations
- Other related codes and standards, as needed

Achievement Criteria:

- Given a 10 question test on sourcing and using trade-related codes, standards and regulations the learner will be required to answer a minimum of 7 questions correctly.

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-5 Identify electrical hazards and apply safe work practices (includes CEC)

Learning Objectives:

The learner will be able to explain standards and safe practices when working with AC and DC electrical circuits and devices.

LEARNING TASKS

1. Examine CEC regulations

CONTENT

- Scope, general rules and applications
 - Sizing of wire and fuses
 - Class 1 and Class 2 circuits
 - Proper installation and grounding of electrical equipment
 - Area classification
 - Other sections as needed

2. Examine OHS guide to electrical hazards

- WorkSafeBC Publication (free download from website) *Working Safely Around Electricity*

Achievement Criteria:

Given a 10 question test on safe practices when working with AC and DC circuits and devices, the learner must score 70% or higher.

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-6 Use trade related schematics and drawings

Learning Objectives:

The learner will be able to use schematics and drawings related to Level One instrumentation.

LEARNING TASKS

1. Examine types of schematics and drawings
2. Examine symbols and conventions
3. Use basic schematics and drawings

CONTENT

- P&ID, SAMA, isometric and orthographic drawings
- ISA and SAMA symbols
- P&ID / P&C drawings

Achievement Criteria:

- Given a 10 question test on the symbols, conventions, drawings and schematics used in Level One, the learner must answer 7 or more questions correctly.
- The learner's use of Level One drawings and schematics will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

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:

- Given a 10 question test on the types of recording and indicating devices and their calibration and servicing the learner must answer 7 or more questions correctly.
- The learner must also score 70% or higher on a lab assignment in which principles of links and levers (zero, span and angularity adjustments) are used to calibrate 3 gauges and 4 chart recorders.

**LINE B: INSTALLS AND MAINTAINS MEASURING
AND INDICATING DEVICES**

Competency: B-2 Measure Pressure

Learning Objectives:

The learner will be able to configure and calibrate pneumatic, electronic and digital measuring devices to process requirements.

LEARNING TASKS

1. Examine types of pressure

2. Examine types of pressure measuring devices

3. Install pressure measuring devices

CONTENT

- Absolute
- Differential
- Gage
- Vacuum
- Conversion tables
- Pressure conversion formulas
- Steam tables (relationship between temperature and pressure)
- Head correction calculation
- Pneumatic
- Electronic
- Digital
- 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
- Manometer types
- Well
- Raised Well
- Dual tube
- Incline
- U-tube
- Slack tube
- Manometer fluids
- Mercury
- Unity oil
- Water
- Red oil
- Meriam #3
- Fluoroscien
- Dead weight testers
- Pneumatic
- Hydraulic
- Calibration / configuration parameters
- Interpretation of results
- Identification of cause/effect of calibration errors
- Adjustments to bring device within calibration parameters
- Returning device to service after calibration
- Document calibration results
- Manufacturers' recommended maintenance procedures

5. Maintain device

Achievement Criteria:

- Given a 10 question test on pressure measuring devices the learner must answer 7 or more questions correctly.
- The learner's ability to configure and calibrate pressure measuring devices will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE D: INSTALLS AND MAINTAINS SAFETY AND PROCESS MONITORING SYSTEMS

Competency: D-3 Service ESD (emergency shutdown devices)

Learning Objectives:

The learner will be able to explain the types of Emergency Shutdown Devices (ESD), their purposes and testing procedures.

LEARNING TASKS

1. Examine types of ESD control systems

2. Examine purposes of different types of ESD

3. Examine ESD testing procedures

CONTENT

- Levels of Shutdown
- Equipment Shutdown
- Area Shutdown
- Total / Plant Shutdown
- Types of ESD
- Electric
- Pneumatic
- Hydraulic
- Mechanical
- Personnel protection
- Environmental protection
- Equipment protection
- Partial Stroke Test
- Time test
- Valve integrity
- Interlock checks (system shut down check)

Achievement Criteria:

- Given a 10 question test on the types, purposes and testing procedures for ESD the learner must answer 7 or more questions correctly.

LINE D: INSTALLS AND MAINTAINS SAFETY AND PROCESS MONITORING SYSTEMS

Competency: D-4 Service and calibrate personal safety systems

Learning Objectives:

The learner will be able to identify the types of personal safety systems and explain their applications.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <ol style="list-style-type: none">1. Examine personal gas monitors and standard calibration routines2. Examine radiation safety devices | <ul style="list-style-type: none">• Portable personal gas monitor (Cl, SO₂, H₂S, O₂, LEL, CO)• Pull tube (Draeger)• Radiation (gamma) survey meter• Personal dosimeter |
|--|---|

Achievement Criteria:

- Given a 10 question test on personal gas monitors, standard calibration routines and radiation safety devices, the learner must answer 7 or more questions correctly.

LINE E: INSTALLS AND MAINTAINS PNEUMATIC AND HYDRAULIC SYSTEMS

Competency: E-1 Examine air supply systems

Learning Objectives:

The learner will be able to explain the purpose, operation and servicing of air supply systems.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Examine instrument air systems and equipment | <ul style="list-style-type: none">• Need for clean, dry air• Air compressors• Air dryers• Air receivers• Air filters |
| 2. Examine air distribution systems | <ul style="list-style-type: none">• Mill air• Instrument air• System requirements |
| 3. Examine use of relative humidity to infer dew point | <ul style="list-style-type: none">• Chilled mirror• Hygrometer• Hair hygrometer• Sling psychrometer• Digital psychrometer |
| 4. Examine the servicing procedures for air supply systems | <ul style="list-style-type: none">• Bulk polymer resistance sensor• Servicing requirements• Traps• Dessicant• Pre and post filters |

Achievement Criteria:

- Given a 10 question test on air supply systems the learner must answer 7 or more questions correctly.
- The learner's ability to service air supply systems will be evaluated during lab activities. The learner must achieve a minimum grade of 70%.

LINE E: INSTALLS AND MAINTAINS PNEUMATIC AND HYDRAULIC SYSTEMS

Competency: E-2 Install tubing and fittings

Learning Objectives:

The learner will 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 | <ul style="list-style-type: none">• Plastic• Stainless steel• Copper• Rubber• Process and pressure requirements• Sizes• Pressure and Temperature Ratings |
| 2. Examine types of fittings and installation procedures | <ul style="list-style-type: none">• Types of fittings• Unions• Elbows• Tees• Couplings• Bushings• Reducers• Caps• Plugs• Bulkhead fittings• Others• Tube fittings• Compression• Flared• Hydraulic• Process and pressure requirements• Sizes• Pressure and Temperature Ratings |
| 3. Examine tube bending techniques | <ul style="list-style-type: none">• Pipe fittings• Ratings• Calculating dimensions• Manual tube benders• Hydraulic tube benders |
| 4. Install tubing and fittings | <ul style="list-style-type: none">• Ferrule construction and location• Tightening fittings• Follow P&ID drawings• Select appropriate tubing and fittings |

Achievement Criteria:

- The learner's ability to (1) identify types of fittings and (2) bend tubing to a pre-determined pattern will be evaluated during lab activities, and the learner must achieve a minimum grade of 70% for both of these tasks.

LINE E: INSTALLS AND MAINTAINS PNEUMATIC AND HYDRAULIC SYSTEMS

Competency: E-3 Install and Service Pneumatic Instruments

Learning Objectives:

The learner will be able to calibrate pneumatic instruments to required specifications.

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Examine specifications and hazards of pneumatic equipment | <ul style="list-style-type: none">• Compressed air safety• Pneumatic signals (3-15 psi, 6-30 psi, 20-100 kPa) |
| 2. Examine types of pneumatic equipment | <ul style="list-style-type: none">• Required air supplies• Transmitters• Converters• Positioners• Controllers• Relays |
| 3. Examine operating principles of pneumatic equipment | <ul style="list-style-type: none">• Force balance• Motion balance |
| 4. Examine pneumatic equipment installation procedures | <ul style="list-style-type: none">• Selection of equipment• Application• Materials• Location• Set up and adjustments• Isolation of equipment• Repair and replacement methods |
| 5. Calibrate pneumatic transmitters | <ul style="list-style-type: none">• Component selections• Force balance calibration procedure• Motion balance calibration procedure• Documentation of calibration results |

Achievement Criteria:

- The learner's ability to calibrate pneumatic equipment will be evaluated during lab activities. The learner must achieve a minimum grade of 70%.

LINE F: INSTALLS AND MAINTAINS ELECTRICAL AND ELECTRONIC SYSTEMS

Competency: F-2 Apply basic principles of DC electricity

Learning Objectives:

The learner will be able to explain and apply basic principles of DC electricity using DC electrical equipment and instruments.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Examine operation and applications of various batteries | <ul style="list-style-type: none">• Lead acid• NiCad• NiMh |
| 2. Measure electrical current, voltage and resistance | <ul style="list-style-type: none">• Analog multimeters• Digital Multimeters |
| 3. Calculate currents, voltages and resistance using Ohm's law | <ul style="list-style-type: none">• Series circuits• Parallel and combination circuits• Formula $E = I \times R$ |
| 4. Define and reference voltage measurement to circuit common | <ul style="list-style-type: none">• Difference between ground and circuit common• Multimeter• Oscilloscope and scope meter |
| 5. Calculate electrical power in watts | <ul style="list-style-type: none">• Circuit schematic• Apply Watt's Law to define power rating of appliances |
| 6. Examine resistors, potentiometers and rheostats | <ul style="list-style-type: none">• $Watts = E \times I$• Differences• Power ratings• Applications• Colour codes |
| 7. Apply appropriate sections of CEC | <ul style="list-style-type: none">• Scope, general rules and definitions of the CEC |

Achievement Criteria:

- Given a 10 question test on basic principles of DC electricity, voltage, amperage, resistance and the application of related mathematical formulae, the learner must achieve a minimum score of 70%.
- During Lab activities the learner's ability to (1) calculate and measure current, voltage and resistance and (2) define and reference voltage measurement to circuit common will be evaluated. The learner must achieve a minimum grade of 70% in these labs.

