PROGRAM PROGRAMME
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# Red Seal Occupational Standard

## Instrumentation and Control Technician

INTERPROVINCIAL STANDARD
CANADA
NORME INTERPROVINCIALE

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Employment and Social Development Canada
Emploi et Développement social Canada

Canada

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# RED SEAL OCCUPATIONAL STANDARD

## INSTRUMENTATION AND CONTROL TECHNICIAN

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CANADA
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Title: Instrumentation and Control Technician

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# FOREWORD

***The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Red Seal Occupational Standard (RSOS) as the Red Seal standard for the Instrumentation and Control Technician trade.***

**Background**

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. Employment and Social Development Canada (ESDC) sponsors the Red Seal Program, which, under the guidance of the CCDA, develops a national occupational standard for each of the Red Seal trades.

Standards have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and assessment tools for apprenticeship and certification authorities;
- to develop common tools for apprenticeship on-the-job and technical training in Canada;
- to facilitate the mobility of apprentices and skilled workers in Canada;
- to supply employers, employees, associations, industries, training institutions and governments with occupational standards.

Any questions, comments, or suggestions for changes, corrections, or revisions to this standard or any of its related products may be forwarded to:

Trades and Apprenticeship Division
Apprenticeship and Sectoral Initiatives Directorate
Employment and Social Development Canada
140 Promenade du Portage, Phase IV, 6th Floor
Gatineau, Quebec K1A 0J9

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Special thanks are offered to the following representatives who contributed greatly to the original draft of the standard and provided expert advice throughout its development:

| | |
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This standard was prepared by the Apprenticeship and Sectoral Initiatives Directorate of ESDC. The coordinating, facilitating and processing of this standard was undertaken by employees of the standards development team of the Trades and Apprenticeship Division and of Alberta, the host jurisdiction for this trade.

# STRUCTURE OF THE OCCUPATIONAL STANDARD

This standard contains the following sections:

**Methodology:** an overview of the process for development, review, validation and weighting of the standard

**Description of the Instrumentation and Control Technician trade:** an overview of the trade's duties, work environment, job requirements, similar occupations and career progression

**Trends in the Instrumentation and Control Technician trade:** some of the trends identified by industry as being the most important for workers in this trade

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

**Industry Expected Performance:** description of the expectations regarding the level of performance of the tasks, including information related to specific codes, regulations and standards that must be observed

**Language Requirements:** description of the language requirements for working and studying in this trade in Canada

**Pie Chart of Red Seal Examination Weightings:** a graph which depicts the national percentages of exam questions assigned to the major work activities

**Task Matrix:** a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard

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

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

**Task Descriptor:** a general description of the task

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

**Skills**:

**Performance Criteria:** description of the activities that are done as the sub-task is performed

**Evidence of Attainment:** proof that the activities of the sub-task meet the expected performance of a tradesperson who has reached journeyperson level

**Knowledge:**

**Learning Outcomes:** describes what should be learned relating to a sub-task while participating in technical or in-school training

**Learning Objectives:** topics to be covered during technical or in-school training in order to meet the learning outcomes for the sub-task

**Range of Variables:** elements that provide a more in-depth description of a term used in the performance criteria, evidence of attainment, learning outcomes, or learning objectives

**Appendix A – Acronyms:** a list of acronyms used in the standard with their full name

**Appendix B – Tools and Equipment / Outils et équipement:** a non-exhaustive list of tools and equipment used in this trade

**Appendix C – Glossary / Glossaire:** definitions or explanations of selected technical terms used in the standard

# METHODOLOGY

### Development of the Standard

A draft standard is developed by a broad group of trade representatives, including tradespersons, instructors and employers at a National Workshop led by a team of facilitators. This draft standard breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

### Draft Review

The RSOS development team forwards a copy of the standard and its translation to provincial and territorial authorities who consult with industry representatives to review it. Their recommendations are assessed and incorporated into the standard.

### Validation and Weighting

Participating provinces and territories also consult with industry to validate and weight the document for the purpose of planning the makeup of the Red Seal Interprovincial Examination for the trade. They validate and weight the MWA, tasks and sub-tasks, of the standard as follows:

| | |
|---|---|
| **MWA** | Each jurisdiction assigns a percentage of questions to each MWA for an examination that would cover the entire trade. |
| **TASKS** | Each jurisdiction assigns a percentage of exam questions to each task within a MWA. |
| **SUB-TASKS** | Each jurisdiction indicates, with a YES or NO, whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction. |

The results of this exercise are submitted to the RSOS development team who then analyzes the data and incorporates it into the document. The RSOS provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for MWA and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

The validation of the RSOS is used to identify common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions' industry performs a sub-task, it shall be considered common core. Interprovincial Red Seal Examination questions are limited to the common core sub-tasks identified through this validation process.

**Definitions for Validation and Weighting**

| | |
|---|---|
| **YES** | sub-task performed by qualified workers in the occupation in that province or territory |
| **NO** | sub-task not performed by qualified workers in the occupation in that province or territory |
| **NV** | standard Not Validated by that province or territory |
| **ND** | trade Not Designated in a province or territory |
| **NOT COMMON CORE (NCC)** | sub-task, task or MWA performed less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade |
| **NATIONAL AVERAGE %** | average percentage of questions assigned to each MWA and task in Interprovincial Red Seal Examination for the trade |

**Provincial/Territorial Abbreviations**

| | |
|---|---|
| **NL** | Newfoundland and Labrador |
| **NS** | Nova Scotia |
| **PE** | Prince Edward Island |
| **NB** | New Brunswick |
| **QC** | Quebec |
| **ON** | Ontario |
| **MB** | Manitoba |
| **SK** | Saskatchewan |
| **AB** | Alberta |
| **BC** | British Columbia |
| **NT** | Northwest Territories |
| **YT** | Yukon Territory |
| **NU** | Nunavut |

# DESCRIPTION OF THE INSTRUMENTATION AND CONTROL TECHNICIAN TRADE

"Instrumentation and Control Technician" is this trade's official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by instrumentation and control technicians whose occupational title has been identified by some provinces and territories of Canada under the following names:

| | NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Instrumentation and Control Technician | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | | | | |
| Instrument Technician | | | | | | | | | | | ■ | | |
| Industrial Instrument Technician | | | | | | | | | | | | | ■ |
| Industrial Instrument Mechanic | | | | | | | | | | ■ | | ■ | |

Instrumentation and control technicians are knowledgeable in measurement and automation of process control systems. Examples of industries that use process control systems are oil and gas refineries, power generation plants, pulp and paper mills, and manufacturing facilities.

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

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

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

Instrumentation and control technicians work in various industrial sectors such as pulp and paper/fibre processing; food and beverage processing; pharmaceuticals processing; nuclear, thermal and hydropower generation; landfill/cogeneration; mining; petrochemical; pipeline; oil and gas; military; steel; water and wastewater treatment; medical instrumentation; manufacturing; and industrial/commercial instrument servicing.

When performing their duties, instrumentation and control technicians must comply with federal, jurisdictional, industrial and site-specific standards, codes and regulations. They install and commission new instrumentation systems according to these requirements. They contribute to keeping processes operating and equipment maintained within these set standards, codes and regulations. Keeping up-to-date with advances in technology in industry and in the trade is essential.

Instrumentation and control technicians may work in a variety of hazardous environments where they could be exposed to confined spaces, heights, noise, dust, cold and heat. There may also be risks working with chemicals, gases, electricity, radiation, laser equipment and substances under pressure. Instrumentation and control technicians are trained to identify hazards and work safely in these environments.

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

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

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

# TRENDS IN THE INSTRUMENTATION AND CONTROL TECHNICIAN TRADE

**Digital Technology**

As technology is ever changing, instrumentation and control technicians must forever be adapting to these new technologies. This has increased the need for more technology-driven competencies to perform this trade and an increase in time being spent using digital technology.

Process control systems are increasingly being designed with more components that communicate with one another. Control systems have traditionally been separate entities from the internet. However, in order to keep software up to date, systems now require the ability to connect to the internet to acquire software and licensing. Instrumentation and control technicians must be aware of the use and implications of internet connectivity such as one-way communication devices (data diodes), cyber security and firewalls.

Increasingly, process systems are seeing more automation including HMI, DCS, SCADA, PLC and open systems interconnection (OSI) systems. There is also more automation in networking/communication systems.

Some applications of wireless technologies are being introduced for functions such as monitoring process systems and meter verification.

Predictive technologies are increasingly being used in process optimization. Trends in optimization will require that the instrumentation and control technician be knowledgeable in the use of advanced diagnostics.

**Tools and Equipment**

Portable digital communication devices are being used to diagnose and perform tasks more efficiently and effectively.

**Quality Acceptance**

When installing and replacing parts, there is an increase in the need to perform quality acceptance activities and properly document and store this information to meet regulatory requirements and traceability.

**Health and Safety**

An increased emphasis on safety in the workplace has led to an increase in documentation for instrumentation and control technicians.

There are more safety instrumented systems (SIS) being implemented. This requires that instrumentation and control technicians be familiar with the functioning of these systems.

**Regulations**

There is a continued increase in industry practices for environmental monitoring driven by governmental regulations. This has increased the workload of instrumentation and control technicians in areas such as reporting on carbon capture and emissions.

# ESSENTIAL SKILLS SUMMARY

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

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

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

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

The tools are available online or for order at: https://www.canada.ca/en/employment-social-development/programs/essential-skills/profiles.html.

The application of these skills may be described throughout this document within the skills and knowledge that support each sub-task of the trade. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at http://www.red-seal.ca/.

## READING

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

## DOCUMENT USE

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

## WRITING

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

## ORAL COMMUNICATION

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

## NUMERACY

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

## THINKING

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

## DIGITAL TECHNOLOGY

Instrumentation and control technicians install and service process automation controllers such as PLC, DCS, SCADA systems and HMI. They may use portable digital communication devices to configure settings and to access data such as measurement and operational values. Instrumentation and control technicians may use a variety of software and applications such as word processing software, databases, spreadsheets, communication software and devices, the internet, and computer-assisted design (CAD).

## WORKING WITH OTHERS

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

## CONTINUOUS LEARNING

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

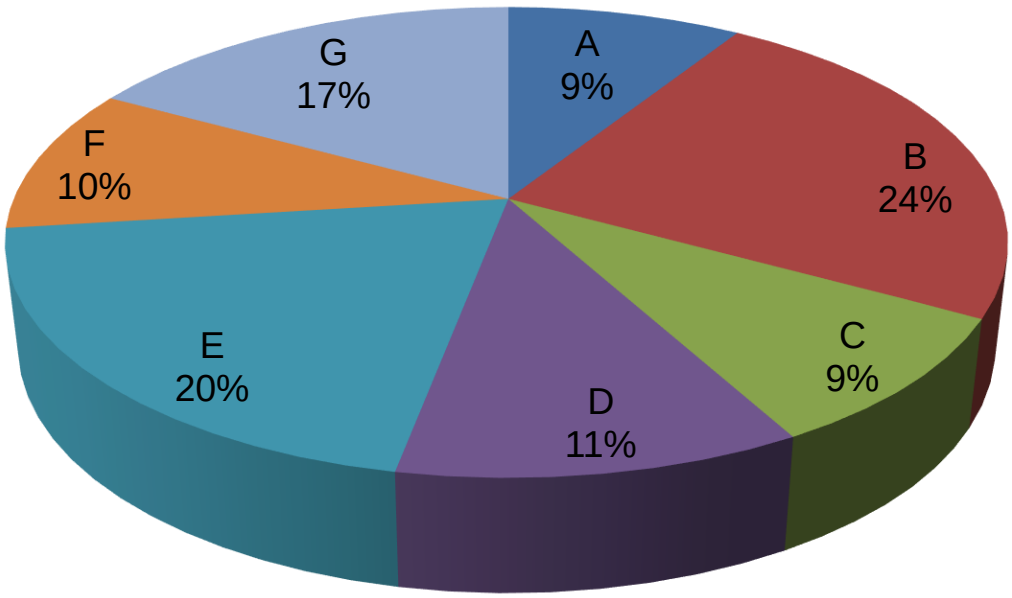
# INDUSTRY EXPECTED PERFORMANCE

All tasks must be performed according to the applicable jurisdictional codes, regulations and standards. All health and safety standards must be respected and observed. Work should be done efficiently and to a high quality without material waste or environmental damage. All requirements of employers, engineers, designers, manufacturers, clients and quality control policies must be met. At a journeyperson level of performance, all tasks must be done with minimal direction and supervision. As a journeyperson progresses in their career, there is an expectation they continue to upgrade their skills and knowledge to maintain pace with industry and promote continuous learning in their trade through mentoring of apprentices.

# LANGUAGE REQUIREMENTS

It is expected that journeypersons are able to understand and communicate in either English or French, which are Canada's official languages. English or French are the common languages of business as well as languages of instruction in apprenticeship programs.

# PIE CHART
## OF RED SEAL EXAMINATION WEIGHTINGS




| | | |
|---|---|---|
| MWA A | Performs common occupational skills | 9% |
| MWA B | Installs and services process measuring and indicating devices | 24% |
| MWA C | Installs and services safety and security systems and devices | 9% |
| MWA D | Installs and services hydraulic, pneumatic and electrical systems | 11% |
| MWA E | Installs, configures and services final control elements | 20% |
| MWA F | Installs and services communication systems and devices | 10% |
| MWA G | Installs and services control systems and process control | 17% |

This pie chart represents a breakdown of the interprovincial Red Seal examination. Percentages are based on the collective input from workers from the trade from across Canada. The Task Matrix on the next pages indicates the breakdown of tasks and sub-tasks within each Major Work Activity and the breakdown of questions assigned to the tasks. The Interprovincial examination for this trade has 125 questions.