LINE F: INSTALLS AND MAINTAINS ELECTRICAL AND ELECTRONIC SYSTEMS

Competency: F-3 Apply basic principles of AC electricity

Learning Objectives:

The learner will be able to explain and apply basic principles of AC electricity using AC circuits.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Define AC electricity | <ul style="list-style-type: none">• Generation |
| 2. Examine various types of transformers | <ul style="list-style-type: none">• Polarity and waveform analysis• Step up• Step down• Automatic• SOLA• Isolation |
| 3. Examine the use of capacitors and inductors in AC circuits | <ul style="list-style-type: none">• Applications• Filtering• Regulating voltage• Power factor correction |
| 4. Size electrical components for various circuits | <ul style="list-style-type: none">• Capacitors• Inductors• Resistors• Wire• Fuses |
| 5. Build and test circuits | <ul style="list-style-type: none">• Demonstrate use of various AC components in circuits• Measuring techniques and equipment |
| 6. Types of AC circuits | <ul style="list-style-type: none">• Sizing components• Class 1• Class 2• Section 16 CEC |
| 7. Examine installation procedures for AC equipment | <ul style="list-style-type: none">• Wiring methods (Section 12 CEC)• Support• Grounding• Shielding |
| 8. Apply proper circuit connection techniques | <ul style="list-style-type: none">• Soldering• Crimping• Printed circuit board repair |

Achievement Criteria:

- Given a 10 question test on AC electricity, the learner must achieve a minimum score of 70%.
- During Lab activities the learner's ability to (1) size electrical components, (2) build and test AC circuits, and (3) apply proper circuit connection techniques will be evaluated. The learner must achieve a minimum grade of 70%.

LINE G: INSTALLS AND MAINTAINS FINAL CONTROL ELEMENTS

Competency: G-1 Service regulators and examine relief valves

Learning Objectives:

The learner will be able to service regulators and explain the operation of relief valves.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Examine regulators | <ul style="list-style-type: none">• Purpose• Pressure drops• Types• Relieving• Non- Relieving• Pilot operated• Definitions• Droop• Turndown• Applications• Pressure reducing• Pressure relieving |
| 2. Examine operation and applications of regulators | <ul style="list-style-type: none">• Air• Water• Steam• Oil• Gas• Differential |
| 3. Service and maintain regulators | <ul style="list-style-type: none">• Components• Diaphragms• Bolts• Springs• Seats• Gaskets• Disassembling• Spring compression• Inspect• Reassemble |
| 4. Examine relief valves | <ul style="list-style-type: none">• Test• Applications• Safety Device• Reset Differential• Certification and testing |

Achievement Criteria:

- Given a 10 question test on the operation of relief valves the learner must answer 7 or more questions correctly.
- The learner's ability to service regulators will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE G: INSTALLS AND MAINTAINS FINAL CONTROL ELEMENTS

Competency: G-2 Service, size and install control valves and actuators

Learning Objectives:

The learner will be able to install and service control valves and actuators.

LEARNING TASKS

1. Examine actuators

CONTENT

- Types
- Pneumatic
- Hydraulic
- Electric
- Applications
- Fail open
- Fail close
- Fail last
- Actions
- Spring return
- Double-acting
- Components
- Diaphragms
- Plates
- Stem connector (coupling)
- Bushings
- O-rings
- Pistons
- Motors
- Springs
- Required Operating Environment
- Process applications
- Metallurgy
- Seal / shut off requirements
- Flow Characteristics
- Quick opening
- Linear
- Equal percentage
- Body Types
- Sliding stem
 - Globe
 - Bar stock
 - Pinch valve
- Rotary
 - Butterfly
 - E-Disc
 - Segmented ball
 - Through-bore ball
 - Restricted trim
- Components
- Cages
- Plugs
- Seats
- Stems
- Packing
- Types and applications of valve packing

2. Examine control valves

3. Install and service control valves

- Teflon
- Graphite
- Rope
- Gaskets
- Sealants
- Positioning valve in process
- Securing valve using appropriate process
- Flanged
- Screwed
- Wafered / Flangeless
- Isolation of valve from process
- Testing procedures
- Stroke to ensure proper operation
- Leak testing
- Possible faults
- Leaking packing
- Valve passing
- Damaged parts
- Incorrect travel
- Cleaning / lubricating
- Repairing / Rebuilding
- Matching to valve
- Connecting to valve
- Valve travel
- Bench set
- 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

4. Install and service actuators

Achievement Criteria:

- Given a 10 question test on the operation of valves and actuators the learner must answer 7 or more questions correctly.
- The learner's ability to service regulators will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE G: INSTALLS AND MAINTAINS FINAL CONTROL ELEMENTS

Competency: G-3 Install and service valve positioners (includes advanced diagnostics)

Learning Objectives:

The learner will be able to service and install valve positioners on final control elements.

LEARNING TASKS

CONTENT

1. Examine valve positioners

- Types
- Pneumatic
- Electronic
- Digital
- Electro hydraulic
- Electro mechanical
- Applications
- Sliding stem / Rotary
- Piston / Diaphragm
- Components
- Levers
- Nozzles
- Flappers
- Relays
- Auxiliaries
- Locks
- Boosters
- Speed controls
- Parameters
- Relation to actuator type / application
- Mounting
- Connecting to actuator
- Connecting to process control system
- Configuring
- Set stroke
- Set pressures
- Match to actuator
- Auto tune
- Calibrating
- Connecting calibration instruments
- Calibration parameters
- Interpretation of calibration results
- Cause/effect of calibration errors
- Component maintenance
- Remove
- Replace
- Repair
- Clean
- Returning to service

2. Install and service valve positioners

Achievement Criteria:

- Given a 10 question test on valve positioners, the learner must answer 7 or more questions correctly.
- The learner's ability to install and service valve positioners will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE H: INSTALLS AND MAINTAINS COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H-2 Install wiring in accordance with CEC

Learning Objectives:

The learner will be able to install wiring in accordance with CEC requirements.

LEARNING TASKS

1. Examine wiring requirements

2. Install wiring

CONTENT

- Materials
- Connections
 - Crimping
 - Terminal blocks
 - Marrettes
 - Soldering
 - Protection (heat shrink, taping etc.)
- Shielding
- Grounding
- Grounding loops
- CEC requirements
- Sizing wire
- Routing of wiring runs
- Stripping wire
- Labeling / colour-coding wire
- Connecting wire

Achievement Criteria:

- Given a 10 question test on wiring requirements the learner must answer 7 or more questions correctly.
- The learner's ability to install wiring will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE I: INSTALLS AND MAINTAINS CONTROL SYSTEMS

Competency: I-7 Service programmable logic controllers (PLCs)

Learning Objectives:

The learner will be able to explain the basics of programmable logic controllers (PLCs).

LEARNING TASKS

1. Examine types of PLCs

2. Examine PLC languages and symbols

3. Examine PLC components

CONTENT

- Hardware Architecture
- Control Capabilities
- Discrete control
- Analog control
- Compatibility with other process systems
- Networks
- Protocols
- Structured Text
- Instruction list
- Ladder Logic
- Function block
- Sequential function chart
- CPU
- Memory organization
- Input interface
- Output interface
- Power supply
- Programming/Monitoring interface
- Data Table
- User Program

Achievement Criteria:

- Given a 10 question test on PLC types, components and languages the learner must answer 7 or more questions correctly.

PROGRAM OUTLINE FOR LEVEL 2

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-3 Use computers and related applications

Learning Objectives:

The learner will be able to configure and program Level Two instrumentation devices to manufacturers' specifications given related hardware, software and firmware.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <ol style="list-style-type: none">1. Examine diagnostic and configuration software, hardware and firmware2. Use diagnostic and configuration software, hardware and firmware | <ul style="list-style-type: none">• Configuration and programming software used in level 2 (e.g. flow element sizing programs, temperature and density signal linearization)• Configuration and programming software used in level 2 (e.g. flow element sizing programs, temperature and density signal linearization) |
|---|---|

Achievement Criteria:

- Given a 10 question test on the configuration and programming software, hardware and firmware used in Level Two, the learner must answer 7 or more questions correctly.
- The learner's use of Level Two configuration and programming software, hardware and firmware will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-6 Use trade related schematics and drawings

Learning Objectives:

The learner will be able to use schematics and drawings related to instrumentation.

LEARNING TASKS

1. Examine types of schematics and drawings
2. Examine symbols and conventions
3. Use and develop basic schematics and drawings

CONTENT

- P&ID, SAMA, isometric, orthographic and loop drawings
- ISA and SAMA symbols
- P&ID / P&C / loop drawings

Achievement Criteria:

- Given a 10 question test on the symbols, conventions, drawings and schematics used in Level Two the learner must answer 7 or more questions correctly.
- The learner's use of Level Two drawings and schematics will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

4. Installs, calibrates and services temperature measuring devices

- Manufacturers' specifications
- Best Practices for selection /location of measuring device
- Response time
- Temperature ranges
- Resolution
- Thermo well 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)
- RTDs
- Alpha and DIN standards
- 2, 3 and 4 wire
- 100, 200...1000 ohm
- Device check / calibration
- Wheatstone bridge
- Simulators
- Decade box
- Interpretation of calibration results
- Cause / effect of calibration error
- Device adjustments
- Repairing/replacing device components
- Verification of operation
- Returning device to service
- Documenting calibration

Achievement Criteria:

- Given a 10 question test on temperature measuring devices and their operation, calibration and servicing requirements, the learner must answer 7 or more questions correctly.
- The learner's ability to calibrate and service temperature measuring devices will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE B: INSTALLS AND MAINTAINS MEASURING AND INDICATING DEVICES

Competency: B-4 Measure level

Learning Objectives:

The learner will be able to install, calibrate and service level measuring devices.

LEARNING TASKS

1. Examine level measuring devices and their operation

CONTENT

- Point level
- Capacitance
- Float switches
- Tuning fork
- Bindicator
- Microwave
- Ultrasonic
- Nuclear
- Continuous level
- Hydrostatic head
- Laser
- Ultrasonic
- Radar
- Sight glass
- Bubble pipe
- Resistance tape
- Magnetic float
- Load cell
- Displacement
- Capacitance
- Drum level
- Pressure calibrator
- Laptop / software
- Handheld programmer (configurator)
- Manufacturers' specifications
- Selection /Location of measuring device
- Process application
- Process medium
- Price
- Best practices
- Verify operation
- Device check / calibration
- Interpretation of calibration results
- Cause / effect of calibration error
- Device adjustments
- Repairing/replacing device components
- Verification of operation
- Returning device to service
- Documenting calibration

2. Examine calibration instruments used on level measuring devices

3. Install, calibrate and service level measuring devices

Achievement Criteria:

- Given a 10 question test on level measuring devices and their operation, calibration and servicing requirements, the learner must answer 7 or more questions correctly.
- The learner's ability to calibrate and service level measuring devices will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE B: INSTALLS AND MAINTAINS MEASURING AND INDICATING DEVICES

Competency: B-5 Measure density

Learning Objectives:

The learner will be able to install, calibrate and service density measuring devices.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Examine density measuring devices and their operation | <ul style="list-style-type: none">• Types• Hydrometer• Hydrostatic head• Displacers• Nuclear• Refractometer• Boiling point rise• Coriolis meters• Effect of temperature on density |
| 2. Examine calibration instruments used on density measuring devices | <ul style="list-style-type: none">• Pressure calibrator• Laptop / software• Handheld programmer (configurator) |
| 3. Install, calibrate and service density measuring devices | <ul style="list-style-type: none">• Manufacturers' specifications• Selection /Location of measuring device• Process application• Process medium• Cost• Best practices• Verify operation• Device check / calibration• Interpretation of calibration results• Cause / effect of calibration error• Device adjustments• Repair/replace device components• Returning device to service• Documenting calibration |

Achievement Criteria:

- Given a 10 question test on density measuring devices and their operation, calibration and servicing requirements, the learner must answer 7 or more questions correctly.
- The learner's ability to calibrate and service density measuring devices will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE B: INSTALLS AND MAINTAINS MEASURING AND INDICATING DEVICES

Competency: B-6 Measure weight

Learning Objectives:

The learner will be able to install, calibrate and service weight measuring devices.

LEARNING TASKS

1. Examine weight measuring devices and their operation
2. Examine calibration instruments used on weight measuring devices
3. Install, calibrate and service weight measuring devices

CONTENT

- Load cells
- Scales
- Strain gauges
- Test weights
- Calibration chains
- Wheatstone bridge
- Laptop / software
- Handheld programmer (configurator)
- Manufacturers' specifications
- Selection /Location of measuring device
- Process application
- Cost
- Best practices
- Verify operation
- Device check / calibration
- Interpretation of calibration results
- Cause / effect of calibration error
- Device adjustments
- Repair/replace device components
- Returning device to service
- Documenting calibration

Achievement Criteria:

- Given a 10 question test on weight measuring devices and their operation, calibration and servicing requirements, the learner must answer 7 or more questions correctly.
- The learner's ability to calibrate and service weight measuring devices will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE B: INSTALLS AND MAINTAINS MEASURING AND INDICATING DEVICES

Competency: B-7 Measure flow (volumetric, mass flow)

Learning Objectives:

The learner will be able to install, calibrate and service flow measuring devices to process requirements.

LEARNING TASKS

1. Examine flow measuring devices and their operation

2. Examine calibration instruments used on flow measuring devices

3. Install, calibrate and service flow measuring devices

CONTENT

- Bernoulli's Theorem
- Differential pressure
- Orifice plate
- Flumes / weirs
- Annubar
- Pitot tube
- Target meter
- Elbow meter
- Venturi
- Wedge
- Flow nozzle
- Multi-variable mass flow
- Variable area flow meters
- Velocity
- Turbine
- Vortex
- Ultrasonic
- Magnetic flow meter
- Mass flow
- Coriolis
- Thermal
- Positive displacement meter
- Other flow measurement devices
- Pressure calibrators
- Flow simulators
- Temperature calibrator
- Frequency generator
- Laptop / software
- Handheld programmer (configurator)
- Manufacturers' specifications
- Selection /Location factors
- Straight pipe requirements
- Accuracy requirements
- Process application
- Process medium
- Cost
- Best practices
- Verify operation
- Device check / calibration
- Interpretation of calibration results
- Cause / effect of calibration error
- Device adjustments
- Repair/replace device components
- Returning device to service
- Documenting calibration

Achievement Criteria:

- Given a 10 question test on flow measuring devices and their operation, calibration and servicing requirements, the learner must answer 7 or more questions correctly.
- The learner's ability to calibrate and service flow measuring devices will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE E: INSTALLS AND MAINTAINS PNEUMATIC AND HYDRAULIC SYSTEMS

Competency: E-3 Install and Service Pneumatic Instruments

Learning Objectives:

The learner will be able to align pneumatic controllers to process requirements.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| <ol style="list-style-type: none">1. Examine pneumatic controllers
2. Align pneumatic controllers | <ul style="list-style-type: none">• Force balance• Motion balance• Input /output calibration• Temperature and pressure inputs• Indication calibration• Controller alignment and service• Auto / manual transfer stations |
|--|---|

Achievement Criteria:

- Given a 10 question test on pneumatic controls, the learner must answer 7 or more questions correctly.
- The learner's ability to align pneumatic controllers will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE E: INSTALLS AND MAINTAINS PNEUMATIC AND HYDRAULIC SYSTEMS

Competency: E-4 Install and maintain signal conditioners

Learning Objectives:

The learner will be able to install and calibrate signal conditioners to process requirements.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Examine signal conditioners and their operation | <ul style="list-style-type: none">• Pneumatic relays• Signal converters• Volume boosters• I/P , P/I transducers• Hardware and software (high select, function block)• Square root extraction• Integrators |
| 2. Install and calibrate signal conditioners | <ul style="list-style-type: none">• Manufacturers' specifications for installation (Moore Industries, Fisher 846, Rosemount) |

Achievement Criteria:

- Given a 10 question test on signal conditioners and their operation, the learner must answer 7 or more questions correctly.
- The learner's ability to install and calibrate signal conditioners will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE F: INSTALLS AND MAINTAINS ELECTRICAL AND ELECTRONIC SYSTEMS

Competency: F-4 Apply principles of electronics

Learning Objectives:

The learner will be able to install and service electronic equipment to manufacturers' specifications.

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Examine electronic equipment and its operation | <ul style="list-style-type: none">• Analog and Digital• Discrete components and their operation• Transistors• Op amps• Diodes• Zener diodes• Power supplies• Half and full wave rectified• Switching• Bridges• Filtering• UPS systems |
| 2. Install and troubleshoot electronic equipment | <ul style="list-style-type: none">• Select equipment• Application• Components• Select / install wiring• Current loops• Wiring – 2, 3 and 4 wire transmitters• I/I• Ground loops• Manufacturer's specifications• Connect to system• Adjust settings• Creating and updating loop drawings and documentation |
| 3. Service electronic equipment | <ul style="list-style-type: none">• Isolate equipment• Repair/replacement methods and equipment• Oscilloscope (Scope meter)• Multimeter• Logic probe• Electronic assemblies• Troubleshooting to board level<ul style="list-style-type: none">– Power supply– Input conditioning– Signal manipulation– Output circuit– Back plane• Board replacement procedures<ul style="list-style-type: none">– Ground strap– Power down and Power Up• Cleaning methods |

Achievement Criteria:

- Given a 10 question test on the principles of electronics, electronic components and power supplies and troubleshooting electronic equipment, the learner must answer 7 or more questions correctly.
- The learner's ability to troubleshoot electronic equipment to board level will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE F: INSTALLS AND MAINTAINS ELECTRICAL AND ELECTRONIC SYSTEMS

Competency: F-5 Apply Boolean logic and principles of digital electronics

Learning Objectives:

The learner will be able to apply principles of digital electronics in logic applications.

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Examine principles of digital logic | <ul style="list-style-type: none">• Discrete values• Waveforms• Logic levels• Conversions• Digital to analog• Analog to digital• Binary to decimal• Sum of weights• Octal to decimal• Decimal to octal• Binary to octal• Binary to hexadecimal• Logic gate symbols• NOT circuit• Negation and polarity indicators• AND gate• OR gate• NAND gate• NOR gate• XOR gate• XNOR gate |
| 2. Examine digital signal processing | <ul style="list-style-type: none">• Analog to digital conversion• Digital to analog conversion• Signal to noise ratio• Analog and digital filters• Signals transformation• Magnitude• Phase |

Achievement Criteria:

- Given a 10 question test on Boolean logic and basic principles of digital electronics, the learner must answer 7 or more questions correctly.
- The learner's ability to apply principles of digital electronics in logic applications will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE H: INSTALLS AND MAINTAINS COMMUNICATIONS, NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H-5 Service Supervisory Control and Data Acquisition (SCADA) systems

Learning Objectives:

The learner will be able to explain SCADA protocols, configurations, equipment and servers.