# INSTRUMENTATION AND CONTROL TECHNICIAN

# TASK MATRIX

## A – Performs common occupational skills — 9%

| | | | |
|---|---|---|---|
| **Task A-1**<br>**Performs safety-related functions**<br>**30%** | **A-1.01 Maintains safe work environment** | **A-1.02 Uses personal protective equipment (PPE) and safety equipment** | **A-1.03 Performs de-energizing, lock-out and tag-out procedures** |
| **Task A-2**<br>**Uses tools and equipment**<br>**34%** | **A-2.01 Uses calibration, configuration and test equipment** | **A-2.02 Uses hand and power tools** | **A-2.03 Uses access equipment** |
| | **A-2.04 Uses rigging, hoisting and lifting equipment** | | |
| **Task A-3**<br>**Organizes work**<br>**24%** | **A-3.01 Uses documentation** | **A-3.02 Interprets drawings and schematics** | **A-3.03 Plans tasks** |
| **Task A-4**<br>**Uses communication and mentoring techniques**<br>**12%** | **A-4.01 Uses communication techniques** | **A-4.02 Uses mentoring techniques** | |

## B – Installs and services process measuring and indicating devices 24%

| | | | |
|---|---|---|---|
| **Task B-5**<br>**Installs and services pressure, temperature, level and flow devices**<br>**30%** | **B-5.01 Installs pressure, temperature, level and flow devices** | **B-5.02 Maintains pressure, temperature, level and flow devices** | **B-5.03 Diagnoses pressure, temperature, level and flow devices** |
| | **B-5.04 Repairs pressure, temperature, level and flow devices** | | |
| **Task B-6**<br>**Installs and services signal transducers**<br>**14%** | **B-6.01 Performs installation and configuration of signal transducers** | **B-6.02 Diagnoses signal transducers** | **B-6.03 Performs maintenance and repairs on signal transducers** |
| **Task B-7**<br>**Installs and services motion, speed, position and vibration devices**<br>**12%** | **B-7.01 Installs motion, speed, position and vibration devices** | **B-7.02 Maintains motion, speed, position and vibration devices** | **B-7.03 Diagnoses motion, speed, position and vibration devices** |
| | **B-7.04 Repairs motion, speed, position and vibration devices** | | |
| **Task B-8**<br>**Installs and services mass, density and consistency devices**<br>**14%** | **B-8.01 Installs mass, density and consistency devices** | **B-8.02 Maintains mass, density and consistency devices** | **B-8.03 Diagnoses mass, density and consistency devices** |
| | **B-8.04 Repairs mass, density and consistency devices** | | |
| **Task B-9**<br>**Installs and services process analyzers**<br>**17%** | **B-9.01 Installs process analyzers** | **B-9.02 Maintains process analyzers** | **B-9.03 Diagnoses process analyzers** |
| | **B-9.04 Repairs process analyzers** | | |

| | | | |
|---|---|---|---|
| **Task B-10**<br>**Installs and services multiple variable computing devices**<br>**13%** | **B-10.01 Installs multiple variable computing devices** | **B-10.02 Maintains multiple variable computing devices** | **B-10.03 Diagnoses multiple variable computing devices** |
| | **B-10.04 Repairs multiple variable computing devices** | | |

## C – Installs and services safety and security systems and devices — 9%

| | | | |
|---|---|---|---|
| **Task C-11**<br>**Installs and services safety systems and devices**<br>**55%** | **C-11.01 Installs safety systems and devices** | **C-11.02 Maintains safety systems and devices** | **C-11.03 Diagnoses safety systems and devices** |
| | **C-11.04 Repairs safety systems and devices** | | |
| **Task C-12**<br>**Installs and services facility security systems**<br>**(NOT COMMON CORE)** | **C-12.01 Installs facility security systems (NOT COMMON CORE)** | **C-12.02 Maintains facility security systems (NOT COMMON CORE)** | **C-12.03 Diagnoses facility security systems (NOT COMMON CORE)** |
| | **C-12.04 Repairs facility security systems (NOT COMMON CORE)** | | |
| **Task C-13**<br>**Installs and services safety instrumented systems (SIS)**<br>**45%** | **C-13.01 Installs SIS** | **C-13.02 Configures SIS** | **C-13.03 Maintains SIS** |
| | **C-13.04 Diagnoses SIS** | **C-13.05 Repairs SIS** | |

## D – Installs and services hydraulic, pneumatic and electrical systems

**11%**

| | | | |
|---|---|---|---|
| **Task D-14**<br>**Installs and services control devices for hydraulic systems**<br>**19%** | **D-14.01 Installs control devices for hydraulic systems** | **D-14.02 Diagnoses control devices for hydraulic systems** | **D-14.03 Performs maintenance and repairs on control devices for hydraulic systems** |
| **Task D-15**<br>**Installs and services pneumatic equipment**<br>**40%** | **D-15.01 Installs pneumatic equipment** | **D-15.02 Diagnoses pneumatic equipment** | **D-15.03 Performs maintenance and repairs on pneumatic equipment** |
| **Task D-16**<br>**Installs and services electrical and electronic equipment**<br>**41%** | **D-16.01 Installs electrical and electronic equipment** | **D-16.02 Diagnoses electrical and electronic equipment** | **D-16.03 Performs maintenance and repairs for electrical and electronic equipment** |

# E – Installs, configures and services final control elements

**20%**

| | | | |
|---|---|---|---|
| **Task E-17**<br>**Installs and services valves**<br>**25%** | **E-17.01 Installs valves** | **E-17.02 Maintains valves** | **E-17.03 Diagnoses valves** |
| | **E-17.04 Repairs valves** | | |
| **Task E-18**<br>**Installs and services actuators**<br>**27%** | **E-18.01 Installs actuators** | **E-18.02 Maintains actuators** | **E-18.03 Diagnoses actuators** |
| | **E-18.04 Repairs actuators** | | |
| **Task E-19**<br>**Installs and services positioners**<br>**32%** | **E-19.01 Installs positioners** | **E-19.02 Maintains positioners** | **E-19.03 Diagnoses positioners** |
| | **E-19.04 Repairs positioners** | | |
| **Task E-20**<br>**Configures and services variable speed drives (VSD)**<br>**16%** | **E-20.01 Configures VSD** | **E-20.02 Maintains VSD** | **E-20.03 Diagnoses VSD** |
| | **E-20.04 Repairs VSD** | | |

## F – Installs and services communication systems and devices — 9%

| | | | |
|---|---|---|---|
| **Task F-21**<br>**Installs and services control network systems**<br>**42%** | **F-21.01 Performs installation and configuration on control network systems** | **F-21.02 Diagnoses control network systems** | **F-21.03 Performs maintenance and repairs on control network systems** |
| **Task F-22**<br>**Installs and services signal converters**<br>**33%** | **F-22.01 Performs installation and configuration of signal converters** | **F-22.02 Diagnoses signal converters** | **F-22.03 Performs maintenance and repairs on signal converters** |
| **Task F-23**<br>**Installs and services gateways, bridges and media converters**<br>**25%** | **F-23.01 Performs installation and configuration of gateways, bridges and media converters** | **F-23.02 Diagnoses gateways, bridges and media converters** | **F-23.03 Performs maintenance and repairs on gateways, bridges and media converters** |

## G – Installs and services control systems and process control — 17%

| | | | |
|---|---|---|---|
| **Task G-24**<br>**Establishes and optimizes process control strategies**<br>**22%** | **G-24.01 Determines process control strategy** | **G-24.02 Optimizes process control** | |
| **Task G-25**<br>**Installs and services stand-alone controllers (SAC)**<br>**12%** | **G-25.01 Installs SAC** | **G-25.02 Configures SAC** | **G-25.03 Performs maintenance, diagnostics and repairs on SAC** |
| **Task G-26**<br>**Installs and services programmable logic controllers (PLC)**<br>**23%** | **G-26.01 Installs PLC** | **G-26.02 Configures PLC** | **G-26.03 Performs maintenance, diagnostics and repairs on PLC** |
| **Task G-27**<br>**Installs and services distributed control systems (DCS)**<br>**19%** | **G-27.01 Installs DCS** | **G-27.02 Configures DCS** | **G-27.03 Performs maintenance, diagnostics and repairs on DCS** |

| | | | |
|---|---|---|---|
| **Task G-28**<br>**Installs and services human machine interface (HMI)**<br>**14%** | **G-28.01 Installs HMI** | **G-28.02 Configures HMI** | **G-28.03 Performs maintenance, diagnostics and repairs on HMI** |
| **Task G-29**<br>**Installs and services supervisory control and data acquisition (SCADA) systems**<br>**10%** | **G-29.01 Installs SCADA systems** | **G-29.02 Configures SCADA systems** | **G-29.03 Performs maintenance, diagnostics and repairs on SCADA systems** |

# MAJOR WORK ACTIVITY A

# Performs common occupational skills

## TASK A-1 Performs safety-related functions

### TASK DESCRIPTOR

Instrumentation and control technicians must ensure a safe work environment by complying with safety regulations and procedures. They use personal protective equipment (PPE) and safety equipment to ensure their safety and that of others. They also use de-energizing, lock-out and tag-out procedures to ensure safe conditions when working on equipment.

### A-1.01 Maintains safe work environment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-1.01.01P | follow ***safety procedures*** | ***safety procedures*** are followed according to Occupational Health and Safety (OH&S), site specifications and standards |
| A-1.01.02P | identify ***potential hazards*** | ***potential hazards*** are identified according to site conditions |
| A-1.01.03P | maintain a clean and safe work site | work site is kept clean and safe to avoid injuries to self and others |
| A-1.01.04P | coordinate tasks with other workers | tasks with other workers are coordinated to avoid injury to self and others |
| A-1.01.05P | install barricades and signage | barricades and signage are installed to identify hazards in work areas |
| A-1.01.06P | handle hazardous materials | hazardous materials are handled according to Workplace Health Management Information System ***(WHMIS) procedures*** |
| A-1.01.07P | participate in safety meetings and discussions | safety meetings and discussions are attended to ensure that information is recorded and distributed to all team members |

| | | |
|---|---|---|
| A-1.01.08P | recognize and report unsafe conditions and personal injury hazards | unsafe conditions and personal injury hazards are reported so that they may be rectified |
| A-1.01.09P | use ***safety mechanisms*** | ***safety mechanisms*** are used according to OH&S, site specifications and standards |

## RANGE OF VARIABLES

***safety procedures*** include: fall arrest, job safety hazard assessment (JSHA), confined space procedures

***potential hazards*** include: high voltage, rotating equipment, nuclear radiation, hazardous gases, environmental extremes, working at heights, noisy locations, arc flash, confined space, temperature extremes, discharge/spills

***WHMIS procedures*** include: disposal, labelling, using PPE

***safety mechanisms*** include: double-block-and-bleed, railings, tie-offs, SWP

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-1.01.01L | demonstrate knowledge of safe work practices (SWP) | identify hazardous area classifications |
| | | describe safety policies and procedures |
| | | identify ***potential hazards*** |
| | | describe housekeeping practices |
| | | identify emergency procedures and location of safety equipment |
| | | describe disposal and recycling procedures |
| A-1.01.02L | demonstrate knowledge of regulatory requirements pertaining to safety | identify and describe ***workplace safety and health regulations*** |
| | | identify workers' rights and responsibilities |
| | | identify ***training requirements*** |
| | | identify fire safety codes and procedures |
| | | identify ***work permit and safe work analysis requirements*** |

## RANGE OF VARIABLES

***potential hazards*** include: high voltage, rotating equipment, nuclear radiation, hazardous gases, environmental extremes, working at heights, noisy locations, arc flash, confined space, temperature extremes, discharge/spills

***workplace safety and health regulations*** include: WHMIS, transportation of dangerous goods (TDG), jurisdictional health and safety acts

***training requirements*** include: fall protection, confined space entry, hoisting and rigging and elevated work platforms, hazardous gas awareness

***work permit and safe work analysis requirements*** include: JSHA, SWP, lock-out and tag-out procedures, hot work permits, field level risk assessment (FLRA)

## A-1.02 Uses personal protective equipment (PPE) and safety equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| A-1.02.01P | select and wear ***PPE*** | ***PPE*** is used as appropriate for task as identified by site policies, jurisdictional regulations and WHMIS |
| A-1.02.02P | inspect ***PPE*** prior to use | ***PPE*** is inspected prior to use for appropriate fit, expiration date and ***damage*** |
| A-1.02.03P | locate and use ***safety equipment*** | ***safety equipment*** is located and used according to OH&S, site specifications and standards |
| A-1.02.04P | maintain ***PPE*** and ***safety equipment*** | ***PPE*** and ***safety equipment*** are maintained according to manufacturers' specifications |
| A-1.02.05P | test, recertify or replace ***PPE*** and ***safety equipment*** | ***PPE*** and ***safety equipment*** are tested, recertified and replaced according to jurisdictional regulations, company policies and manufacturers' specifications |

### RANGE OF VARIABLES

***PPE*** includes: safety glasses, safety boots, gloves, coveralls, face shields, personal monitors, hearing protection, hard hats, arc flash protection, respirators, fall protection harness, self-contained breathing apparatus (SCBA)

***damage*** includes: excessively worn boots, cracked safety glasses, expired hard hats, safety harness integrity

***safety equipment*** includes: first aid kits, fire extinguishers, eye wash stations, chemical showers

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| A-1.02.01L | demonstrate knowledge of ***PPE*** and ***safety equipment***, their applications, maintenance and procedures for use | identify ***PPE*** and ***safety equipment*** and describe their applications, maintenance and procedures for use |
| | | identify ***PPE*** and ***safety equipment*** operation and limitations |
| | | identify maintenance schedules and certification requirements for ***PPE*** and ***safety equipment*** |

## RANGE OF VARIABLES

***PPE*** includes: safety glasses, safety boots, gloves, coveralls, face shields, personal monitors, hearing protection, hard hats, arc flash protection, respirators, fall protection harness, SCBA

***safety equipment*** includes: first aid kits, fire extinguishers, eye wash stations, chemical showers

## A-1.03 Performs de-energizing, lock-out and tag-out procedures

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| A-1.03.01P | identify ***sources of potential energy*** | ***sources of potential energy*** are identified |
| A-1.03.02P | select ***isolation points*** | ***isolation points*** are identified to ensure that energy cannot be added to system |
| A-1.03.03P | de-energize system | system is de-energized according to site specifications and procedures |
| A-1.03.04P | perform lock-out and zero energy verification | lock-out is performed and verified for zero energy according to site specifications and procedures |
| A-1.03.05P | document equipment lock-out specifics | equipment lock-out specifics are documented according to site specifications and procedures |
| A-1.03.06P | perform work on energized equipment and systems | live work is performed within jurisdictional limitations and according to special procedures |

## RANGE OF VARIABLES

***sources of potential energy*** include: suspended weight, trapped pressure, electrical potential, radiation sources

***isolation points*** include: valves, blinds/blanks on piping systems, brakes, motor control centre (MCC), local disconnects and breakers

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| A-1.03.01L | demonstrate knowledge of energizing, de-energizing, lock-out and tag-out procedures | identify sources of potential energy |
| | | describe procedures for shutting down equipment and processes |
| | | describe procedures for isolating equipment from energy sources |

| | |
|---|---|
| | describe ***methods for de-energizing system*** and verifying zero energy of all energy sources |
| | describe methods for energizing equipment |
| | identify types of ***equipment that can be energized and de-energized*** |
| | identify special procedures that require work on live equipment and processes |

### RANGE OF VARIABLES

***methods for de-energizing system*** include: relieving pressure, removing electrical potential, applying grounds, releasing brakes

***equipment that can be energized and de-energized*** includes: electrical, mechanical, hydraulic, pneumatic, nuclear

## TASK A-2 Uses tools and equipment

### TASK DESCRIPTOR

Instrumentation and control technicians must be able to select, use and maintain tools and equipment in a safe and effective manner relevant to the task performed.