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Examine types of SCADA protocols and configurations | <ul style="list-style-type: none">• Applications• Custody transfer• AGA/API calculations• Online history• Remote equipment operation• Time synchronization and time stamping• Network layout• Protocols• Host• Field• Addressing methods• Configuration licensing |
| 2. Examine types of SCADA equipment and servers for data acquisition and storage | <ul style="list-style-type: none">• Radio Telemetry Units (RTU)• Wireless Communications systems• Cellular• Satellite• Radio |

Achievement Criteria:

- Given a 10 question test on SCADA protocols, configurations, equipment and servers, the learner must answer 7 or more questions correctly.

LINE I: INSTALLS AND MAINTAINS CONTROL SYSTEMS

Competency: I-1 Examine fundamental theories of process operation and equipment

Learning Objectives:

The learner will be able to explain the basic operation of a range of common industrial processes.

LEARNING TASK

CONTENT

1. Examine common industrial processes

- Basic Oil & gas field processes
- Raw gas processing
- Compression
- Dehydration
- Material Handling / Quality control
- Pulp consistency control process
- Separation
- Magnets
- Screening
- Centrifugal
- Electrostatic
- Steam generation (boilers)
- Batch process
- Digester
- Concrete plant
- Food
- Pharmaceuticals
- Chemical Reaction
- pH
- Electrolytic
- Distillation column
- Fractionation
- Binary tower
- Cryogenic
- Evaporation
- Flotation

Achievement Criteria:

- Given a 10 question test on common industrial processes, the learner must answer 7 or more questions correctly.

PROGRAM OUTLINE FOR LEVEL 3

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-2 Organize work and maintain records

Learning Objectives:

The learner will be able to estimate labour and material and complete work-related documentation.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Examine standard work requirements | <ul style="list-style-type: none">• Materials• Equipment and tools• Personnel• Task planning• Work scheduling |
| 2. Examine related skills | <ul style="list-style-type: none">• Estimating• Time• Cost• Materials• Manpower needed• Identifying / organizing• Tools• Equipment |
| 3. Examine types of trade related documentation | <ul style="list-style-type: none">• Calibration sheets• Data sheets• Work orders• Log entries• Permits• SOP (Standard Operating Procedure)• Management of Change Documentation• Instrument change• Range change• Process change• Maintenance schedules• Preventative• Predictive• Reliability centered• Related software• Spreadsheets• Databases• Word processing |

Achievement Criteria:

- Given a 10 question test on standard work requirements, estimating and trade related documentation, the learner must answer 7 or more questions correctly.

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-3 Use computers and related applications

Learning Objectives:

The learner will be able to configure and program Level 3 instrumentation devices to manufacturers' specifications given related hardware, software and firmware.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <ol style="list-style-type: none">1. Examines diagnostic and configuration software, hardware and firmware2. Uses diagnostic and configuration software, hardware and firmware | <ul style="list-style-type: none">• Configuration and programming software used in level 3• e.g.: Autocad, valve sizing software, HMI• Configuration and programming software used in level 3• e.g.: Autocad, valve sizing software, HMI |
|---|---|

Achievement Criteria:

- Given a 10 question test on the configuration and programming software, hardware and firmware used in Level Three, the learner must answer 7 or more questions correctly.
- The learner's use of Level Three configuration and programming software, hardware and firmware will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE A: APPLIES OCCUPATIONAL SKILLS

Competency: A-6 Use trade related schematics and drawings

Learning Objectives:

The learner will be able to use schematics and drawings related to instrumentation.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Examine types of schematics and drawings | <ul style="list-style-type: none">• P&ID, SAMA, isometric and orthographic drawings• Loop drawings• Autocad |
| 2. Examine symbols and conventions | <ul style="list-style-type: none">• P&ID, SAMA, isometric and orthographic drawings• Loop drawings• Autocad |
| 3. Use and develop schematics and drawings | <ul style="list-style-type: none">• P&ID / P&C drawings• Loop drawings• Autocad |

Achievement Criteria:

- Given a 10 question test on the symbols, conventions, drawings and schematics used in Level Three the learner must answer 7 or more questions correctly.
- The learner's use of Level Three drawings and schematics will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE B: **INSTALLS AND MAINTAINS MEASURING AND INDICATING DEVICES**

Competency: **B-8 Measure consistency and viscosity**

Learning Objectives:

The learner will be able to install, calibrate and service consistency and viscosity measuring devices to process requirements.

LEARNING TASKS

1. Examine consistency and viscosity measuring devices and their operation

2. Examine instruments and techniques used to calibrate consistency and viscosity measuring devices

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

CONTENT

- Types (analog and Smart)
- Optical
- Rotary
- Blade
- Microwave
- Nuclear
- Viscometer
- Factors affecting system performance
- Temperature
- Flow
- Vibration
- Pressure
- Process considerations
- Multimeters
- Calibrated weights
- Sampling / Lab tests

- Manufacturers' specifications
- Selection /Location factors
- Accuracy requirements
- Process application
- Process medium
- Cost
- 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:

- Given a 10 question test on consistency and viscosity measuring devices, the learner must answer 7 or more questions correctly.
- The learner's ability to install, calibrate and service consistency and viscosity measuring devices will be evaluated in lab, with required minimum grade of 70%.

LINE B: INSTALLS AND MAINTAINS MEASURING AND INDICATING DEVICES

Competency: B-9 Measure and service environmental monitoring devices

Learning Objectives:

The learner will be able to install, configure and calibrate monitoring devices to process safety requirements.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <ol style="list-style-type: none">1. Examine types of hazardous gases and particulates to be monitored
2. Examine types of detection equipment for hazardous gases
3. Examine operation of monitoring systems
4. Install, configure and calibrate monitoring devices | <ul style="list-style-type: none">• Classes and groups of gases• Terms and definitions for hazardous gases• LEL/HEL (Low/High Explosive Limit)• PEL (Personnel Exposure Limit)• Monitored Gases• H₂S• CO• Cl₂• SOX• NOX• TRS (Total Reduced Sulphur)• Particulates• Protection• Personnel• Equipment• Environment• Infrared• Catalytic bead• Electro-chemical cell• Lead acid strip• Other technologies• Acceptable limits• Accuracy limitations• Shut down• Procedures• Actions• Implications• Manufacturers' specifications• Selection /Location factors• Connection to control system or indicator• Configuration of devices• Alarming methods• Calibration of devices• Laptop / software• Test gas selection and storage• Documenting calibration |
|---|--|

Achievement Criteria:

- Given a 10 question test on hazardous gases, gas detection equipment and monitoring equipment operation, the learner must answer 7 or more questions correctly.
- The learner's ability to install, configure and calibrate environmental monitoring devices will be evaluated in lab, with required minimum grade of 70%.

LINE C: INSTALLS AND MAINTAINS ANALYTICAL INSTRUMENTATION

Competency: C-1 Measure analytical properties of process gases

Learning Objectives:

The learner will be able to explain the installation, calibration and servicing requirements of gas chromatographs.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Examine gas chromatographs | <ul style="list-style-type: none">• Gas analysis• Methane, Ethane, Propane, Butane, etc.• Sulfur species |
| 2. Examine gas chromatograph operational theory | <ul style="list-style-type: none">• Chromatography• FID (Flame Ionization detector)• PID (Photo Ionization detector)• Thermal Conductivity detector |
| 3. Examine operating parameters of gas chromatographs | <ul style="list-style-type: none">• Accuracy• Repeatability• Interaction with process• Sources of contamination• Sampling systems• In situ• Extractive |
| 4. Examine the installation, calibration and servicing of process gas chromatographs | <ul style="list-style-type: none">• Conditions required• Manufacturers' specifications• Selection /Location factors• Connection to control system or indicator• Configuration of devices• Alarming methods• Calibration of devices• Laptop / software• Test gas selection and storage |

Achievement Criteria:

- Given a 10 question test on gas chromatographs the learner must answer 7 or more questions correctly.

LINE C: INSTALLS AND MAINTAINS ANALYTICAL INSTRUMENTATION

Competency: **C-2 Measure analytical properties of process liquids**

Learning Objectives:

The learner will be able to calibrate and service process liquid analyzers to process requirements.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Examine process liquid analyzers | <ul style="list-style-type: none">• pH• Measuring electrode• Reference electrode• FET• Conductivity• 2 electrode• 4 electrode• Torroidal• ORP• Specific ion• Dissolved oxygen• Turbidity• Water / effluent treatment• BOD (Biological Oxygen Demand)• COD (Chemical Oxygen Demand)• Silica• Sodium• Residual Chlorine• X-ray Fluorescence |
| 2. Examine process liquid analyzer operational theory and operating parameters | <ul style="list-style-type: none">• 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 | <ul style="list-style-type: none">• Manufacturers' specifications• Selection /Location factors• Measurement delays• Chemical mixing• Temperature requirements• Connection to control system or indicator• Configuration of devices• Calibration of devices• Buffering solutions• Calibration standards |

Achievement Criteria:

- Given a 10 question test on process liquid analyzers, the learner must answer 7 or more questions correctly.
- The learner's ability to calibrate and service process liquid analyzers will be evaluated in lab, with required minimum grade of 70%.