### A-2.01 Uses calibration, configuration and test equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-2.01.01P | inspect ***calibration and test equipment*** | ***calibration and test equipment*** is inspected according to manufacturers' specifications and regulatory requirements |
| A-2.01.02P | inspect and verify functionality of ***configuration equipment*** | ***configuration equipment*** is inspected according to manufacturers' specifications and regulatory requirements |
| A-2.01.03P | confirm versions of software and firmware and perform updates | software and firmware are updated to required version |
| A-2.01.04P | recertify ***calibration and test equipment*** and devices | ***calibration and test equipment*** and devices are recertified according to known and traceable standards, manufacturers' recommendations and regulations |

| | | |
|---|---|---|
| A-2.01.05P | store ***configuration, calibration and test equipment*** | ***configuration***, ***calibration and test equipment*** is stored according to manufacturers' recommendations |
| A-2.01.06P | document maintenance and certification of ***configuration***, ***calibration and test equipment*** | maintenance and certification of ***configuration***, ***calibration and test equipment*** is documented according to site and regulatory requirements |

## RANGE OF VARIABLES

***calibration and test equipment*** includes: multimeters, process calibrators (temperature, pressure, frequency), hand-held communicators, dead weight testers, networking/communication testers

***configuration equipment*** includes: hand-held communicators, computers, associated software

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-2.01.01L | demonstrate knowledge of ***configuration***, ***calibration and test equipment***, their applications, maintenance and procedures for use | identify types of ***configuration***, ***calibration and test equipment*** and describe their applications |
| | | describe procedures used to inspect and maintain ***configuration***, ***calibration and test equipment*** |
| | | describe limitations of ***configuration***, ***calibration and test equipment*** |
| | | identify maintenance schedule and certification requirements of ***configuration***, ***calibration and test equipment*** |

## RANGE OF VARIABLES

***configuration equipment*** includes: hand-held communicators, computers, associated software

***calibration and test equipment*** includes: multimeters, process calibrators (temperature, pressure, frequency), hand-held communicators, dead weight testers, networking/communication testers

## A-2.02 Uses hand and power tools

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| A-2.02.01P | organize and store ***hand and power tools*** and ***components*** | ***hand and power tools*** and ***components*** are organized and stored in designated cases and areas according to company and job site requirements |
| A-2.02.02P | maintain ***hand and power tools*** | ***hand and power tools*** are maintained according to manufacturers' specifications |
| A-2.02.03P | identify worn, damaged and defective ***hand and power tools*** | damaged and defective ***hand and power tools*** are tagged and replaced or repaired according to manufacturers' specifications |
| A-2.02.04P | change tool ***components*** | ***components*** are changed according to job requirements |
| A-2.02.05P | identify hazards associated with ***hand and power tools*** | hazards are identified and ***hand and power tools*** are used with PPE and safety equipment according to location, environment and application |

### RANGE OF VARIABLES

***hand and power tools*** include: see Tools and Equipment (Appendix B)
***components*** include: chucks, bits, blades, cords, attachment plugs

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| A-2.02.01L | demonstrate knowledge of ***hand and power tools***, their ***components***, applications and procedures for use | identify types of ***hand and power tools*** and their ***components***, and describe their applications, limitations and procedures for use |
| | | describe operating and maintenance procedures of ***hand and power tools*** and their ***components*** |
| A-2.02.02L | demonstrate knowledge of inspection procedures | describe procedures used to inspect ***hand and power tools*** |
| A-2.02.03L | demonstrate knowledge of powder-actuated tools, their applications and certification requirements | identify types of powder-actuated tools and describe their applications, limitations and procedures for use |
| | | describe certification requirements to use powder-actuated tools |

## RANGE OF VARIABLES

***hand and power tools*** include: see Tools and Equipment (Appendix B)
***components*** include: chucks, bits, blades, cords, attachment plugs

## A-2.03 Uses access equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-2.03.01P | identify traffic areas and ***potential hazards*** | traffic areas and ***potential hazards*** are identified according to job site |
| A-2.03.02P | install barricades and signage to contain work zone | barricades and signage are installed according to regulations and ***potential hazards*** |
| A-2.03.03P | select ***access equipment*** | ***access equipment*** is selected according to their limitations and task at hand |
| A-2.03.04P | set up and secure stepladders and extension ladders | ladders are set up and used according to manufacturers' recommendations, site specifications and jurisdictional regulations |
| A-2.03.05P | visually and mechanically inspect for worn, damaged and defective ***access equipment*** | ***access equipment*** is inspected for ***damage*** |
| A-2.03.06P | report, tag and decommission ***access equipment*** | unsafe, worn, damaged and defective ***access equipment*** is tagged and removed from service |
| A-2.03.07P | organize and store ***access equipment*** | ***access equipment*** is organized and stored according to manufacturers' specifications and job site requirements |
| A-2.03.08P | work from approved and certified ***access equipment*** | ***access equipment*** is certified and approved for job task and operator is certified in equipment use according to job site requirements and jurisdictional regulations |

## RANGE OF VARIABLES

***potential hazards*** include: overhead hazards, ladder footing and stability, confined spaces, trenches, slips, trips and falls
***access equipment*** includes: ladders, elevated work platforms, scaffolding, fall protection (fall arrest and fall restraint)
***damage*** includes: broken ladder, leaking oil, defective safety chains and gates, fall protection integrity

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-2.03.01L | demonstrate knowledge of ***access equipment***, their characteristics, applications, limitations and procedures for use | identify types of ***access equipment*** and describe their characteristics, applications and limitations |
| | | identify hazards and describe safe work practices pertaining to ***access equipment*** |
| | | describe procedures used to inspect, maintain and store ***access equipment*** |
| | | identify certification for use of ***access equipment*** |
| A-2.03.02L | demonstrate knowledge of ***regulatory requirements*** pertaining to ***access equipment*** | identify and interpret ***regulatory requirements*** and responsibilities pertaining to ***access equipment*** |

## RANGE OF VARIABLES

***access equipment*** includes: ladders, elevated work platforms, scaffolding, fall protection (fall arrest and fall restraint)

***regulatory requirements*** include: inspection documentation, training and certification

## A-2.04 Uses rigging, hoisting and lifting equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-2.04.01P | identify traffic areas and ***potential hazards*** | traffic areas and ***potential hazards*** are identified according to job site requirements |
| A-2.04.02P | install barricades and signage to contain work zone | barricades and signage are installed according to regulations, job site requirements and ***potential hazards*** |
| A-2.04.03P | select rigging, hoisting and lifting equipment | rigging, hoisting and lifting equipment are selected according to their limitations, task at hand and job site requirements |
| A-2.04.04P | visually and mechanically inspect for worn, damaged and defective rigging, hoisting and lifting equipment | rigging, hoisting and lifting equipment is inspected for ***damages*** |
| A-2.04.05P | report, tag and decommission unsafe, damaged and defective rigging, hoisting and lifting equipment | damaged and defective rigging, hoisting and lifting equipment is tagged and removed from service |

| | | |
|---|---|---|
| A-2.04.06P | secure rigging, hoisting and lifting equipment | rigging, hoisting and lifting equipment is secured according to manufacturers' specifications and job site requirements |
| A-2.04.07P | use and interpret hand and audible signals | hand and audible signals are used to direct load to intended position |
| A-2.04.08P | secure load for application | load is secured according to engineer and manufacturers' specifications, and industry practices |
| A-2.04.09P | move load to final position | load is moved to final position according to required location |
| A-2.04.10P | clean, lubricate and store rigging, hoisting and lifting equipment | rigging, hoisting and lifting equipment is cleaned, lubricated and stored according to manufacturers' specifications and job site procedures |

## RANGE OF VARIABLES

***potential hazards*** include: overhead hazards, overhead power hazards, dropped loads, damaged rigging hardware, congested worksites, confined spaces, trenches, uneven surfaces, weather conditions

***damages*** include: worn slings, worn shackles, missing or distorted safety catches, frayed ropes and slings, oil leaks

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-2.04.01L | demonstrate knowledge of hoisting, lifting and rigging equipment, their applications, limitations and procedures for use | identify ***types of rigging equipment*** and accessories, and describe their applications, limitations and procedures for use |
| | | identify types of hoisting and lifting equipment and accessories and describe their applications and procedures for use |
| | | identify ***potential hazards*** and describe safe work practices pertaining to hoisting, lifting and rigging |
| | | describe procedures used to inspect, maintain and store hoisting, lifting and rigging equipment |
| | | identify hoisting and lifting capacities |
| | | identify ***material handling equipment*** |
| A-2.04.02L | demonstrate knowledge of ***regulatory requirements*** pertaining to hoisting, lifting and rigging equipment | identify and adhere to codes and regulations pertaining to hoisting, lifting and rigging |
| A-2.04.03L | demonstrate knowledge of basic hoisting and lifting operations | identify types of knots, hitches, splices and bends, and describe their applications and procedures used to tie them |

| | |
|---|---|
| | describe ***considerations*** when rigging material/equipment for lifting |
| | identify and describe ***procedures used to communicate*** during hoisting, lifting and rigging operations |

### RANGE OF VARIABLES

***types of rigging equipment*** include: chains, ropes, cables, slings, shackles

***potential hazards*** include: overhead hazards, overhead power hazards, dropped loads, damaged rigging hardware, congested worksites, confined spaces, trenches, uneven surfaces, weather conditions

***material handling equipment*** includes: pallet jacks, forklifts, portable or stationary cranes and rigging equipment

***regulatory requirements*** include: inspection documentation, training, certification

***considerations*** include: load characteristics, working load limit (WLL), equipment and accessories, environmental factors, anchor points, sling angles

***procedures used to communicate*** include: hand signals, electronic communications, audible/visual

## TASK A-3 Organizes work

### TASK DESCRIPTOR

Instrumentation and control technicians organize work effectively using tools and procedures. They interpret and update drawing schematics and documentation to access information required for their work. Instrumentation and control technicians plan and coordinate their tasks with other trades and services when required. They also ensure work site, tools and equipment are prepared prior to performing tasks.

### A-3.01 Uses documentation

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-3.01.01P | update ***documentation*** | ***documentation*** is updated according to maintenance procedures |
| A-3.01.02P | update and develop maintenance procedures | maintenance procedures are updated and developed to reflect equipment changes |
| A-3.01.03P | create backup databases of equipment configuration and software | backup databases of equipment configuration and software are created according to maintenance procedures |
| A-3.01.04P | maintain and update maintenance records and operation procedures | maintenance records and operation procedures are maintained and updated |

| | | |
|---|---|---|
| A-3.01.05P | provide condition and assessment reports of equipment to supervisors | condition and assessment reports of equipment are provided to supervisors |
| A-3.01.06P | use forms and data sheets to create service reports | service reports are created |
| A-3.01.07P | file and update regulatory documentation | regulatory documentation is filed and updated according to regulatory requirements |
| A-3.01.08P | use ***asset management systems*** | ***asset management systems*** are used to log, predict and validate maintenance |

## RANGE OF VARIABLES

***documentation*** includes: calibration sheets, data sheets, drawings, work orders, maintenance schedules
***asset management systems*** include: work orders, preventative maintenance programs, instrument databases

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-3.01.01L | demonstrate knowledge of trade-related ***documentation*** and their use | identify types of trade-related ***documentation*** and describe their purpose, applications and procedures for use |
| | | identify ***standards and codes*** used in the trade |

## RANGE OF VARIABLES

***documentation*** includes: calibration sheets, data sheets, drawings, work orders, maintenance schedules
***standards and codes*** include: International Society of Automation (ISA) standards, Canadian Standards Association (CSA) standards, Canadian Electrical Code (CEC), site-specific standards

## A-3.02 Interprets drawings and schematics

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-3.02.01P | identify symbols found on drawings and schematics | symbols are identified from legends, notes and specifications |
| A-3.02.02P | determine location of equipment and devices | location of equipment and devices is determined by making a measurement using drawings |

| | | |
|---|---|---|
| A-3.02.03P | locate and cross-reference information on plans, drawings, specifications and contract documents | installation information is obtained by interpreting plans, drawings, specifications and contract documents |
| A-3.02.04P | determine if plans, drawings, schematics and specifications are current | plans, drawings, schematics and specifications are compared with existing installation |
| A-3.02.05P | create, modify and update diagrams, drawings, schematics and other documentation | diagrams, drawings, schematics and other documentation are created, modified and updated according to industry and company standards |

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-3.02.01L | demonstrate knowledge of drawings, schematics, their applications and ***information contained in them*** | define terminology associated with drawings and schematics |
| | | identify ***types of drawings*** and describe their applications |
| | | identify symbols and conventions used in diagrams and schematics |
| | | describe metric and imperial systems |

## RANGE OF VARIABLES

***information contained in drawings and schematics*** includes: lines, legends, symbols, abbreviations, notes, specifications, metric and Society of Automotive Engineers (SAE) dimensions

***types of drawings*** include: mechanical, plant layout, process equipment details, process, process and instrument diagrams/process and control (P&ID/P&C), Scientific Apparatus Makers Association (SAMA), loop drawings, electrical, hydraulic, pneumatic, orthographic, isometric, schematics, wiring diagrams, as-builts, logic

## A-3.03 Plans tasks

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-3.03.01P | schedule tasks | tasks are scheduled according to operations, personnel availability and tools and equipment |
| A-3.03.02P | interpret drawings and schematics | drawings and schematics are interpreted according to task requirements |

| | | |
|---|---|---|
| A-3.03.03P | select PPE, safety equipment, tools, equipment, materials, parts and personnel | PPE, safety equipment, tools, equipment, materials, parts and personnel are selected according to ***task requirements*** |
| A-3.03.04P | coordinate tasks with other trades | tasks are coordinated with other trades according to ***task requirements*** |
| A-3.03.05P | coordinate tasks with operations | tasks are coordinated with operations for process equipment availability and safety |
| A-3.03.06P | identify Management of Change (***MOC***) ***procedures*** | ***MOC procedures*** are identified according to site-specific policies and requirements |
| A-3.03.07P | identify sources of potential energy | sources of potential energy are identified |
| A-3.03.08P | identify inventory requirements | inventory requirements are identified according to ***factors*** |
| A-3.03.09P | prepare work site | work site is prepared by performing ***activities*** |

## RANGE OF VARIABLES

***task requirements*** include: job planning, safety procedures planning, permits, emergency protocols, commissioning

***MOC procedures*** include: authorized sign-offs, traceability, quality control/quality assurance, equipment replacement

***factors*** include: criticality, operational needs, manufacturers' recommendations

***activities*** include: hazard assessment, environmental assessment, setting up barricades

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-3.03.01L | demonstrate knowledge of procedures used to plan and organize jobs | identify ***sources of information*** relevant to job planning |
| | | describe considerations for determining ***task requirements*** |
| | | describe procedures used to plan job tasks |
| | | explain importance of maintaining a parts inventory |
| | | identify ***MOC procedures*** |
| | | identify ***forms*** used in job planning |
| | | identify regulations related to ***environment*** and measurement |

## RANGE OF VARIABLES

***sources of information*** include: documentation, drawings, related professionals, clients

***task requirements*** include: job planning, safety procedures planning, permits, emergency protocols, commissioning

***MOC procedures*** include: authorized sign-offs, traceability, quality control/quality assurance, equipment replacement

***forms*** include: bill of materials, purchase orders, material requisitions, MOC documents

***environment*** includes: hazardous designations, ambient conditions, contamination

# TASK A-4 Uses communication and mentoring techniques

## TASK DESCRIPTOR

Learning in the trades is done primarily in the workplace with tradespersons passing on their skills and knowledge to apprentices, as well as sharing knowledge among themselves. Apprenticeship is, and always has been about mentoring – learning workplace skills and passing them on. Because of the importance of this to the trade, this task covers the activities related to communication in the workplace and mentoring skills.