LINE C: INSTALLS AND MAINTAINS ANALYTICAL INSTRUMENTATION

Competency: C-3 Measure analytical properties of process solids

Learning Objectives:

The learner will be able to explain the theory and operating parameters of process solids analyzers.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| 1. Examine types of process solids analyzers | <ul style="list-style-type: none">• Nuclear devices• Assays• Moisture content• X-ray devices• Near infra-red |
| 2. Examine methods used by process solids analyzer | <ul style="list-style-type: none">• Online• Material handling considerations• Interface with system• Offline / Lab Test• Sample/weigh/dry/weigh• Chemical theory• Standards• ASTM |
| 3. Examine operating parameters of process solids analyzers | <ul style="list-style-type: none">• Accuracy• Repeatability• Interaction with process• Sources of contamination• Sampling systems• Conditions required• Method used |

Achievement Criteria:

- Given a 10 question test on process solid analyzers, the learner must answer 7 or more questions correctly.

LINE C: INSTALLS AND MAINTAINS ANALYTICAL INSTRUMENTATION

Competency: C-4 Install, calibrate and maintain process analyzers

Learning Objectives:

The learner will be able to describe the types and purpose of other process analyzers.

LEARNING TASK

CONTENT

- | | |
|--------------------------------------|--|
| 1. Examine other process analyzers | <ul style="list-style-type: none">• Brightness• Paper sheet scanners• Kappa (K#) analyzers• Sulfidity |
|--------------------------------------|--|

Achievement Criteria:

- Given a 10 question test on other process analyzers, the learner must answer 7 or more questions correctly.

LINE G: INSTALLS AND MAINTAINS FINAL CONTROL ELEMENTS

Competency: G-2 Service, size and install control valves and actuators

Learning Objectives:

The learner will be able to explain the sizing and selection of control valves and actuators.

LEARNING TASKS

CONTENT

- | | |
|--|--|
| <ol style="list-style-type: none">1. Examine sizing and selection of actuators2. Examine sizing and selection of control valves | <ul style="list-style-type: none">• Size and force required by process conditions
• Defining C_v• Flow characteristics• Quick opening• Equal percentage• Linear• Process requirements• Medium (Liquid / gas / steam)• Pressure• Flow• Temperature• Viscosity• TDH (Total Dynamic Head) and NPSH (Net Positive Suction Head)• Correlating Pump curve• Flashing / Cavitation• Noise suppression• Sizing for maximum ΔP allowable• Perform sizing calculations (Liquid / gas / steam)• Manual (nomograph)• Valve sizing software |
|--|--|

Achievement Criteria:

- Given a 10 question test on the sizing and selection of control valves and actuators the learner will answer 7 or more correctly.

**LINE G: INSTALLS AND MAINTAINS FINAL
CONTROL ELEMENTS**

Competency: G-3 Install and service valve positioners (includes advanced diagnostics)

Learning Objectives:

The learner will be able to explain the advanced diagnostics and operational capabilities of Smart Positioners.

LEARNING TASK

CONTENT

1. Examine advanced diagnostics and operational capabilities of Smart positioners

- Troubleshooting
- Determining valve and actuator health
- Stiction
- Friction
- Hysteresis
- Duty cycles
- Strokes
- Travel
- Time near closed
- Time near open
- History
- Alarming
- Control system interface
- Offline diagnostic testing

Achievement Criteria:

- Given a 10 question test on the advanced diagnostics used in Smart positioners the learner will answer 7 or more correctly.

LINE H: INSTALLS AND MAINTAINS COMMUNICATIONS NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H-1 Examine communication systems

Learning Objectives:

The learner will be able to explain the features and limitations on specified communication protocols.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Examine types of signal transmission systems | <ul style="list-style-type: none">• Fibre optics• Armoured cable• Non armoured cable• Multimode / single mode transmission• Wired• Coax• UTP• Wireless• Satellite• Cellular• Blue tooth• RF• IR |
| 2. Examine features and limitations of communication protocols | <ul style="list-style-type: none">• IEEE standards• Types of protocols• RS232• RS422/485• MODBUS• MODBUS+• ASi BUS• Device Net• Profibus• Highway Addressable Remote Transducer (HART)• FSK (Frequency Shift Keying)• Foundation Fieldbus• Spread spectrum• Ethernet TCP/IP• Addressing methods and components• Potential sources of interference• Related standards, codes, licenses |

Achievement Criteria:

- The learner must score 70% or higher on a 10 question test on signal transmission systems and related communication protocols.

LINE H: INSTALLS AND MAINTAINS COMMUNICATIONS NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H-3 Examine communication network structures and components

Learning Objectives:

The learner will be able to explain the basic structures and components of communication networks.

LEARNING TASKS

1. Examine hardware layers

CONTENT

- Network switches (routers)
- Configurable
- Nonconfigurable
- Firewalls
- Hubs
- Gateways
- Protocol interface
- Media interface
- Network isolation
- Hardware topologies
- Rapid spanning tree
- Self-healing rings
- Star
- Types of Connectors
- USB
- Firewire
- 9 pin, 25 pin serial port
- RJ45
- RJ11
- M12
- M10
- BNC
- Cannon plugs
- Resistance and Environmental Standards
- IP standards (IP67)

2. Examine network connectors

Achievement Criteria:

- Given a 10 question test on communication networks and their components, the learner must score 70% or higher.

LINE H: INSTALLS AND MAINTAINS COMMUNICATIONS NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

Competency: H-5 Service Supervisory Control and Data Acquisition (SCADA) systems

Learning Objectives:

The learner will be able to perform basic servicing tasks on a SCADA system.

LEARNING TASK

CONTENT

1. 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

Achievement Criteria:

- The learner's ability to service SCADA systems will be evaluated in lab, with required minimum grade of 70%.

LINE I: INSTALLS AND MAINTAINS CONTROL SYSTEMS

Competency: I-2 Examine control theory

Learning Objectives:

The learner will be able to explain basic control theory, actions and operational modes.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Examine basic control theory | <ul style="list-style-type: none">• 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 | <ul style="list-style-type: none">• On / Off control• Differential Gap• Proportional only• Integral only• Proportional plus Integral• PID -Proportional, Integral, Derivative• Reset rate / Reset time• Series / parallel• Interactive / non-interactive / rate on PV |
| 3. Examine controller action | <ul style="list-style-type: none">• Direct acting• Reverse acting |
| 4. Examine controller operating modes | <ul style="list-style-type: none">• Automatic• Manual• Remote• Local• Supervisory |

Achievement Criteria:

- The learner must score 70% or higher on a 10 question test on control theory, actions and operational modes.

LINE I: INSTALLS AND MAINTAINS CONTROL SYSTEMS

Competency: I-3 Examine process control techniques and strategies

Learning Objectives:

The learner will be able to explain control techniques and strategy applications to different processes.

LEARNING TASKS

CONTENT

- | | |
|--|--|
| 1. Examine control techniques | <ul style="list-style-type: none">• Loop tuning• Zeigler Nicholls• Lambda• Tuning from manual output changes |
| 2. Examine basic control strategies | <ul style="list-style-type: none">• Feedback control• Feedforward indexed control• Cascade control• Gap action control• Duplex control• Auto select control |

Achievement Criteria:

- The learner must score 70% or higher on a 10 question test on control techniques and strategies.

LINE I: INSTALLS AND MAINTAINS CONTROL SYSTEMS

Competency: I-4 Implement process control strategies

Learning Objectives:

The learner will be able to implement process control strategies.

LEARNING TASK

CONTENT

1. Implement process control strategies

- Determining required controller action based on process and valve action
- Consulting loop diagrams
- Overrides
- Interlocks
- Limits
- Select relays
- Loop impact on overall process
- Permitting procedures
- Consulting operators
- Alarming
- Selecting control strategy
- Tuning
- 2 mode
- 3 mode
- Cascade
- Implementation on live processes
- Upset recovery

Achievement Criteria:

- The learner's ability to implement process control strategies will be evaluated in lab, with required minimum grade of 70%.

LINE I: INSTALLS AND MAINTAINS CONTROL SYSTEMS

Competency: I-7 Service programmable logic controllers (PLCs)

Learning Objectives:

The learner will be able to troubleshoot various PLCs.

LEARNING TASKS

1. Review PLC languages and symbols

2. Examine and troubleshoot industrial PLC installations

3. Examine and troubleshoot PLC components

CONTENT

- IEC Standard 1131-3 Programming Languages
- Instruction List (IL)
- Structured Text (ST)
- Ladder Diagram (LD)
- Function Block Diagram (FBD)
- Sequential Function Chart (SFC)

- Hardware
- Assembly
- Configuration
- I/O addressing
- Programming
- Data Tables
- User Programs
- CPU
- Memory organization
- Input interface
- Output interface
- Power supply
- Programming/Monitoring interface
- Network communication module

Achievement Criteria:

- The learner must score 70% or higher on a 10 question test on PLC languages, symbols, installations and components.
- The learner's ability to troubleshoot PLC industrial installations and components will be evaluated in lab activities, with required minimum grade of 70%.

PROGRAM OUTLINE FOR LEVEL 4

LINE A:

APPLIES OCCUPATIONAL SKILLS

LEVEL FOUR

Competency: A-3 Use computers and related applications

Learning Objectives:

The learner will be able to configure and program Level Four instrumentation devices to manufacturers' specifications given related hardware, software and firmware.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| <ol style="list-style-type: none">1. Examines diagnostic and configuration software, hardware and firmware2. Uses diagnostic and configuration software, hardware and firmware | <ul style="list-style-type: none">• Configuration and programming software used in level 4• Configuration and programming software used in level 4 |
|---|---|

Achievement Criteria:

- Given a 10 question test on the configuration and programming software, hardware and firmware used in Level Four, the learner must answer 7 or more questions correctly.
- The learner's use of Level Four configuration and programming software, hardware and firmware will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE A:

APPLIES OCCUPATIONAL SKILLS

LEVEL FOUR

Competency: A-6 Use trade related schematics and drawings

Learning Objectives:

The learner will be able to use the Autocad program to create basic schematics and drawings.

LEARNING TASK

CONTENT

1. Use Autocad program

- Create basic drawings
 - P&ID and SAMA drawings
 - Loop drawings

Achievement Criteria:

The learner must score 70% or higher on instructor evaluation of Autocad-produced drawing.

LINE B: INSTALLS AND MAINTAINS MEASURING AND INDICATING DEVICES

LEVEL FOUR

Competency: B-10 Measure vibration

Learning Objectives:

The learner will be able to calibrate and service vibration measuring devices using a vibration monitoring system.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Examine vibration measuring devices | <ul style="list-style-type: none">• Probes• Proximeters• Transmitters |
| 2. Examine the installation, calibration and servicing of vibration measuring devices | <ul style="list-style-type: none">• Manufacturers' recommended maintenance procedures• Maintenance actions• Identifying cause of calibration errors• Repair and cleaning of device |
| 3. Service vibration monitoring system | <ul style="list-style-type: none">• Test and set up vibration monitoring system on operating process equipment |

Achievement Criteria:

- Given a 10 question test on vibration measuring devices, the learner must answer 7 or more questions correctly.
- The learner's ability to calibrate and service vibration measuring devices will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE B:

**INSTALLS AND MAINTAINS MEASURING
AND INDICATING DEVICES**

LEVEL FOUR

Competency: B-11 Measure speed

Learning Objectives:

The learner will be able to explain the servicing requirements of speed measuring devices.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <ol style="list-style-type: none">1. Examine relevant laws & principles of physics2. Examine speed measuring devices and their applications
3. Examine the installation, calibration and servicing of speed measuring devices | <ul style="list-style-type: none">• Speed• Velocity• Speed measuring devices• Tachometers• Probes• Proximeters• RPM counters• Strobe lights• Applications• Belt weightometers• Belt slippage• Governors• Radar gun• Interlock• Overspeed trips• Manufacturers' recommended maintenance procedures• Maintenance actions• Identifying cause of calibration errors• Repair and cleaning of device |
|---|--|

Achievement Criteria:

- Given a 10 question test on the installation, calibration and servicing of speed measuring devices the learner must answer 7 or more questions correctly.

LINE B:

**INSTALLS AND MAINTAINS MEASURING
AND INDICATING DEVICES**

LEVEL FOUR

Competency: B-12 Measure position

Learning Objectives:

The learner will be able to explain the servicing requirements of position measuring devices.

LEARNING TASKS

CONTENT

- | | |
|--|---|
| 1. Examine position measuring devices and their applications | <ul style="list-style-type: none">• Analog position sensors• Temposonic rods (LVDT)• Proximity switches• Proximity probes• Analog position sensors• Lasers• GPS• Examples of industrial applications• Pulp and paper• Oil and gas• Mining• Food Industry |
| 2. Examine the installation, calibration and servicing of position measuring devices | <ul style="list-style-type: none">• Manufacturers' recommended maintenance procedures• Maintenance actions• Identifying cause of calibration errors• Bringing device within calibration parameters• Repair and cleaning of device |

Achievement Criteria:

- Given a 10 question test on the installation, calibration and servicing of position measuring devices the learner must answer 7 or more questions correctly.

LINE B:

**INSTALLS AND MAINTAINS MEASURING
AND INDICATING DEVICES**

LEVEL FOUR

Competency: B-13 Measure motion

Learning Objectives:

The learner will be able to explain the servicing requirements of motion measuring devices.

LEARNING TASKS

1. Examine motion measuring devices and their applications

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

CONTENT

- Types
- Torque switches
- Proximity switches
- Proximity probes
- Analog position sensors
- Camera
- Applications
- Security
- Safety
- Monitoring rig torque
- Manufacturers' recommended maintenance procedures
- Maintenance actions
- Identifying cause of calibration errors
- Bringing device within calibration parameters
- Repair and cleaning of device

Achievement Criteria:

- Given a 10 question test on the installation, calibration and servicing of motion measuring devices the learner must answer 7 or more questions correctly.

LINE C: INSTALLS AND MAINTAINS ANALYTICAL INSTRUMENTATION**LEVEL FOUR****Competency: C-1 Measure analytical properties of process gases****Learning Objective:**

The learner will be able to calibrate and service flue gas analyzers.

LEARNING TASKS**CONTENT**

- | | |
|---|---|
| 1. Examine flue gas analyzers | <ul style="list-style-type: none">• Online Flue gas analyzers• Excess oxygen• CO• Particulate / opacity• TRS• NOX• SOX• Lab tests• Orsat• Fyrite |
| 2. Examine flue gas analyzer operational theory | <ul style="list-style-type: none">• Thermo-paramagnetic• Zirconium oxide• Catalytic combustibles detector• Infrared laser |
| 3. Examine operating parameters of flue gas analyzers | <ul style="list-style-type: none">• Accuracy• Repeatability• Interaction with process• Sources of contamination• Sampling systems• In situ• Convective• Close-coupled extractive• Extractive |
| 4. Calibrate and service process flue gas analyzers | <ul style="list-style-type: none">• Manufacturers' specifications• Selection /Location factors• Connection to control system or indicator• Configuration of devices• Alarming methods• Calibration of devices• Laptop / software• Test gas selection and storage |

Achievement Criteria:

- Given a 10 question test on the calibration and servicing of flue gas analyzers, the learner must answer 7 or more questions correctly.
- The learner's ability to calibrate and service flue gas analyzers will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE D: INSTALLS AND MAINTAINS SAFETY AND PROCESS MONITORING SYSTEMS
LEVEL FOUR

Competency: D-1 Service and test flame safety systems

Learning Objectives:

The learner will be able to service flame detection equipment.

LEARNING TASKS

CONTENT

- | | |
|---|---|
| 1. Examine flame detection equipment | <ul style="list-style-type: none">• Ultraviolet• Infrared• Magnetic• Rate of rise• Heat sensors (thermopile) |
| 2. Examine operation of flame safety systems | <ul style="list-style-type: none">• Ionic• Acceptable limits• Accuracy• Shut down• Procedures• Actions• Implications |
| 3. Service flame detection equipment | <ul style="list-style-type: none">• Manufacturers' specifications and recommendations• Selecting required equipment• Connecting to process / indicator• Configuring• Calibrating• Alarming |

Achievement Criteria:

- Given a 10 question test on flame detection equipment and its calibration and servicing, the learner must answer 7 or more questions correctly.
- The learner's ability to service flame detection equipment will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

**LINE D: INSTALLS AND MAINTAINS SAFETY AND
PROCESS MONITORING SYSTEMS**

LEVEL FOUR

Competency: D-2 Install and service process cameras

Learning Objectives:

The learner will be able to service process cameras.

LEARNING TASKS

1. Examine process camera applications

2. Install and service process cameras

CONTENT

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

Achievement Criteria:

- Given a 10 question test on process cameras, the learner must answer 7 or more questions correctly.
- The learner's ability to service process cameras will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE D:

**INSTALLS AND MAINTAINS SAFETY AND
PROCESS MONITORING SYSTEMS**

LEVEL FOUR

Competency: D-3 Service ESD (emergency shut down devices)

Learning Objectives:

The learner will be able to service emergency shutdown devices (ESDs).

LEARNING TASK

CONTENT

1. Service ESD

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

Achievement Criteria:

- The learner's ability to service ESD will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE G: INSTALLS AND MAINTAINS FINAL CONTROL ELEMENTS LEVEL FOUR

Competency: G-4 Configure variable speed drive (VSD) and variable frequency drive (VFD)

Learning Objectives:

The learner will be able to configure and test VSD and VFD.

LEARNING TASKS

1. Examine basic operation of VSDs and VFDs

2. Test operation of a VSD/VFD

3. Examine interaction of PID tuning and VSD configuration

CONTENT

- Operation
- Tuning parameter identification
- Signal isolation DCS/VFD
- Control of speed
- ECC (Eddy Current Coupling)
- Hydraulic Speed Control
- Input signals (digital and analog)
- Set up and test a VSD / VFD

- PID control in PLC/DCS with configuration parameters in VSD

Achievement Criteria:

- Given a 10 question test on VSD and VFD, the learner must answer 7 or more questions correctly.
- The learner's ability to configure and test VSD and VFD will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE H: INSTALLS AND MAINTAINS COMMUNICATIONS NETWORKING AND SIGNAL TRANSMISSION SYSTEMS

LEVEL FOUR

Competency: H-4 Troubleshoot signal transmission systems

Learning Objectives:

The learner will be able to troubleshoot and restore malfunctioning signal transmission systems to operational requirements.

LEARNING TASKS

CONTENT

1. Troubleshoot wired signal transmission systems

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

2. Troubleshoot wireless signal transmission systems

Achievement Criteria:

- The learner's ability to troubleshoot wired and wireless signal transmission systems will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE I:

INSTALLS AND MAINTAINS CONTROL SYSTEMS

LEVEL FOUR

Competency: I-4 Implement process control strategies

Learning Objectives:

The learner will be able to implement process control strategies.

LEARNING TASK

1. Implement and tune process control strategies

CONTENT

- Determining required controller action based on process and valve action
- Consulting loop diagrams
- Overrides
- Interlocks
- Limits
- Select relays
- Loop impact on overall process
- Permitting procedures
- Consulting operators
- Alarming
- Selecting control strategy
- Cascade control
- Feed forward index control
- Constant Ratio control
- Part-to-total Ratio control
- Implementation on live processes
- Upset recovery

Achievement Criteria:

- The learner's ability to implement and tune process control strategies will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE I: INSTALLS AND MAINTAINS CONTROL SYSTEMS**LEVEL FOUR****Competency: I-5 Service stand alone controllers****Learning Objectives:**

The learner will be able to configure stand alone controllers for various control strategies.