### A-4.01 Uses communication techniques

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-4.01.01P | demonstrate communication practices with individuals or in a group | instructions and messages are interpreted by all parties involved in communication |
| A-4.01.02P | listen using ***active listening*** practices | ***active listening*** practices are utilized |
| A-4.01.03P | receive and respond to feedback on work | response to feedback indicates understanding and corrective measures are taken |
| A-4.01.04P | explain and provide feedback | explanation and feedback is provided and task is carried out as directed |
| A-4.01.05P | use questioning to improve communication | questions enhance understanding, on-the-job training and goal setting |
| A-4.01.06P | participate in information meetings | meetings are attended, information is relayed to workforce, and is applied |

## RANGE OF VARIABLES

***active listening*** includes: hearing, interpreting, reflecting, responding, paraphrasing

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-4.01.01L | demonstrate knowledge of trade terminology | define terminology used in the trade |
| A-4.01.02L | demonstrate knowledge of effective communication practices | describe importance of using effective verbal and non-verbal communication with ***people in the workplace*** |
| | | identify ***sources of information*** to effectively communicate |
| | | identify communication and ***learning styles*** |
| | | describe effective listening and speaking skills |
| | | identify ***personal responsibilities and attitudes*** that contribute to on-the-job success |
| | | identify value of diversity in the workplace |
| | | identify communication that constitutes ***harassment, discrimination*** and ***code of conduct*** |

## RANGE OF VARIABLES

***people in the workplace*** include: other tradespersons, colleagues, apprentices, supervisors, clients, authorities having jurisdiction (AHJ), manufacturers

***sources of information*** include: regulations, codes, occupational health and safety requirements, AHJ requirements, prints, drawings, specifications, company and client documentation

***learning styles*** include: seeing it, hearing it, trying it

***personal responsibilities and attitudes*** include: asking questions, working safely, accepting constructive feedback, time management and punctuality, respect for authority, good stewardship of materials, tools and property, efficient work practice

***harassment*** includes: objectionable conduct, comment or display made either on a one-time or continuous basis that demeans, belittles, or causes personal humiliation or embarrassment to the recipient

***discrimination*** is prohibited based on: race, national or ethnic origin, colour, religion, age, sex, sexual orientation, gender identity or expression, marital status, family status, disability, genetic characteristics, pardoned conviction

***code of conduct*** includes: ethics, policies regarding conflict of interest, respectful workplace

## A-4.02 Uses mentoring techniques

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| A-4.02.01P | identify and communicate learning objective and point of lesson | apprentice or learner can explain objective and point of lesson |
| A-4.02.02P | link lesson to other lessons and the job | lesson order and unplanned learning opportunities are defined |
| A-4.02.03P | demonstrate performance of a skill to an apprentice or learner | ***steps required to demonstrate a skill*** are performed |
| A-4.02.04P | set up conditions required for an apprentice or learner to practice a skill | ***practice conditions*** are set up so that skill can be practiced safely by the apprentice or learner |
| A-4.02.05P | assess apprentice or learners' ability to perform tasks with increasing independence | performance of apprentice or learner improves with practice to a point where skill can be done with little supervision |
| A-4.02.06P | give supportive and corrective feedback | apprentice or learner adopts best practice after having been given supportive or corrective feedback |
| A-4.02.07P | support apprentices or learners in pursuing technical training opportunities | technical training is completed within timeframe prescribed by apprenticeship authority |
| A-4.02.08P | support anti-***harassment*** in workplace | workplace is ***harassment*** and ***discrimination***-free |
| A-4.02.09P | assess apprentice or learner suitability to the trade during probationary period | apprentice or learner is given feedback that helps them identify their own strengths and weaknesses and suitability for the trade |

## RANGE OF VARIABLES

***steps required to demonstrate a skill*** include: understanding the who, what, where, when, why, and how, explaining, showing, giving encouragement, following up to ensure skill is performed correctly

***practice conditions*** means: guided, limited independence, full independence

***harassment*** includes: objectionable conduct, comment or display made either on a one-time or continuous basis that demeans, belittles, or causes personal humiliation or embarrassment to the recipient

***discrimination*** is prohibited based on: race, national or ethnic origin, colour, religion, age, sex, sexual orientation, gender identity or expression, marital status, family status, disability, genetic characteristics, pardoned conviction

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| A-4.02.01L | demonstrate knowledge of strategies for learning skills in workplace | describe importance of individual experience |
| | | describe shared responsibilities for workplace learning |
| | | determine one's own learning preferences and explain how these relate to learning new skills |
| | | describe importance of different types of skills in workplace |
| | | describe importance of ***essential skills*** in workplace |
| | | identify different ***learning styles*** |
| | | identify different ***learning needs*** and strategies to meet them |
| | | identify ***strategies to assist in learning a skill*** |
| A-4.02.02L | demonstrate knowledge of strategies for ***teaching*** workplace ***skills*** | identify different roles played by a workplace mentor |
| | | describe ***teaching skills*** |
| | | explain importance of identifying point of a lesson |
| | | identify how to choose a good time to present a lesson |
| | | explain importance of linking lessons |
| | | identify components of skill (context) |
| | | describe considerations in setting up opportunities for skill practice |
| | | explain importance of providing feedback |
| | | identify techniques for giving effective feedback |
| | | describe a skills assessment |
| | | identify methods of assessing progress |
| | | explain how to adjust a lesson to different situations |
| A-4.02.03L | demonstrate knowledge of workplace ***harassment*** and ***discrimination*** | identify legislation related to ***harassment*** and ***discrimination*** |
| | | describe ***code of conduct*** for workplace |

## RANGE OF VARIABLES

***essential skills*** are: reading, document use, writing, oral communication, numeracy, thinking, working with others, digital technology, continuous learning

***learning styles*** include: seeing it, hearing it, trying it

***learning needs*** include: learning disabilities, learning preferences, language proficiency

***strategies to assist in learning a skill*** include: understanding the basic principles of instruction, developing coaching skills, being mature and patient, providing feedback

***teaching skills*** include: identifying the point of the lesson, linking the lesson, demonstrating the skill, providing practice, giving feedback, assessing skills and progress, demonstrating empathy

***harassment*** includes: objectionable conduct, comment or display made either on a one-time or continuous basis that demeans, belittles, or causes personal humiliation or embarrassment to the recipient

***discrimination*** is prohibited based on: race, national or ethnic origin, colour, religion, age, sex, sexual orientation, gender identity or expression, marital status, family status, disability, genetic characteristics, pardoned conviction

***code of conduct*** includes: ethics, policies regarding conflict of interest, respectful workplace

# MAJOR WORK ACTIVITY B

# Installs and services process measuring and indicating devices

## TASK B-5 Installs and services pressure, temperature, level and flow devices

### TASK DESCRIPTOR

Instrumentation and control technicians install, maintain, diagnose and repair these devices to ensure process operations using various conversion calculations. These measuring devices are used to monitor and control various processes and equipment.

### B-5.01 Installs pressure, temperature, level and flow devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| B-5.01.01P | select and use tools and equipment | tools and equipment are selected and used according to ***type of device*** |
| B-5.01.02P | confirm device selection | device selected is confirmed to meet process application, environmental conditions and engineered designs |
| B-5.01.03P | select mounting location | mounting location is selected according to engineered designs and manufacturers' specifications |
| B-5.01.04P | mount device | device is mounted according to industry practices, engineered designs, manufacturers' specifications and codes |
| B-5.01.05P | modify enclosures and panels | enclosures and panels are modified to hold devices and indicators according to code and site requirements |
| B-5.01.06P | connect device to process | device is connected to process using ***connection methods*** according to industry practices, engineered designs, manufacturers' specifications and codes |
| B-5.01.07P | terminate wiring to device | wiring to device is terminated according to industry practices, engineered designs, manufacturers' specifications and codes |

| | | |
|---|---|---|
| B-5.01.08P | configure and calibrate device | device is configured and calibrated according to manufacturers' instructions, process requirements and data sheets |
| B-5.01.09P | verify operation of device | operation of device is verified within specified parameters by using certified test equipment |
| B-5.01.10P | commission device and loop | device and loop are commissioned according to engineered designs and site specifications |
| B-5.01.11P | backup and document configuration and calibration settings | configuration and calibration settings are backed up and documented for future data recovery according to site-specific procedures |

## RANGE OF VARIABLES

***type of device*** includes: pressure, temperature, level, flow

***connection methods*** include: tubing, piping, wiring, in-line installation, thermowell, wireless

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-5.01.01L | demonstrate knowledge of pressure measurement and calibration | define terminology associated with pressure measurement and calibration |
| | | identify ***types of pressure and vacuum measuring devices*** |
| B-5.01.02L | demonstrate knowledge of temperature measurement and calibration | define terminology associated with temperature measurement and calibration |
| | | identify ***types of temperature measuring devices*** |
| B-5.01.03L | demonstrate knowledge of level measurement and calibration | define terminology associated with level measurement and calibration |
| | | identify ***types of level measuring devices*** |
| B-5.01.04L | demonstrate knowledge of flow measurement and calibration | define terminology associated with flow measurement and calibration |
| | | identify ***types of flow measuring devices*** |
| B-5.01.05L | demonstrate knowledge of relationships between pressure, temperature, level and flow | explain relationships between pressure, temperature, level and flow |
| B-5.01.06L | demonstrate knowledge of procedures used to install pressure, temperature, level and flow measurement devices | identify hazards and describe ***safe work practices*** pertaining to pressure, temperature, level and flow measurement and calibration |
| | | identify tools and equipment used to install pressure, temperature, level and flow measuring devices and describe their applications and procedures for use |

| | | |
|---|---|---|
| | | identify ***types of indicating devices*** |
| | | identify ***units of measurement for pressure*** |
| | | perform conversions and calculations |
| | | identify ***types of temperature scales*** |
| | | interpret information pertaining to pressure, temperature, level and flow measuring devices found on drawings, specifications and nameplates |
| | | interpret and maintain calibration records |
| | | describe ***connection methods*** |
| | | describe ***primary pressure elements*** |
| | | describe ***primary temperature elements*** |
| | | describe ***primary level elements*** |
| | | describe ***primary flow elements*** |
| B-5.01.07L | demonstrate knowledge of procedures used to calibrate pressure, temperature, level and flow measurement devices | identify ***pressure, level and flow calibration instruments*** and describe their applications |
| | | identify ***temperature calibration instruments*** and describe their applications |
| | | determine accuracy, certification and limitations of calibration instruments |
| | | determine required ***calibrating parameters of measuring devices*** |
| | | describe procedures used to install and calibrate pressure, temperature, level and flow measurement devices |

## RANGE OF VARIABLES

***types of pressure and vacuum measuring devices*** include: pneumatic, electronic, mechanical

***types of temperature measuring devices*** include: contacting, non-contacting

***types of level measuring devices*** include: differential pressure (DP) transmitter, ultrasonic, radar, floats/float switches, displacers (mechanical), nuclear, sight glasses, capacitance probes

***types of flow measuring devices*** include: vortex, thermal mass, Coriolis, magnetic flowmeters, ultrasonic, turbine, DP transmitter, positive displacement (PD) meters

***safe work practices*** include: permits, isolation, lock-out/tag-out, blowdown procedure, commissioning/decommissioning procedures

***types of indicating devices*** include: chart recorders, digital display, gauges, flow measuring devices, variable area flowmeters

***units of measurement for pressure*** include: Pascals, pounds per square inch (psi), inches of water, Torr, millimetres of mercury, bars (atmospheres)

***types of temperature scales*** include: Kelvin, Celsius, Rankine, Fahrenheit

***connection methods*** include: tubing, piping, wiring, in-line installation, thermowell, wireless

***primary pressure elements*** include: capsules, strain gauges, capacitance gauges, cells, bourdon tubes, bellows

***primary temperature elements*** include: thermocouples, resistive thermal device (RTD), thermistor, filled thermal systems, pyrometers

***primary level elements*** include: displacement floats, capacitance probes

***primary flow elements*** include: orifice plates, V-cone, venturi tubes, flow nozzles, pitot tubes, weirs, flumes, vortex bluff body, turbines, Coriolis tubes

***pressure, level and flow calibration instruments*** include: pressure calibrators, dead weight testers, multimeters, manometers

***temperature calibration instruments*** include: multimeters, temperature baths, dry block calibrators, thermometers

***calibrating parameters of measuring devices*** include: zero, span, range, repeatability, specific gravity, accuracy

## B-5.02 Maintains pressure, temperature, level and flow devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-5.02.01P | select and use tools and equipment | tools and equipment are selected and used according to ***type of device*** |
| B-5.02.02P | perform inspection | inspection is performed to detect ***irregularities*** |
| B-5.02.03P | perform function check of devices | function check of devices is performed to confirm proper operation |
| B-5.02.04P | clear sensing lines and sensing taps of devices | sensing lines and sensing taps of devices are cleared by isolating, equalizing or blowing down, to ensure lines are not plugged |

| | | |
|---|---|---|
| B-5.02.05P | clean devices using ***cleaning materials*** | devices are cleaned using ***cleaning materials*** according to manufacturers' instructions and process requirements |
| B-5.02.06P | verify calibration of devices | calibration of devices is verified according to maintenance specifications |
| B-5.02.07P | calibrate device | device is calibrated according to manufacturers' instructions and data sheets before returning to service |

## RANGE OF VARIABLES

***type of device*** includes: pressure, temperature, level, flow
***irregularities*** include: leaks, loose connections, corrosion, physical damage, process build-up
***cleaning materials*** include: solvents, fine wire, abrasives, contact cleaners, steam, water