LEARNING TASKS

1. Examine stand alone controllers

2. Configure stand alone controller

CONTENT

- Microprocessor
- Single loop
- Cascade loop
- I/O
- HART
- Electronic
- Installation requirements
- Ambient temperature
- Area classification
- Configuration
- Techniques
- Tools
 - Hand held programmers
 - Software

Achievement Criteria:

- The learner's ability to configure stand alone controllers for various control strategies will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE I:

INSTALLS AND MAINTAINS CONTROL SYSTEMS

LEVEL FOUR

Competency: I-6 Install, configure, maintain and service Distributed Control Systems (DCS)

Learning Objectives:

The learner will be able to configure DCS equipment.

LEARNING TASKS

CONTENT

- | | |
|------------------|---|
| 1. Examine DCS | <ul style="list-style-type: none">• DCS and PLC interface• Foxboro I/A¹• System configuration• LAN communication protocols• Hardware components• Configuration software• Troubleshooting I/A DCS• Fisher Provox / Delta V¹• Operator console and diagnostic tools<ul style="list-style-type: none">– Analog and discrete input and output signals– Tunable parameters in software blocks |
| 2. Configure DCS | <ul style="list-style-type: none">• Build and troubleshoot a cascade control system (including operator interface graphics) for I/A DCS• Configure and troubleshoot analog inputs, analog outputs, control loops and pump stop/start points in Fisher Provox DCS¹ |

Achievement Criteria:

- Given a 10 question test on DCS, the learner must answer 7 or more questions correctly.
- The learner's ability to build, configure and troubleshoot a DCS will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

¹ Or similar DCS equipment

LINE I:

INSTALLS AND MAINTAINS CONTROL SYSTEMS

LEVEL FOUR

Competency: I-7 Service programmable logic controllers (PLCs)

Learning Objectives:

The learner will be able to configure and tune PLCs.

LEARNING TASK

CONTENT

1. Configure PLC

- Configuration and tuning of analog control strategies using ladder logic and one of the following IEC 1131 standard protocols:
 - FBD
 - ST
 - IS
 - SFC
 - Software interface
 - Operation
 - Troubleshooting

Achievement Criteria:

- The learner's ability to configure a PLC will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE I:

INSTALLS AND MAINTAINS CONTROL SYSTEMS

LEVEL FOUR

Competency: I-8 Service human machine interface (HMI)

Learning Objectives:

The learner will be able to program HMI software to communicate with a PLC or DCS.

LEARNING TASKS

CONTENT

- | | |
|-------------------------|--|
| 1. Examine HMI | <ul style="list-style-type: none">• 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 | <ul style="list-style-type: none">• 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 |

Achievement Criteria:

- The learner's ability to program HMI software to communicate with a PLC or DCS will be evaluated during lab activities, and the learner must achieve a minimum grade of 70%.

LINE I:

INSTALLS AND MAINTAINS CONTROL SYSTEMS

LEVEL FOUR

Competency: I-9 **Install and demonstrate knowledge of advanced supervisory control systems**

Learning Objectives:

The learner will be able to explain process optimization for an advanced supervisory control system.

LEARNING TASKS

CONTENT

- | | |
|---|--|
| <ol style="list-style-type: none">1. Examine batch process control2. Compare Batch Process Control to other control applications and strategies3. Examine batch process control software in use
4. Examine boiler control systems

5. Examine other advanced supervisory control systems | <ul style="list-style-type: none">• Operation and application of Batch Process Control• Continuous• Discontinuous
• DCS and PLC• Applications (examples)<ul style="list-style-type: none">– Batch pulp digester process– Concrete plant– Oil pipeline transmission– Chemical industry– Food plant• Combustion control systems• Parallel open/closed loop• 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• FD and ID fans• Predictive control techniques• Smith Predictors• MPC |
|---|--|

Achievement Criteria:

- Given a 10 question test on process optimization, the learner must answer 7 or more questions correctly.

SECTION 3

TRAINING PROVIDER STANDARDS

RECOMMENDED REFERENCE MATERIALS

INTRODUCTION

The amount of technical data and the rate of technological innovation confronting workers in this trade are extremely high.² Manufacturers who formerly maintained in-house publishing operations (due to the sheer quantity of specialized technical information associated with their products) have now moved to providing technical information in on-line and/or CD formats, in order to reduce costs associated with frequent revisions and updates to technical materials. The implications for the development of trade training materials are clear: there is potential for rapid redundancy of information and a need for constant Subject Matter Expert-led evaluation of curriculum.

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

- A. Materials in Print
- B. Online Resources
- C. Materials from other IIM Training Programs

A. Materials in Print

NORTHERN LIGHTS COLLEGE IDENTIFIED COURSE REFERENCE MATERIALS IN PRINT

Industrial Instrument Mechanic - Technical reference Book List for Northern Lights College

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

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

Cooke and Adams
 Ptec
 Kirk, Franklin & Philip, Weeder, Thomas A
 Murrill, Paul W
 Buchla, David
 Floyd
 Bartlet, Terry
 Patrick, Dale R & Steven R
 Faulk, Sutko
 Thomson, Delmar Learning
 Price, Winston T & Miller, Merlin
 Alerich, Walter N & Keljik, Jeff
 Considine, Douglas M
 Anderson, Norman A
 Bell, David A
 Rease, Dudley A
 Skoog, Douglas A & West, Donald M
 Shortley and Williams
 Wildi, Theodore
 Johnston, Curtis D
 Steingress, Frederick M
 Heath, Macnaughton and Martindale

**Basic Math for Electronics
 Instrumentation
 Instrumentation
 Fundamentals of Process Control Theory
 Experiments of Digital Fundamentals
 Principals of Electric Circuits
 Instrumentation and Process Control
 Pneumatic Instrumentation
 Industrial Instrumentation
 Fundamentals of Instrumentation
 Elements of Data Processing Math
 Electricity 3
 Process Industrial Instrumentation and Control Hand Book
 Instruments for Process Measurement and Control
 Fundamentals of Electric Circuits
 Basic Fluid Power
 Fundamentals of Analytical Chemistry
 Elements of Physics
 Electrical Machines, Drives and Power Systems
 Process Control Instrument Technologies
 Low Pressure Boilers
 Fundamentals of Physics**

OTHER NORTHERN LIGHTS COLLEGE REFERENCE MATERIALS

- Piping Systems NLC Mechanical Series 736
- Pneumatic Equipment NLC Mechanical Series 739
- Pneumatic Equipment Maintenance NLC Mechanical Series 740
- Introduction to Process Control NLC Process Control Series 771
- Foundations of Measurement Instruments NLC Process Control Series 772
- Pressure Measurement NLC Process Control Series 773
- Final Control Elements NLC Process Control Series 779
- Principles of Electricity NLC Electrical Equipment Series 721
- Semiconductors NLC Electronic Series 751
- Power Supplies NLC Electronic Series 752
- Amplifiers NLC Electronic Series 753
- Oscillators NLC Electronic Series 754
- Digital Logic Systems NLC Electronic Series 791
- Programmable Logic Controllers NLC Electronic Series 798
- Flow Measurement NLC Process Control Series 775
- Level Measurement NLC Process Control Series 776
- Temperature Measurement NLC Process Control Series 777

BCIT IDENTIFIED INSTRUCTOR REFERENCE MATERIALS IN PRINT

Canadian Electrical Code, Part 1, 20th Edition. _CSA, January 2006.

Floyd, Thomas L. *Digital Fundamentals*, 8th edition.
Prentice-Hall, 2005.

Liptak, Bella G., Ed. *Instrument Engineer's Handbook, Volume 1, Process Measurement and Analysis*, 4th edition.
Boca Raton, Florida: CRC Press, 2003.

Liptak, Bella G., Ed. *Instrument Engineer's Handbook, Volume 2, Process Control*, 4th edition.
Boca Raton, Florida: CRC Press, 2005.

Liptak, Bella G., Ed. *Instrument Engineer's Handbook, Volume 3, Process Software and Digital Networks*, 3rd edition.
Boca Raton, Florida: CRC Press, 2002

Principles of Electricity. Schoolcraft Publishing.
www.schoolcraftpub.com

Process Instrumentation 1. Schoolcraft Publishing.
www.schoolcraftpub.com

Process Instrumentation 2. Schoolcraft Publishing.
www.schoolcraftpub.com

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.

OTHER IDENTIFIED PRINT RESOURCES

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

www.abb.com ABB

www.boschrexroth.ca - Bosch Rexroth Canada is the Canadian partner of Bosch Rexroth, international company specializing in “Drive and Control.” Some technical information on hydraulics, including course outlines for intro and maintenance.

www1.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/ --Lots on density here

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 tech literature... Fee?)

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.

<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 --This is an amazing website with excellent info 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 info 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 info

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.

Other Curriculum Materials (Alberta)

Alberta textbooks and resources for this trade may be purchased from the training institute offering the apprenticeship program.