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-5.02.01L | demonstrate knowledge of pressure measurement and calibration | define terminology associated with pressure measurement and calibration |
| | | identify ***types of pressure and vacuum measuring devices*** |
| B-5.02.02L | demonstrate knowledge of temperature measurement and calibration | define terminology associated with temperature measurement and calibration |
| | | identify ***types of temperature measuring devices*** |
| B-5.02.03L | demonstrate knowledge of level measurement and calibration | define terminology associated with level measurement and calibration |
| | | identify ***types of level measuring devices*** |
| B-5.02.04L | demonstrate knowledge of flow measurement and calibration | define terminology associated with flow measurement and calibration |
| | | identify ***types of flow measuring devices*** |
| B-5.02.05L | demonstrate knowledge of relationships between pressure, temperature, level and flow | explain relationships between pressure, temperature, level and flow |
| B-5.02.06L | demonstrate knowledge of procedures used to maintain pressure, temperature, level and flow measurement devices | identify hazards and describe ***safe work practices*** pertaining to pressure, temperature, level and flow measurement and calibration |
| | | identify tools and equipment used to maintain pressure, temperature, level and flow measuring devices and describe their applications and procedures for use |
| | | identify ***types of indicating devices*** |
| | | identify ***units of measurement for pressure*** |

| | | |
|---|---|---|
| | | perform conversions and calculations |
| | | identify ***types of temperature scales*** |
| | | interpret information pertaining to pressure, temperature, level and flow measuring devices found on drawings, specifications and nameplates |
| | | interpret and maintain calibration records |
| | | identify types of basic pressure, temperature, level and flow measurement devices and describe their applications |
| | | describe ***connection methods*** |
| | | describe ***primary pressure elements*** |
| | | describe ***primary temperature elements*** |
| | | describe ***primary level elements*** |
| | | describe ***primary flow elements*** |
| | | identify documentation and scheduling related to maintenance of pressure, temperature, level and flow measurement devices |
| B-5.02.07L | demonstrate knowledge of procedures and instruments used to calibrate pressure, temperature, level and flow measurement devices | identify ***temperature calibration instruments*** and describe their applications |
| | | identify ***pressure, level and flow calibration instruments*** and describe their applications |
| | | determine accuracy, certification and limitations of calibration instruments |
| | | determine required ***calibrating parameters of measuring devices*** |
| | | describe procedures used to maintain and calibrate pressure, temperature, level and flow measurement devices |

## RANGE OF VARIABLES

***types of pressure and vacuum measuring devices*** include: pneumatic, electronic, mechanical

***types of temperature measuring devices*** include: contacting, non-contacting

***types of level measuring devices*** include: DP transmitter, ultrasonic, radar, floats/ float switches, displacers (mechanical), nuclear, sight glasses, capacitance probes

***types of flow measuring devices*** include: vortex, thermal mass, Coriolis, magnetic flowmeters, ultrasonic, turbine, DP transmitter, PD meters

***safe work practices*** include: permits, isolation, lock-out/tag-out, blowdown procedure, commissioning/decommissioning procedures

***types of indicating devices*** include: chart recorders, digital display, gauges, flow measuring devices, variable area flowmeters

***units of measurement for pressure*** include: Pascals, psi, inches of water, Torr, millimetres of mercury, bars (atmospheres)

***types of temperature scales*** include: Kelvin, Fahrenheit, Celsius, Rankine

***connection methods*** include: tubing, piping, wiring, in-line installation, thermowell, wireless

***primary pressure elements*** include: capsules, strain gauges, capacitance gauges, cells, bourdon tubes, bellows

***primary temperature elements*** include: thermocouples, RTD, thermistor, filled thermal systems, pyrometers

***primary level elements*** include: displacement floats, capacitance probes

***primary flow elements*** include: orifice plates, V-cone, venturi tubes, flow nozzles, pitot tubes, weirs, flumes, vortex bluff body, turbines, Coriolis tubes

***temperature calibration instruments*** include: multimeters, temperature baths, dry block calibrators, infrared thermometers

***pressure, level and flow calibration instruments*** include: pressure calibrators, dead weight testers, multimeters, manometers

***calibrating parameters of measuring devices*** include: zero, span, range, repeatability, specific gravity, accuracy

## B-5.03 Diagnoses pressure, temperature, level and flow devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-5.03.01P | select and use ***diagnostic tools and equipment*** | ***diagnostic tools and equipment*** are selected and used according to ***type of device*** |
| B-5.03.02P | perform inspection and function check to detect ***faults*** | inspection and function check is performed to detect ***faults*** |

| | | |
|---|---|---|
| B-5.03.03P | perform as-found calibration check | as-found calibration check is performed according to data sheets |
| B-5.03.04P | determine probable root cause and location of ***faults***, and identify required repairs | probable root cause and location of ***faults*** are determined and required repairs are identified |

## RANGE OF VARIABLES

***diagnostic tools and equipment*** include: software, hand-held configurators, multimeters, simulators, pumps, manometers

***type of device*** includes: pressure, temperature, level, flow

***faults*** include: leaks, physical damage, poor wiring connections, failures, plugged sensing line, inadequate power, depleted impulse lines

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-5.03.01L | demonstrate knowledge of pressure measurement and calibration | define terminology associated with pressure measurement and calibration |
| | | identify types of ***types of pressure and vacuum measuring devices*** |
| B-5.03.02L | demonstrate knowledge of temperature measurement and calibration | define terminology associated with temperature measurement and calibration |
| | | identify ***types of temperature measuring devices*** |
| B-5.03.03L | demonstrate knowledge of level measurement and calibration | define terminology associated with level measurement and calibration |
| | | identify ***types of level measuring devices*** |
| B-5.03.04L | demonstrate knowledge of flow measurement and calibration | define terminology associated with flow measurement and calibration |
| | | identify ***types of flow measuring devices*** |
| B-5.03.05L | demonstrate knowledge of relationships between pressure, temperature, level and flow | explain relationships between pressure, temperature, level and flow |
| B-5.03.06L | demonstrate knowledge of procedures used to diagnose pressure, temperature, level and flow measurement devices | identify hazards and describe ***safe work practices*** pertaining to pressure, temperature, level and flow measurement and calibration |
| | | identify ***diagnostic tools and equipment*** used to diagnose and calibrate pressure, temperature, level and flow measuring devices, and describe their applications and procedures for use |
| | | identify ***types of indicating devices*** |
| | | identify ***units of measurement for pressure*** |

| | |
|---|---|
| | perform conversions and calculations |
| | identify ***types of temperature scales*** |
| | interpret information pertaining to pressure, temperature, level and flow measuring devices found on drawings, specifications and nameplates |
| | interpret and maintain calibration records |
| | describe ***connection methods*** |
| | describe ***primary pressure elements*** |
| | describe ***primary temperature elements*** |
| | describe ***primary level elements*** |
| | describe ***primary flow elements*** |
| | describe procedures used to perform root cause diagnostics and analysis of pressure, temperature, level and flow measurement devices |

## RANGE OF VARIABLES

***types of pressure and vacuum measuring devices*** include: pneumatic, electronic, mechanical

***types of temperature measuring devices*** include: contacting, non-contacting

***types of level measuring devices*** include: DP transmitter, ultrasonic, radar, floats/ float switches, displacers (mechanical), nuclear, sight glasses, capacitance probes

***types of flow measuring devices*** include: vortex, thermal mass, Coriolis, magnetic flowmeters, ultrasonic, turbine, DP transmitter, PD meters

***safe work practices*** include: permits, isolation, lock-out/tag-out, blowdown procedure, commissioning/decommissioning procedures

***diagnostic tools and equipment*** include: software, hand-held configurators, multimeters, simulators, pumps, manometers

***types of indicating devices*** include: chart recorders, digital display, gauges, flow measuring devices, variable area flowmeters

***units of measurement for pressure*** include: Pascals, psi, inches of water, Torr, millimetres of mercury, bars (atmospheres)

***types of temperature scales*** include: Kelvin, Celsius, Rankine, Fahrenheit

***connection methods*** include: tubing, piping, wiring, in-line installation, thermowell, wireless

***primary pressure elements*** include: capsules, strain gauges, capacitance gauges, cells, bourdon tubes, bellows

***primary temperature elements*** include: thermocouples, RTD, thermistor, filled thermal systems, pyrometers

***primary level elements*** include: displacement floats, capacitance probes

***primary flow elements*** include: orifice plates, V-cone, venturi tubes, flow nozzles, pitot tubes, weirs, flumes, vortex bluff body, turbines, Coriolis tubes

## B-5.04 Repairs pressure, temperature, level and flow devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-5.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to ***type of device*** |
| B-5.04.02P | select required replacement ***components*** | required replacement ***components*** are selected according to codes and manufacturers' specifications |
| B-5.04.03P | replace ***components*** | ***components*** are replaced according to manufacturers' specifications |
| B-5.04.04P | clear plugged lines | plugged lines are cleared using inert/compatible pressurized fluids |
| B-5.04.05P | inspect and clean process-wetted components where device contacts process | process-wetted components are inspected and cleaned where device contacts process |
| B-5.04.06P | calibrate device | device is calibrated according to manufacturers' instructions and data sheets |

### RANGE OF VARIABLES

***tools and equipment*** include: digital multimeters, process calibrators, test gauges
***type of device*** includes: pressure, temperature, level, flow
***components*** include: sensor boards, liquid crystal displays, temperature elements

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| B-5.04.01L | demonstrate knowledge of pressure measurement and calibration | define terminology associated with pressure measurement and calibration |
| | | identify types of ***types of pressure and vacuum measuring devices*** |
| B-5.04.02L | demonstrate knowledge of temperature measurement and calibration | define terminology associated with temperature measurement and calibration |
| | | identify ***types of temperature measuring devices*** |
| B-5.04.03L | demonstrate knowledge of level measurement and calibration | define terminology associated with level measurement and calibration |
| | | identify ***types of level measuring devices*** |
| B-5.04.04L | demonstrate knowledge of flow measurement and calibration | define terminology associated with flow measurement and calibration |

| | | |
|---|---|---|
| | | identify ***types of flow measuring devices*** |
| B-5.04.05L | demonstrate knowledge of relationships between pressure, temperature, level and flow | explain relationships between pressure, temperature, level and flow |
| B-5.04.06L | demonstrate knowledge of procedures used to repair pressure, temperature, level and flow measurement devices | identify hazards and describe safe work practices pertaining to pressure, temperature, level and flow measurement and calibration |
| | | identify ***tools and equipment*** used to repair pressure, temperature, level and flow measuring devices, and describe their applications and procedures for use |
| | | identify ***units of measurement for pressure*** |
| | | perform conversions and calculations |
| | | identify ***types of temperature scales*** |
| | | interpret information pertaining to pressure, temperature, level and flow measuring devices found on drawings, specifications and nameplates |
| | | interpret and maintain calibration records |
| | | identify types of basic pressure measurement devices and describe their applications |
| | | describe ***connection methods*** |
| | | describe ***primary pressure elements*** |
| | | describe ***primary temperature elements*** |
| | | describe ***primary level elements*** |
| | | describe ***primary flow elements*** |
| | | describe procedures used to repair and replace ***components*** of pressure, temperature, level and flow measurement devices |
| B-5.04.07L | demonstrate knowledge of procedures used to calibrate pressure, temperature, level and flow measurement devices | describe procedures used to calibrate pressure, temperature, level and flow measurement devices |
| | | identify ***pressure, level and flow calibration instruments*** and describe their applications |
| | | identify ***temperature calibration instruments*** and describe their applications |
| | | determine accuracy and limitations of calibration instruments |

| | |
|---|---|
| | determine required ***calibrating parameters of measuring devices*** |
| | identify documentation and scheduling related to repair of pressure, temperature, level and flow measurement devices |

## RANGE OF VARIABLES

***types of pressure and vacuum measuring devices*** include: pneumatic, electronic, mechanical

***types of temperature measuring devices*** include: contacting, non-contacting

***types of level measuring devices*** include: DP transmitter, ultrasonic, radar, floats/ float switches, displacers (mechanical), nuclear, sight glasses, capacitance probes

***types of flow measuring devices*** include: vortex, thermal mass, Coriolis, magnetic flowmeters, ultrasonic, turbine, DP transmitter, PD meters

***tools and equipment*** include: digital multimeters, process calibrators, test gauges

***units of measurement for pressure*** include: Pascals, psi, inches of water, Torr, millimetres of mercury, bars (atmospheres)

***types of temperature scales*** include: Kelvin, Celsius, Rankine, Fahrenheit

***connection methods*** include: tubing, piping, wiring, in-line installation, thermowell, wireless

***primary pressure elements*** include: capsules, strain gauges, capacitance gauges, cells, bourdon tubes, bellows

***primary temperature elements*** include: thermocouples, RTD, thermistor, filled thermal systems, pyrometers

***primary level elements*** include: displacement floats, capacitance probes

***primary flow elements*** include: orifice plates, V-cone, venturi tubes, flow nozzles, pitot tubes, weirs, flumes, vortex bluff body, turbines, Coriolis tubes

***components*** include: sensor boards, liquid crystal displays, temperature elements

***pressure, level and flow calibration instruments*** include: pressure calibrators, dead weight testers, multimeters, manometers

***temperature calibration instruments*** include: multimeters, temperature baths, dry block calibrators, infrared thermometers

***calibrating parameters of measuring devices*** include: zero, span, range, repeatability, specific gravity, accuracy

# TASK B-6 Installs and services signal transducers

## TASK DESCRIPTOR

Instrumentation and control technicians install, configure, calibrate, diagnose, maintain, repair and replace signal transducers. A signal transducer converts an analogue signal from one form of energy to another form of energy. This could include converting pneumatic-to-electric, electric-to-pneumatic, electric-to-electric and pneumatic-to-pneumatic.

## B-6.01 Performs installation and configuration of signal transducers

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| B-6.01.01P | select signal transducers | signal transducers are selected according to required functionality and environment |
| B-6.01.02P | mount signal transducers | signal transducers are mounted according to industry practices, engineered designs, manufacturers' specifications and codes |
| B-6.01.03P | terminate wiring | wiring is terminated according to industry practices, engineered designs, manufacturers' specifications and codes |
| B-6.01.04P | connect tubing | tubing is connected according to industry practices, engineered designs, manufacturers' specifications and codes |
| B-6.01.05P | configure signal transducers | signal transducers are configured according to manufacturers' specifications, process requirements and data sheets |
| B-6.01.06P | calibrate signal transducers | signal transducers are calibrated to required specifications using ***calibration instruments*** according to manufacturers' specifications, process requirements and data sheets |
| B-6.01.07P | document ***information*** | ***information*** is recorded for future reference |

## RANGE OF VARIABLES

***calibration instruments*** include: hand-held configurators, current calibrators, pressure calibrators, process calibrators, software, laptops

***information*** includes: overall condition, maintenance record, settings

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-6.01.01L | demonstrate knowledge of signal transducers and describe their characteristics and applications | define terminology associated with signal transducers |
| | | identify ***types of signal transducers*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to installation and configuration of signal transducers |
| | | interpret information pertaining to signal transducers found on drawings and specifications |
| B-6.01.02L | demonstrate knowledge of regulatory requirements pertaining to signal transducers | interpret ***standards, codes and regulations*** pertaining to signal transducers |
| B-6.01.03L | demonstrate knowledge of procedures used to install and configure signal transducers | identify tools and equipment used to install and configure signal transducers and describe their applications and procedures for use |
| | | describe procedures used to select, install and configure signal transducers |
| | | describe ***conditions of surrounding environment*** to consider when installing signal transducers |
| | | describe ***utilities*** required to operate signal transducers |
| B-6.01.04L | demonstrate knowledge of procedures used to calibrate signal transducers | describe procedures used to calibrate signal transducers |
| | | describe procedures and ***parameters*** to calibrate signal transducers |
| | | perform ***conversions and calculations*** |

## RANGE OF VARIABLES

***types of signal transducers*** include: pneumatic-to-electric, electric-to-pneumatic, electric-to-electric, pneumatic-to-pneumatic

***standards, codes and regulations*** include: CEC, Institute of Electrical and Electronic Engineering (IEEE), ISA, CSA, Canadian Radio and Telecommunications Council (CRTC)

***conditions of surrounding environment*** include: ambient conditions, contamination, hazardous/non-hazardous

***utilities*** include: quality of instrument air, access to instrument air, possible use of natural gas as pneumatic signal

***parameters*** include: zero, span, range, accuracy, trim adjustments

***conversions and calculations*** include: pneumatic-to-electric, electric-to-pneumatic, electric-to-electric, pneumatic-to-pneumatic

## B-6.02 Diagnoses signal transducers

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-6.02.01P | perform inspection of signal transducers | inspection of signal transducers is performed |
| B-6.02.02P | check calibration and configuration of signal transducers | calibration and configuration of signal transducers is checked using calibration instruments |
| B-6.02.03P | review documentation and historical data | documentation and historical data is reviewed to assist in determining probable root cause |

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| B-6.02.01L | demonstrate knowledge of signal transducers and describe their characteristics and applications | define terminology associated with signal transducers |
| | | identify ***types of signal transducers*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to signal transducers |
| | | interpret information pertaining to signal transducers found on drawings and specifications |
| B-6.02.02L | demonstrate knowledge of regulatory requirements pertaining to signal transducers | interpret ***standards, codes and regulations*** pertaining to signal transducers |
| B-6.02.03L | demonstrate knowledge of procedures used to diagnose signal transducers | identify ***types of calibration instruments*** used to diagnose signal transducers and describe their applications and procedures for use |
| | | describe procedures used to inspect and diagnose signal transducers |
| | | describe possible ***problems*** associated with signal transducers |
| | | perform ***conversions and calculations*** |
| | | describe ***conditions of surrounding environment*** to consider when installing signal transducers |

## RANGE OF VARIABLES

***types of signal transducers*** include: pneumatic-to-electric, electric-to-pneumatic, electric-to-electric, pneumatic-to-pneumatic

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***types of calibration instruments*** include: hand-held configurators, current calibrators, pressure calibrators, process calibrators

***problems*** include: inadequate power supply, inadequate air supply, calibration errors, linearity errors

***conversions and calculations*** include: pneumatic-to-electric, electric-to-pneumatic, electric-to-electric, pneumatic-to-pneumatic

***conditions of surrounding environment*** include: ambient conditions, contamination, hazardous/non-hazardous

## B-6.03 Performs maintenance and repairs on signal transducers

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-6.03.01P | perform inspection of signal transducers | inspection of signal transducers is performed to detect ***problems*** |
| B-6.03.02P | perform function check of signal transducers | function check of signal transducers is performed to confirm proper operation |
| B-6.03.03P | perform scheduled maintenance activities | scheduled maintenance activities are performed according to maintenance specifications and procedures |
| B-6.03.04P | repair or replace signal transducers | signal transducers are repaired or replaced according to manufacturers' instructions and site-specific procedures |
| B-6.03.05P | verify operation and calibration | operation and calibration are verified before returning to service |
| B-6.03.06P | document ***information*** | ***information*** is recorded for future reference |

## RANGE OF VARIABLES

***problems*** include: inadequate power, physical damage, faulty connections, contamination, corrosion, improper grounding/shielding

***information*** includes*:* overall condition, maintenance record, settings

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-6.03.01L | demonstrate knowledge of signal transducers and describe their characteristics and applications | define terminology associated with signal transducers |
| | | identify ***types of signal transducers*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to signal transducers |
| | | interpret information pertaining to signal transducers found on drawings and specifications |
| | | describe importance of documenting ***information*** and changes |
| B-6.03.02L | demonstrate knowledge of regulatory requirements pertaining to signal transducers | interpret ***standards, codes and regulations*** pertaining to signal transducers |
| B-6.03.03L | demonstrate knowledge of procedures used to maintain, repair and replace signal transducers | identify tools and equipment used to maintain, repair and replace signal transducers and describe their applications and procedures for use |
| | | describe procedures used to inspect signal transducers |
| | | describe procedures used to maintain, repair and replace signal transducers |
| | | describe possible ***problems*** of signal transducers |
| B-6.03.04L | demonstrate knowledge of procedures used to calibrate signal transducers | describe procedures used to calibrate signal transducers |
| | | perform ***conversions and calculations*** |

## RANGE OF VARIABLES

***types of signal transducers*** include: pneumatic-to-electric, electric-to-pneumatic, electric-to-electric, pneumatic-to-pneumatic

***information*** includes*:* overall condition, maintenance record, settings

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***problems*** include: inadequate power, physical damage, faulty connections, contamination, corrosion, improper grounding/shielding

***conversions and calculations*** include: pneumatic-to-electric, electric-to-pneumatic, electric-to-electric, pneumatic-to-pneumatic

# TASK B-7 Installs and services motion, speed, position and vibration devices

## TASK DESCRIPTOR

Instrumentation and control technicians install, maintain, diagnose and repair these devices to protect the integrity of equipment and to control equipment and processes. These devices sense motion, speed, position and vibration to monitor the operation of equipment.

## B-7.01 Installs motion, speed, position and vibration devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| B-7.01.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to type of device |
| B-7.01.02P | select device | device is selected according to process application, environment and engineered designs |
| B-7.01.03P | select cable | cable is selected according to manufacturers' specifications, engineered designs and CEC |
| B-7.01.04P | select mounting location and hardware | mounting location and hardware is selected according to manufacturers' specifications and engineered designs |
| B-7.01.05P | mount device | device is mounted according to industry practices, engineered designs, manufacturers' and site specifications, and codes |
| B-7.01.06P | terminate wiring to device | wiring to device is terminated according to industry practices, engineered designs, manufacturers' specifications, and ***standards, codes and regulations*** |
| B-7.01.07P | set gap of sensor on device | gap of sensor is set according to manufacturers' specifications |
| B-7.01.08P | verify operation of device | device operation is verified within specified parameters by using test equipment and procedures |
| B-7.01.09P | back up and document configuration and calibration settings | configuration and calibration settings are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***tools and equipment*** include: wrenches, feeler gauges, multimeters
***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-7.01.01L | demonstrate knowledge of motion, speed, position and vibration devices, and their ***components***, principles and operation | define terminology associated with motion, speed, position and vibration devices, and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to motion, speed, position and vibration devices, and their ***components*** |
| | | interpret information pertaining to motion, speed, position and vibration devices, and their ***components*** found on drawings and specifications |
| | | identify ***types of motion and position/displacement devices*** |
| | | identify ***types of speed devices*** |
| | | identify ***types of vibration devices*** |
| | | identify ***types of indicating devices*** |
| | | describe ***principles of operation*** |
| B-7.01.02L | demonstrate knowledge of regulatory requirements pertaining to motion, speed, position and vibration devices | interpret ***standards, codes and regulations*** pertaining to motion, speed, position and vibration devices |
| B-7.01.03L | demonstrate knowledge of procedures used to install motion, speed, position and vibration devices, and their ***components*** | identify ***tools and equipment*** used to install motion, speed, position and vibration devices, and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to select and install motion, speed, position and vibration devices, and their ***components*** |
| | | describe procedures used to configure, calibrate and validate calibration of motion, speed, position and vibration devices, and their ***components*** |
| | | identify ***motion, speed, position and vibration calibration instruments*** |
| | | explain required calibrating of ***measuring parameters*** |

| | |
|---|---|
| | identify types of ***motion, speed, position and vibration measurements*** |
| | describe procedures used to back up and document configuration and calibration settings |

## RANGE OF VARIABLES

***components*** include: optical lenses, probes, cables, mounting hardware, amplifiers

***types of motion and position/displacement devices*** include: torque switches, proximity switches, proximity probes, analogue position sensors, linear variable displacement transformer (LVDT)

***types of speed devices*** include: tachometers, strobes, proximeters

***types of vibration devices*** include: probes, proximeters

***types of indicating devices*** include: chart recorders, digital displays and gauges

***principles of operation*** include: speed, velocity, magnetism, harmonics, periodic motion

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***tools and equipment*** include: wrenches, feeler gauges, multimeters

***motion, speed, position and vibration calibration instruments*** include: strobe lights, multimeters, tachometers, wobulators

***measuring parameters*** include: zero, span, range, accuracy

***motion, speed, position and vibration measurements*** include: speed, axial/radial motion, key phasors, thrust, frequency, amplitude

## B-7.02 Maintains motion, speed, position and vibration devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-7.02.01P | perform inspection | inspection is performed to detect ***irregularities*** |
| B-7.02.02P | perform function check of device | function check is performed to confirm proper operation of device |
| B-7.02.03P | clean ***components*** | ***components*** are cleaned using ***cleaning materials*** |
| B-7.02.04P | verify calibration of device | calibration of device is verified according to manufacturers' specifications and data sheets |
| B-7.02.05P | calibrate device before returning to service | device is calibrated before returning to service according to manufacturers' specifications and data sheets |

## RANGE OF VARIABLES

***irregularities*** include: dirt, loose connections, corrosion
***components*** include: optical lenses, probes, cables, mounting hardware, amplifiers
***cleaning materials*** include: solvents, abrasives, contact cleaners

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-7.02.01L | demonstrate knowledge of motion, speed, position and vibration devices, and their ***components***, principles and operation | define terminology associated with motion, speed, position and vibration devices, and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to motion, speed, position and vibration devices, and their ***components*** |
| | | interpret information pertaining to motion, speed, position and vibration devices, and their ***components*** found on drawings and specifications |
| | | identify ***types of motion and position/displacement devices*** |
| | | identify ***types of speed devices*** |
| | | identify ***types of vibration devices*** |
| | | identify ***types of indicating devices*** |
| | | describe ***principles of operation*** |
| B-7.02.02L | demonstrate knowledge of regulatory requirements pertaining to motion, speed, position and vibration devices, and their ***components*** | interpret ***standards, codes and regulations*** pertaining to motion, speed, position and vibration devices, and their ***components*** |
| B-7.02.03L | demonstrate knowledge of procedures used to maintain motion, speed, position and vibration devices, and their ***components*** | identify ***tools and equipment*** used to maintain motion, speed, position and vibration devices, and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to maintain motion, speed, position and vibration devices, and their ***components*** |
| | | identify ***motion, speed, position and vibration calibration instruments*** |
| | | explain required calibration of ***measuring parameters*** |
| | | identify types of ***motion, speed, position and vibration measurements*** |

## RANGE OF VARIABLES

***components*** include: optical lenses, probes, cables, mounting hardware, amplifiers

***types of motion and position/displacement devices*** include: torque switches, proximity switches, proximity probes, analogue position sensors, LVDT

***types of speed devices*** include: tachometers, strobes, proximeters

***types of vibration devices*** include: probes, proximeters

***types of indicating devices*** include: chart recorders, digital displays and gauges

***principles of operation*** include: speed, velocity, magnetism, harmonics, periodic motion

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***tools and equipment*** include: wrenches, feeler gauges, multimeters

***motion, speed, position and vibration calibration instruments*** include: strobe lights, multimeters, tachometers, wobulators

***motion, speed, position and vibration measurements*** include: speed, axial/radial motion, key phasors, thrust, frequency, amplitude

***measuring parameters*** include: zero, span, range, accuracy

## B-7.03 Diagnoses motion, speed, position and vibration devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| B-7.03.01P | select and use ***diagnostic tools and equipment*** | ***diagnostic tools and equipment*** are selected and used according to application |
| B-7.03.02P | perform inspection and function check | inspection and function check are performed to detect ***faults*** |
| B-7.03.03P | determine probable root cause and location of ***faults*** and identify required repairs | probable root cause and location of ***faults*** are determined and required repairs are identified |

## RANGE OF VARIABLES

***diagnostic tools and equipment*** include: oscilloscopes, multimeters, hand-held configurators, laptops, frequency generators, high-speed cameras

***faults*** include: misalignment, physical damage, poor electrical connections, failed probes, faulty amplifier, dirty optics, faulty sensors, inadequate power

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-7.03.01L | demonstrate knowledge of motion, speed, position and vibration devices, and their ***components***, principles and operation | define terminology associated with motion, speed, position and vibration devices, and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to motion, speed, position and vibration devices, and their ***components*** |
| | | interpret information pertaining to motion, speed, position and vibration devices, and their ***components*** found on drawings and specifications |
| | | identify ***types of motion and position/displacement devices*** |
| | | identify ***types of speed devices*** |
| | | identify ***types of vibration devices*** |
| | | identify ***types of indicating devices*** |
| | | describe ***principles of operation*** |
| B-7.03.02L | demonstrate knowledge of procedures used to diagnose motion, speed, position and vibration devices, and their ***components*** | identify ***diagnostic tools and equipment*** used to diagnose motion, speed, position and vibration devices, and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to diagnose motion, speed, position and vibration devices, and their ***components*** |
| | | identify types of ***faults*** with motion, speed, position and vibration devices, and their ***components*** |

## RANGE OF VARIABLES

***components*** include: optical lenses, probes, cables, mounting hardware, amplifiers

***types of motion and position/displacement devices*** include: torque switches, proximity switches, proximity probes, analogue position sensors, LVDT

***types of speed devices*** include: tachometers, strobes, proximeters

***types of vibration devices*** include: probes, proximeters

***types of indicating devices*** include: chart recorders, digital displays and gauges

***principles of operation*** include: speed, velocity, magnetism, harmonics, periodic motion

***diagnostic tools and equipment*** include: oscilloscopes, multimeters, hand-held configurators, laptops, frequency generators, high-speed cameras

***faults*** include: misalignment, physical damage, poor electrical connections, failed probes, faulty amplifier, dirty optics, faulty sensors, inadequate power

## B-7.04 Repairs motion, speed, position and vibration devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-7.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to application requirements |
| B-7.04.02P | select replacement ***components*** | replacement ***components*** are selected according to manufacturers' specifications |
| B-7.04.03P | remove and replace ***components*** | ***components*** are removed and replaced according to manufacturers' instructions and site-specific procedures |
| B-7.04.04P | inspect and clean ***components*** | ***components*** are inspected and cleaned according to manufacturers' instructions and site-specific procedures |
| B-7.04.05P | calibrate device | device is calibrated according to manufacturers' instructions |
| B-7.04.06P | update documentation | documentation is updated with repair information according to site-specific procedures |