First Period

1. Pneumatic Instruments Lab Manual
2. Workshop Practices
3. Basic Electricity, N.A.I.T.
4. Institutional Note Packages and Competency Based Apprenticeship Training reference materials where appropriate.
5. IPT Pipe Trades Handbook, R. Lee
6. Introduction to W.H.M.I.S.
7. Basic Technical Physics, Second Edition by Paul E. Tippens, McGraw – Hill
8. Instrumentation Mechanics Math/Physics
9. Electronic Fundamentals, Circuits and Devices, 5th Edition (ISBN: 0-1308-5236-8)
10. Introductory Electric Circuits by Robert R. Paynter, Prentice – Hall (ISBN: 0-0239-2500-0)
11. Hazardous Locations - A Guide for the Design, Construction and Installation of Electrical Equipment in Explosive Atmospheres, John A. Bossert, CSA (ISBN: 0-0239-2402-0)
12. S.A.I.T. Modules
13. S.A.I.T. Lab Manuals

Second Period

1. Measurement and Control Instruments - Pneumatics
 2. Process Measurement and Analysis, Third Edition, Bela G. Liptak, Chilton Publishing
 3. Process Equipment
 4. Electronics
 5. Digital Fundamentals
 6. Any textbooks from the previous year
 7. S.A.I.T. Modules
 8. S.A.I.T. Lab Manuals
- 2003-Jan Instrument Technician
2003-Jan Instrument Technician

Third Period

1. Basic Chemistry, Seventh Edition by Seese and Daub, Prentice - Hall
2. Process Measurement and Analysis, Third Edition, Bela G. Liptak, Chilton Publishing
3. Process Measurement - Theory
4. Process Measurement - Lab Manual
5. Analytical Instrumentation
6. Applied Electronics
7. Any textbooks from the previous year
8. Process Analyzer Technology by Kenneth J. Cleve, Wiley, John & Sons (ISBN: 0-4718-8316-6)
9. S.A.I.T. Modules
10. S.A.I.T. Lab Manuals

Fourth Period

1. Process Control Notes
2. Process Control Lab Manual
3. Analytical Instrumentation
4. Advanced Digital Equipment
5. Successful Instrumentation Applications, First Edition by Bob Connell
6. Process Measurement and Analysis, Third Edition by Bela G. Liptak, Chilton
7. Any textbooks from the previous year
8. Logix Pro – The Learning Pit
9. Programmable Logic Controllers by Frank D. Petruzella, Glencoe McGraw Hill (ISBN: 0-0280-2661-6)
10. S.A.I.T. Modules
11. S.A.I.T. Lab Modules

NAIT MATERIALS (ALBERTA CURRICULUM MODULES)

NAIT Course Pack #1066, Analytical Instrumentation Yr3

NAIT Course Pack #1067, Analytical Instrumentation Yr4

NAIT Course Pack #1183, Pneumatic Instruments Lab Manual Yr1

NAIT Course Pack #1239: Advanced Digital Systems Yr4

NAIT Course Pack #1255, Applied Electronics Yr3

NAIT Course Pack #1385, Measurement and Control Instrumentation Yr2

NAIT Course Pack #1454, Workshop Practices Manual Yr1

NAIT Course Pack #1694, Process Equipment Yr2

NAIT Course Pack #1231: Digital Fundamentals Yr2

NAIT Course Pack #1241: Basic Electricity Yr1

NAIT Course Pack #1256: Measurement Instruments Lab Yr3

NAIT Course Pack #1383: Measurement & Control Instruments Yr2

NAIT Course Pack #1386: Process Instruments Note Package Yr3

NAIT Course Pack #1390: Process Control Notes Yr 4

NAIT Course Pack #2433: Personal Computer Applications Yr2

Lee, Robert A; IPT's Pipe Trades Handbook; IPT Publishing, Edmonton

Alberta Canada ISBN 0-920855-18-0

NAIT materials available at Northern Alberta Institute of Technology (NAIT) bookstore (Campus Reads and Needs) (780) 471 – 771, or on line at www.nait.ca

TRAINING PROVIDER STANDARDS

1. Instructor Qualifications

Trade Certification

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

Work Experience

- Minimum of five years recent related work experience as a journeyperson

Education

- Instructors Certificate (minimum 30 hr course) OR
- registered in an Instructor's Diploma Program (to be completed within a five year period) OR
- Bachelors or Masters degree in Education

2. Facilities

Classroom Area

- Comfortable seating and tables suitable for training, teaching, lecturing and drafting
- Compliance with all local and national fire code and occupational safety requirements
- 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
- In-room temperature regulation to ensure comfortable room temperature
- In-room ventilation sufficient to control training room temperature
- Acoustics in the room must allow audibility of the instructor
- White marking board with pens and eraser (optional: flipchart in similar size)
- Projection screen or projection area at front of classroom
- Overhead projector and/or multi-media projector

Lab Area

- Fully operational, representative process equipment with supporting instrumentation and control equipment, for example: distillation column, evaporator and power boiler, pulp stock digester, brownstock washer
- Installed control system (e.g. Fisher Delta V)
- Stand alone controllers (e.g. F&P MC-5000),
- PC-based advanced control software (e.g. Brainwave),
- Programmable Logic Controllers (e.g. Rockwell's PLC-5s, Modicon Quantum PLCs, Rockwell PLCs, GE/Fanuc Series 90/30 PLCs with Genius I/O)
- Distributed Control Systems (e.g. Provox DCS, Honeywell TDC 3000 DCS, Foxboro IA DCS, DeltaV DCS, BaileyNet90 DCS)
- 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
- test bed for interfacing multiple vendor equipment with ease
- Multiple computer stations and an array of interfacing options

N.B.: The Lab Area of the Training Facility must provide learners with the resources to:

- create variety of complex control processes
- feed analog and digital instrumentation into multiple DCS and PLC control platforms
- adapt and modify control configuration easily
- create custom equipment configurations with a minimum of difficulty

Student Facilities

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

EQUIPMENT AND TOOLS

Hand Tools

calipers (assorted)
crowbar
diagonal cutter
drill bits
easy-out (extractor)
fixed vice
flaring tool
flashlight
fuse puller
gauge pointer puller
gasket cutter
grease gun
hammers (assorted)
hand files (assorted)
hex keys (Imperial/Metric)
jackknife
knock out punch
level
magnet
measuring tape
micrometers (assorted)
mirrors
nut drivers (assorted)
packing puller
pinch bar
pipe threader

pliers (assorted)
punches (assorted)
reamer
rubber mallet
saws (assorted)
screw starter
screwdrivers (assorted)
scriber
sockets (Imperial/Metric)
square
steel rule
strap wrench
tap and die set
torch
torque wrench
Torx wrench
tube benders
tube cutter
tweezer
wire brushes
wire crimpers
wire cutter
wire labeler
wire stripper
wrenches (assorted)

Power Tools

air compressor
band saw
cutoff saw
drill press
grinders
hammer drill
heat gun
high pressure grease gun
hydraulic press
impact wrench

jig saw
pipe threader
portable electric drill
portable generator
powder actuated tools (Hilti, Ramset, etc.)
pneumatic tools
pressure and vacuum pumps
reciprocating saw
sandblaster
soldering iron

ELECTRONIC TOOLS AND TEST EQUIPMENT

amp probe
analog multimeter
analyzers
barometer
bridges
calibrated oven
capacitance simulator
current calibrator
data logger
deadweight tester
decade resistance box
deflectional-type strain indicator
dew point tester
digital multimeter
dry block calibrator
eddy current tachometer
electromagnetic flowmeter
electrostatic voltmeter
frequency counter
frequency generator
gauge blocks
hand held programmer (configurator)
hand held pyrometer
hydrometer
infrared camera
infrared thermometer
lab scales
label maker
laptop computer
laser strength meter
logic testers
loop calibrator/simulator
manometer
microscope
microwave leakage meter
millivoltmeter calibrator
mobile phone/pager/two way radio
modem
null balance strain indicator
optical pyrometer
oscilloscope
personal computer
personal digital assistant (PDA)
pH simulator/buffers
pneumatic test stand
portable sound level meter
portable voltage tester
potentiometer
power supplies
pressure calibrator
printers
protocol analyzer
radiation meter
regulator
RPM tester/tachometer
RTD/thermocouple calibrator
signal generator
signal analyzer
sling psychrometer
software
stroboscope
tachometer generator
temperature bath
test gases
test gauges (pressure, vacuum)
thermal meter
thermometer
vacuum pump
variable transformer
vibration table (wobbulator)
wireless signal strength tester
wrist ground strap

PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

All PPE must comply with WorkSafeBC regulations

apron

cap lamp

coveralls (regular, disposable
and fireproof)

ear protection (muffs and plugs)

eye wash bottle

face shield

fire extinguisher

first aid kit

flame retardant clothing

gloves

grounding mat

hard hat

low-voltage gloves

mask

personal dosimeter

personal monitor (gas)

radiation survey meter

radiometer

respirators

rubber boots

rubber suits

safety boots

safety glasses

safety harnesses

safety lines

self contained breathing apparatus

splash goggles

supplied air hood

winter gear

Instrumentation and Control Technician (Industrial Instrument Mechanic)

Date: _____

Practical Skills Assessment Form

STUDENT _____

SCORE: _____%

LAB PROJECT: _____

SCHOOL/TRAINING INSTITUTION: _____

INSTRUCTOR/ ASSESSOR: _____

GENERAL WORK STANDARD CRITERIA

RATE 1-10 OR N/A

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

LAB CRITERIA

RATE 1-10 OR N/A

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

Scoring passing grade is 70%:

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

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

TRADE GLOSSARY AND ACRONYMS

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

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

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

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

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

input/output (I/O) all equipment and activity that transfers information into or out of a computer

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

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

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 to 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

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

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

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

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

weir an engineered obstruction placed in an open channel

Acronyms

ASME American Society of Mechanical Engineers

A/D, ADC Analog to Digital Converter

CEC Canadian Electrical Code

CEMS Continuous Emissions Monitoring System

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

HART Highway Addressable Remote Transducer

HMI Human Machine Interface

I/O input/output

ISA Instrumentation, Systems and Automation Society

MISA Municipal Industry Strategy for Abatement

MSDS Material Safety Data Sheets

OH&S Occupational Health and Safety Act

OPC OLE (Object Linking Embedding) Process Control

ORP Oxidation Reduction Potential

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

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 Workplace Hazardous Materials Information System