### RANGE OF VARIABLES

***tools and equipment*** include: multimeters, wrenches, feeler gauges, tachometers, oscilloscope, frequency generators

***components*** include: optical lenses, probes, cables, mounting hardware, amplifiers

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| B-7.04.01L | demonstrate knowledge of motion, speed, position and vibration devices, and their ***components***, principles and operation | define terminology associated with motion, speed, position and vibration devices, and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to motion, speed, position and vibration devices, and their ***components*** |
| | | interpret information pertaining to motion, speed, position and vibration devices, and their ***components*** found on drawings and specifications |
| | | identify ***types of motion and position/displacement devices*** |
| | | identify ***types of speed devices*** |

| | | |
|---|---|---|
| | | identify ***types of vibration devices*** |
| | | identify ***types of indicating devices*** |
| | | describe ***principles of operation*** |
| B-7.04.02L | demonstrate knowledge of regulatory requirements pertaining to motion, speed, position and vibration devices, and their ***components*** | interpret ***standards, codes and regulations*** pertaining to motion, speed, position and vibration devices, and their ***components*** |
| B-7.04.03L | demonstrate knowledge of procedures used to repair and replace ***components*** of motion, speed, position and vibration devices | identify ***tools and equipment*** used to repair ***components*** of motion, speed, position and vibration devices, and describe their applications and procedures for use |
| | | describe procedures used to repair, replace and calibrate motion, speed, position and vibration devices, and their ***components*** |
| | | identify ***motion, speed, position and vibration calibration instruments*** |
| | | explain required calibration of ***measuring parameters*** |
| | | identify types of ***motion, speed, position and vibration measurements*** |

## RANGE OF VARIABLES

***components*** include: optical lenses, probes, cables, mounting hardware, amplifiers

***types of motion and position/displacement devices*** include: torque switches, proximity switches, proximity probes, analogue position sensors, LVDT

***types of speed devices*** include: tachometers, strobes, proximeters

***types of vibration devices*** include: probes, proximeters

***types of indicating devices*** include: chart recorders, digital displays and gauges

***principles of operation*** include: speed, velocity, magnetism, harmonics, periodic motion

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***tools and equipment*** include: multimeters, wrenches, feeler gauges, tachometers, oscilloscope, frequency generators

***motion, speed, position and vibration calibration instruments*** include: strobe lights, multimeters, tachometers, wobulators

***measuring parameters*** include: zero, span, range, accuracy

***motion, speed, position and vibration measurements*** include: speed, axial/radial motion, key phasors, thrust, frequency, amplitude

# TASK B-8 Installs and services mass, density and consistency devices

## TASK DESCRIPTOR

These devices measure the mass, density and consistency of the material within the process. Instrumentation and control technicians install, maintain, diagnose and repair these devices to control processes and maintain product quality.

## B-8.01 Installs mass, density and consistency devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| B-8.01.01P | select and use tools and equipment | tools and equipment are selected and used according to ***type of device*** |
| B-8.01.02P | select device | device is selected according to process application, environment and engineered designs |
| B-8.01.03P | select mounting location and hardware | mounting location and hardware are selected according to engineered designs and manufacturers' specifications |
| B-8.01.04P | mount device and connect to process | device is mounted and connected to process using ***connection methods*** according to industry practices, engineered designs, manufacturers' specifications and codes |
| B-8.01.05P | terminate wiring to device | wiring is terminated to device according to industry practices, engineered designs, manufacturers' specifications and codes |
| B-8.01.06P | configure and calibrate device | device is configured and calibrated according to manufacturers' instructions, process requirements and data sheets |
| B-8.01.07P | commission device and loop | device and loop are commissioned according to engineered designs and site specifications |
| B-8.01.08P | verify operation of device | device operation is verified within specified parameters by using test equipment and procedures according to manufacturers' instructions |
| B-8.01.09P | back up and document configuration and calibration settings | configuration and calibration settings are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***type of device*** includes: mass, density, consistency
***connection methods*** include: bolting, piping, tubing, wiring

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-8.01.01L | demonstrate knowledge of ***mass, density*** and ***consistency devices***, their components and operation | define terminology associated with ***mass, density*** and ***consistency devices***, and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to mass, density and consistency devices, and their components |
| | | interpret information pertaining to ***mass***, ***density*** and ***consistency devices*** found on drawings and specifications |
| | | explain principles of operation for ***mass***, ***density*** and ***consistency devices*** |
| | | identify types of ***mass, density*** and ***consistency devices***, and their components |
| | | identify types of ***indicating devices*** and their components |
| B-8.01.02L | demonstrate knowledge of regulatory requirements pertaining to ***mass***, ***density*** and ***consistency devices***, and their components and operation | interpret ***codes and regulations*** pertaining to ***mass***, ***density*** and ***consistency devices***, and their components |
| B-8.01.03L | demonstrate knowledge of procedures used to install ***mass***, ***density*** and ***consistency devices***, and their components | identify tools and equipment used to install ***mass***, ***density*** and ***consistency devices***, and describe their applications and procedures for use |
| | | describe procedures used to select and install ***mass***, ***density*** and ***consistency devices***, and their components |
| | | identify ***connection methods*** used to install devices |
| B-8.01.04L | demonstrate knowledge of procedures used to calibrate ***mass***, ***density*** and ***consistency devices***, and their components | describe procedures used to calibrate ***mass***, ***density*** and ***consistency devices***, and their components |
| | | describe required ***calibrating measuring parameters*** |
| | | identify ***types of calibration instruments*** |
| | | describe procedures used to back up and document configuration and calibration settings |

## RANGE OF VARIABLES

***mass devices*** include: load cells, scales, strain gauges

***density devices*** include: displacers, nuclear gauges, refractometers, Coriolis tubes, DP transmitters, tuning forks

***consistency devices*** include: optical, rotary, blade, paddle, microwave, nuclear

***hazards*** include: chemical, temperature, pressure, radiation, biological, electrical, mechanical

***indicating devices*** include: chart recorders, digital displays, gauges

***codes and regulations*** include: environmental regulations, nuclear safety regulations, installation codes

***connection methods*** include: bolting, piping, tubing, wiring

***calibrating measuring parameters*** include: zero, span, range, repeatability, accuracy, specific gravity

***types of calibration instruments*** include: multimeters, radiation survey meters, certified measurement standards

## B-8.02 Maintains mass, density and consistency devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-8.02.01P | perform inspection and function check of device | inspection is performed to detect ***irregularities*** and confirm proper operation |
| B-8.02.02P | clean devices | devices are cleaned using ***cleaning materials*** according to manufacturers' instructions |
| B-8.02.03P | verify calibration of devices | calibration of devices is verified according to manufacturers' instructions and maintenance specifications |
| B-8.02.04P | calibrate device | device is calibrated before returning to service according to manufacturers' instructions and maintenance specifications |

## RANGE OF VARIABLES

***irregularities*** include: leaks, loose connections, corrosion, faulty sensors

***cleaning materials*** include: solvents, fine wire, abrasives, contact cleaners

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-8.02.01L | demonstrate knowledge of ***mass, density*** and ***consistency devices***, their components and operation | define terminology associated with ***mass, density*** and ***consistency devices***, and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to ***mass, density*** and ***consistency devices***, and their components |
| | | interpret information pertaining to ***mass, density*** and ***consistency devices*** found on drawings and specifications |
| | | explain principles of operation for ***mass, density*** and ***consistency devices*** |
| | | identify types of ***mass, density*** and ***consistency devices***, and their components |
| | | identify ***types of indicating devices*** and their components |
| B-8.02.02L | demonstrate knowledge of procedures used to maintain ***mass, density*** and ***consistency devices***, and their components | identify tools and equipment used to maintain ***mass, density*** and ***consistency devices***, and describe their applications and procedures for use |
| | | describe procedures used to maintain ***mass, density*** and ***consistency devices***, and their components |
| | | describe ***factors affecting system performance*** |
| B-8.02.03L | demonstrate knowledge of procedures used to calibrate ***mass***, ***density*** and ***consistency devices***, and their components | describe procedures used to calibrate ***mass, density*** and ***consistency devices***, and their components |
| | | identify ***types of calibration instruments*** |
| | | describe required ***calibrating measuring parameters*** |
| | | describe procedures used to back up and document configuration and calibration settings |
| | | identify ***sampling methodologies*** for calibration of ***mass***, ***density*** and ***consistency devices*** |
| | | describe procedures used to analyze calibration samples of mass, density and consistency |

## RANGE OF VARIABLES

***mass devices*** include: load cells, scales, strain gauges

***density devices*** include: displacers, nuclear gauges, refractometers, Coriolis tubes, DP transmitters, tuning forks

***consistency devices*** include: optical, rotary, blade, paddle, microwave, nuclear

***hazards*** include: chemical, temperature, pressure, radiation, biological, electrical, mechanical

***types of indicating devices*** include: chart recorders, digital displays, gauges

***factors affecting system performance*** include: temperature, vibration, pressure, electromagnetism

***types of calibration instruments*** include: multimeters, radiation survey meters, certified measurement standards

***calibrating measuring parameters*** include: zero, span, range, repeatability, accuracy, specific gravity

***sampling methodologies*** include: Technical Association for the Pulp and Paper Industry (TAPPI), American Petroleum Institute (API), site-specific procedures

## B-8.03 Diagnoses mass, density and consistency devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-8.03.01P | select and use ***diagnostic tools and equipment*** | ***diagnostic tools and equipment*** are selected and used according to application requirements |
| B-8.03.02P | perform inspection and check function of device | inspection to detect ***faults*** is performed |
| B-8.03.03P | perform as-found calibration check | as-found calibration check is performed |
| B-8.03.04P | determine probable root cause and location of ***faults*** and identify required repairs | probable root cause and location of ***faults*** are determined and required repairs are identified |

## RANGE OF VARIABLES

***diagnostic tools and equipment*** include: multimeters, software, hand-held configurators, test equipment, laptops, survey meters

***faults*** include: leaks, misalignment, physical damage, poor electrical connections, dirty lenses, faulty sensors, inadequate power

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-8.03.01L | demonstrate knowledge of ***mass, density*** and ***consistency devices***, and their components and operation | define terminology associated with ***mass, density*** and ***consistency devices***, and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to ***mass, density*** and ***consistency devices***, and their components |
| | | interpret information pertaining to ***mass, density*** and ***consistency devices*** found on drawings and specifications |
| | | explain principles of operation for ***mass, density*** and ***consistency devices*** |
| | | identify types of ***mass, density*** and ***consistency devices***, and their components |
| | | identify ***types of indicating devices*** and their components |
| B-8.03.02L | demonstrate knowledge of procedures used to diagnose ***mass, density*** and ***consistency devices***, and their components | identify ***diagnostic tools and equipment*** used to diagnose ***mass, density*** and ***consistency devices***, and describe their applications and procedures for use |
| | | describe procedures used to diagnose faults in ***mass, density*** and ***consistency devices*** and their components |
| | | identify types of ***faults*** with ***mass, density*** and ***consistency devices*** and their components |

## RANGE OF VARIABLES

***mass devices*** include: load cells, scales, strain gauges

***density devices*** include: displacers, nuclear gauges, refractometers, Coriolis tubes, DP transmitters, tuning forks

***consistency devices*** include: optical, rotary, blade, paddle, microwave, nuclear

***hazards*** include: chemical, temperature, pressure, radiation, biological, electrical, mechanical

***types of indicating devices*** include: chart recorders, digital displays, gauges

***diagnostic tools and equipment*** include: multimeters, software, hand-held configurators, test equipment, laptops, survey meters

***faults*** include: leaks, misalignment, physical damage, poor electrical connections, dirty lenses, faulty sensors, inadequate power

## B-8.04 Repairs mass, density and consistency devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-8.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to application requirements |
| B-8.04.02P | replace ***components*** | ***components*** are replaced according to manufacturers' instructions |
| B-8.04.03P | inspect and clean ***components*** | ***components*** are inspected and cleaned according to manufacturers' instructions |
| B-8.04.04P | calibrate device | device is calibrated according to manufacturers' specifications |
| B-8.04.05P | update documentation | documentation is updated with repair information according to site-specific procedures |

### RANGE OF VARIABLES

***tools and equipment*** include: multimeters, certified measurement standards
***components*** include: sensors, sensor boards, reflectors, lenses

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| B-8.04.01L | demonstrate knowledge of ***mass, density*** and ***consistency devices***, and their ***components*** and operation | define terminology associated with ***mass, density*** and ***consistency devices***, and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to ***mass, density*** and ***consistency devices***, and their ***components*** |
| | | interpret information pertaining to ***mass, density*** and ***consistency devices*** found on drawings and specifications |
| | | explain principles of operation for ***mass, density*** and ***consistency devices*** |
| | | identify types of ***mass, density*** and ***consistency devices***, and their components |
| | | identify ***types of indicating devices*** and their ***components*** |

| | | |
|---|---|---|
| B-8.04.02L | demonstrate knowledge of procedures used to repair and replace ***mass, density*** and ***consistency devices***, and their ***components*** | identify ***tools and equipment*** used to repair and replace ***mass, density*** and ***consistency devices***, and describe their applications and procedures for use |
| | | describe procedures used to repair and replace ***mass, density*** and ***consistency devices,*** and their ***components*** |
| B-8.04.03L | demonstrate knowledge of procedures used to calibrate ***mass, density*** and ***consistency devices***, and their components | describe procedures used to calibrate ***mass, density*** and ***consistency devices***, and their components |
| | | identify ***types of calibration instruments*** |
| | | describe required ***calibrating measuring parameters*** |

## RANGE OF VARIABLES

***mass devices*** include: load cells, scales, strain gauges

***density devices*** include: displacers, nuclear gauges, refractometers, Coriolis tubes, DP transmitters, tuning forks

***consistency devices*** include: optical, rotary, blade, paddle, microwave, nuclear

***components*** include: sensors, sensor boards, reflectors, lenses

***hazards*** include: chemical, temperature, pressure, radiation, biological, electrical, mechanical

***types of indicating devices*** include: chart recorders, digital displays, gauges

***tools and equipment*** include: multimeters, certified measurement standards

***types of calibration instruments*** include: multimeters, radiation survey meters, certified measurement standards

***calibrating measuring parameters*** include: zero, span, range, repeatability, accuracy, specific gravity

# TASK B-9 Installs and services process analyzers

## TASK DESCRIPTOR

Process analyzers are used to measure and verify that processes are working correctly and following quality control and regulatory standards. Instrumentation and control technicians must be able to install, maintain, diagnose and repair process analyzers to maintain process quality and to protect the environment and personnel.

## B-9.01 Installs process analyzers

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| B-9.01.01P | select and use tools and equipment | tools and equipment are selected and used according to type of device |
| B-9.01.02P | select analyzers | analyzers are selected according to process application, environmental conditions, manufacturers' specifications and engineered designs |
| B-9.01.03P | select mounting location and hardware | mounting location and hardware are selected according to engineered designs and manufacturers' specifications |
| B-9.01.04P | mount devices and connect to process using ***connecting methods*** | devices are mounted and connected to process using ***connecting methods*** according to industry practices, engineered designs, manufacturers' instructions and codes |
| B-9.01.05P | terminate wiring to devices | wiring is terminated to devices according to industry practices, engineered designs, manufacturers' specifications and codes |
| B-9.01.06P | configure and calibrate analyzer | analyzer is configured and calibrated according to manufacturers' instructions, process requirements and data sheets |
| B-9.01.07P | install sampling systems and conditioners | sampling systems and conditioners are installed according to process requirements and manufacturers' specifications to ensure sample is representative of process being analyzed |
| B-9.01.08P | verify operation of analyzer and sampling system within specified parameters | operation of analyzer and sampling system are verified within specified parameters by using known standards, sampling routines and procedures |

| | | |
|---|---|---|
| B-9.01.09P | develop or maintain sample phase | sample phase is developed or maintained according to analyzer specifications and physical characteristics of sample |
| B-9.01.10P | back up and document configuration and calibration settings | configuration and calibration settings are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***connecting methods*** include: in-line, tubing, piping, wiring, in-situ, extractive, dilution extractive

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-9.01.01L | demonstrate knowledge of process analyzers, their components, purpose, applications, characteristics and operation | define terminology associated with process analyzers and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to process analyzers and their components |
| | | interpret information pertaining to process analyzers and their components found on drawings and specifications |
| | | explain principles of operation for process analyzers and their components |
| | | identify ***types of process analyzers*** and their components, and describe their purpose, applications, characteristics and operation |
| | | describe ***operating parameters*** of process analyzers |
| | | describe accuracy and repeatability limitations of process analyzers |
| | | describe possible contamination of process analyzers |
| B-9.01.02L | demonstrate knowledge of regulatory requirements pertaining to process analyzers and their components | interpret ***codes and regulations*** pertaining to process analyzers and their components |
| B-9.01.03L | demonstrate knowledge of process sample systems and conditioning | describe ***process sampling*** and its importance to process analysis |
| | | describe procedures and equipment used to obtain and condition samples for process analysis |
| | | describe how sample phase changes affect analyzer |
| B-9.01.04L | demonstrate knowledge of procedures used to install process analyzers and their components | identify tools and equipment used to install process analyzers and their components, and describe their applications and procedures for use |

| | | |
|---|---|---|
| | | describe procedures used to select and install process analyzers and their components |
| | | identify ***connection methods*** |
| | | identify required ***installation conditions*** |
| B-9.01.05L | demonstrate knowledge of procedures used to calibrate process analyzers and their components | describe procedures used to calibrate process analyzers |
| | | identify required calibration parameters of process analyzers |
| | | identify ***calibration material*** |

## RANGE OF VARIABLES

***hazards*** include: chemical, temperature, pressure, radiation, biological, electrical, mechanical

***types of process analyzers*** include: pH, oxidation reduction potential (ORP), conductivity, dissolved oxygen, mass and density, viscosity, humidity, turbidity, specific ion, nuclear (solids composition, liquids composition), chromatography, consistency, spectrographic, flue gas analyzers (continuous emissions monitoring system [CEMS] – opacity, S02, NOx, CO2), environmental (gas, noise, fluids, solids), X-ray, colour, tunable laser diodes

***operating parameters*** include: sampling time, lag time, measurement limitations

***codes and regulations*** include: environmental regulations, installation codes, nuclear safety regulations

***process sampling*** includes: in-situ installations, extraction sample systems, grab samples, sample conditioning (temperature, pressure, filtering, coalescing), fast loop applications, stream switching, sample disposal

***connecting methods*** include: in-line, tubing, piping, wiring, in-situ, extractive, dilution extractive

***installation conditions*** include: ambient conditions, contamination

***calibration material*** include: inert gases, standard gases, water, oil, buffer solutions, certified mixtures

## B-9.02 Maintains process analyzers

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-9.02.01P | perform inspection | inspection is performed to detect ***irregularities*** |
| B-9.02.02P | check function of analyzer and sampling system | function of analyzer and sampling system is checked to confirm proper operation |
| B-9.02.03P | analyze operational history and trends data | operational history and trends data are verified using statistical analysis |
| B-9.02.04P | clean devices | devices are cleaned using ***cleaning materials*** according to manufacturers' instructions |

| | | |
|---|---|---|
| B-9.02.05P | clear sample lines | sample lines are cleared by flushing using ***purging methods*** according to manufacturers' specifications |
| B-9.02.06P | verify calibration of devices | calibration is verified according to maintenance procedures |
| B-9.02.07P | calibrate device before returning to service | device is calibrated before returning to service according to manufacturers' instructions |

## RANGE OF VARIABLES

***irregularities*** include: leaks, incorrect sample flow and pressure, corrosion, incorrect phase of sample
***cleaning materials*** include: solvents, cleaning solutions, brushes, water, steam
***purging methods*** include: air, steam, nitrogen, solvents

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-9.02.01L | demonstrate knowledge of process analyzers, their components, purpose, applications, characteristics and operation | define terminology associated with process analyzers |
| | | identify ***hazards*** and describe safe work practices pertaining to process analyzers and their components |
| | | interpret information pertaining to process analyzers found on drawings and specifications |
| | | explain principles of operation for process analyzers and their components |
| | | identify ***types of process analyzers,*** their purpose, applications, characteristics, operation and components |
| | | describe ***operating parameters*** of process analyzers |
| | | describe accuracy and repeatability limitations of process analyzers |
| | | describe possible contamination of process analyzers |
| B-9.02.02L | demonstrate knowledge of regulatory requirements pertaining to process analyzers and their components | interpret ***codes and regulations*** pertaining to process analyzers and their components |
| B-9.02.03L | demonstrate knowledge of process sample systems and conditioning | describe ***process sampling*** and its importance to process analysis |
| | | describe procedures and equipment used to obtain and condition samples for process analysis |
| | | describe how sample phase changes affect analyzer |

| | | |
|---|---|---|
| B-9.02.04L | demonstrate knowledge of procedures used to maintain process analyzers and their components | identify tools and equipment used to maintain process analyzers and their components, and describe their applications and procedures for use |
| | | describe procedures used to maintain process analyzers and their components |
| | | identify ***cleaning materials*** used to clean devices |
| B-9.02.05L | demonstrate knowledge of procedures used to calibrate process analyzers and their components | describe procedures used to calibrate process analyzers and their components |
| | | identify required calibration parameters of process analyzers |
| | | identify ***calibration material*** |

## RANGE OF VARIABLES

***hazards*** include: chemical, temperature, pressure, radiation, biological, electrical, mechanical

***types of process analyzers*** include: pH, ORP, conductivity, dissolved oxygen, mass and density, viscosity, humidity, turbidity, specific ion, nuclear (solids composition, liquids composition), chromatography, consistency, spectrographic, flue gas analyzers (CEMS – opacity, S02, NOx, CO2), environmental (gas, noise, fluids, solids), X-ray, colour, tunable laser diodes

***operating parameters*** include: sampling time, lag time, measurement limitations

***codes and regulations*** include: environmental regulations, installation codes, nuclear safety regulations

***process sampling*** includes: in-situ installations, extraction sample systems, grab samples, sample conditioning (temperature, pressure, filtering, coalescing), fast loop applications, stream switching, sample disposal

***cleaning materials*** include: solvents, cleaning solutions, brushes, water, steam

***calibration material*** include: inert gases, standard gases, water, oil, buffer solutions, certified mixtures

## B-9.03 Diagnoses process analyzers

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-9.03.01P | select and use ***diagnostic tools and equipment*** | ***diagnostic tools and equipment*** are selected and used according to manufacturers' instructions |
| B-9.03.02P | perform inspection and check function of process analyzer | inspection to detect ***faults*** is performed |
| B-9.03.03P | perform as-found calibration check | as-found calibration check is performed |

| | | |
|---|---|---|
| B-9.03.04P | select and use ***diagnostic materials*** | ***diagnostic materials*** are selected and used according to process requirements and manufacturers' instructions |
| B-9.03.05P | determine probable root cause and location of ***faults*** and identify required repairs | probable root cause and location of ***faults*** are determined and required repairs are identified |

## RANGE OF VARIABLES

***diagnostic tools and equipment*** include: multimeters, software, internal diagnostics, portable analyzers

***faults*** include: leaks, dirty probes, physical damage, poor electrical connections, improper readings, software faults, temperature control, dirty optics, faulty sensors, inadequate power, failed components, sample phase

***diagnostic materials*** include: buffers, certified mixtures

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-9.03.01L | demonstrate knowledge of process analyzers, their components, purpose, applications, characteristics and operation | define terminology associated with process analyzers and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to process analyzers and their components |
| | | interpret information pertaining to process analyzers found on drawings and specifications |
| | | explain principles of operation for process analyzers and their components |
| | | identify ***types of process analyzers***, their components, purpose, applications, characteristics and operation |
| | | describe ***operating parameters*** of process analyzers |
| | | describe accuracy and repeatability limitations of process analyzers |
| | | describe possible contamination of process analyzers |
| B-9.03.02L | demonstrate knowledge of regulatory requirements pertaining to process analyzers and their components | interpret ***codes and regulations*** pertaining to process analyzers and their components |
| B-9.03.03L | demonstrate knowledge of process sample systems and conditioning | describe ***process sampling*** and its importance to process analysis |
| | | describe procedures and equipment used to obtain and condition samples for process analysis |
| | | describe how sample phase changes affect process analyzers |

| | | |
|---|---|---|
| B-9.03.04L | demonstrate knowledge of procedures used to diagnose process analyzers and their components | identify ***diagnostic tools and equipment*** used to diagnose process analyzers and their components, and describe their applications and procedures for use |
| | | describe procedures used to diagnose process analyzers and their components |
| | | identify ***faults*** with process analyzers and their components |

## RANGE OF VARIABLES

***hazards*** include: chemical, temperature, pressure, radiation, biological, electrical, mechanical

***types of process analyzers*** include: pH, ORP, conductivity, dissolved oxygen, mass and density, viscosity, humidity, turbidity, specific ion, nuclear (solids composition, liquids composition), chromatography, consistency, spectrographic, flue gas analyzers (CEMS – opacity, S02, NOx, CO2), environmental (gas, noise, fluids, solids), X-ray, colour, tunable laser diodes

***operating parameters*** include: sampling time, lag time, measurement limitations

***codes and regulations*** include: environmental regulations, installation codes, nuclear safety regulations

***process sampling*** includes: in-situ installations, extraction sample systems, grab samples, sample conditioning (temperature, pressure, filtering, coalescing), fast loop applications, stream switching, sample disposal

***diagnostic tools and equipment*** include: multimeters, software, internal diagnostics, portable analyzers

***faults*** include: leaks, dirty probes, physical damage, poor electrical connections, improper readings, software faults, temperature control, dirty optics, faulty sensors, inadequate power, failed components, sample phase

## B-9.04 Repairs process analyzers

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-9.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to manufacturers' specifications |
| B-9.04.02P | replace components | components are replaced |
| B-9.04.03P | clean components | components are cleaned according to process requirements and manufacturers' instructions |
| B-9.04.04P | rebuild ***devices*** | ***devices*** are rebuilt according to manufacturers' instructions |

| | | |
|---|---|---|
| B-9.04.05P | repair ***sampling system faults*** | ***sampling system faults*** are repaired |
| B-9.04.06P | verify operation and calibration before returning to service | operation and calibration are verified before returning to service using buffers, certified mixture and lab sample |

## RANGE OF VARIABLES

***tools and equipment*** include: multimeters, oscilloscopes

***devices*** include: regulators, solenoids, valves

***sampling system faults*** include: plugged sampling lines, faulty solenoids, clogged filters, sticking and passing valves, faulty regulators, pump failure

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-9.04.01L | demonstrate knowledge of process analyzers, their components, purpose, applications, characteristics and operation | define terminology associated with process analyzers and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to process analyzers and their components |
| | | interpret information pertaining to process analyzers found on drawings and specifications |
| | | explain principles of operation for process analyzers and their components |
| | | identify ***types of process analyzers*****,** their components, purpose, applications, characteristics and operation |
| | | describe ***operating parameters*** of process analyzers |
| | | describe accuracy and repeatability limitations of analyzer |
| | | describe possible contamination of analyzers |
| B-9.04.02L | demonstrate knowledge of regulatory requirements pertaining to process analyzers and their components | interpret ***codes and regulations*** pertaining to process analyzers and their components |
| B-9.04.03L | demonstrate knowledge of process sample systems and conditioning | describe ***process sampling*** and its importance to process analysis |
| | | describe procedures and equipment used to obtain and condition samples for process analysis |
| | | describe how sample phase changes affect process analyzers |

| | | |
|---|---|---|
| B-9.04.04L | demonstrate knowledge of procedures used to repair, replace and rebuild process analyzers, their components and ***devices*** | identify tools and equipment used to repair, replace and rebuild process analyzers, their components and ***devices***, and describe their applications and procedures for use |
| | | describe procedures used to repair, replace and rebuild process analyzers, their components and ***devices*** |
| B-9.04.05L | demonstrate knowledge of procedures used to calibrate process analyzers and their components | describe procedures used to calibrate process analyzers and their components |
| | | identify required calibration parameters of analyzers |
| | | identify ***calibration material*** |

## RANGE OF VARIABLES

***hazards*** include: chemical, temperature, pressure, radiation, biological, electrical, mechanical

***types of process analyzers*** include: pH, ORP, conductivity, dissolved oxygen, mass and density, viscosity, humidity, turbidity, specific ion, nuclear (solids composition, liquids composition), chromatography, consistency, spectrographic, flue gas analyzers (CEMS – opacity, S02, NOx, CO2), environmental (gas, noise, fluids, solids), X-ray, colour, tunable laser diodes

***operating parameters*** include: sampling time, lag time, measurement limitations

***codes and regulations*** include: environmental regulations, installation codes, nuclear safety regulations

***process sampling*** includes: in-situ installations, extraction sample systems, grab samples, sample conditioning (temperature, pressure, filtering, coalescing), fast loop applications, stream switching, sample disposal

***calibration material*** include: inert gases, standard gases, water, oil, buffer solutions, certified mixtures

# TASK B-10 Installs and services multiple variable computing devices

## TASK DESCRIPTOR

Instrumentation and control technicians must be able to install, maintain, diagnose and repair multiple variable computing devices to provide accurate measurements where a higher degree of accuracy is required.

Multiple variable computing devices are stand-alone systems or are integral to measuring devices, SCADA and control systems. They bring in multiple inputs and use these to perform calculations that compensate for variables such as temperature and pressure when calculating flow or level. There are some devices including flow computers that have many configuration parameters such as product composition and primary flow element specifications.

## B-10.01 Installs multiple variable computing devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| B-10.01.01P | select and use tools and equipment | tools and equipment are selected and used according to type of device |
| B-10.01.02P | select device | device is selected according to process applications, environmental conditions, engineered designs and manufacturers' specifications |
| B-10.01.03P | select mounting location and hardware | mounting location and hardware are selected according to engineered designs and manufacturers' specifications |
| B-10.01.04P | terminate wiring to device | wiring is terminated to device according to manufacturers' specifications and engineered designs |
| B-10.01.05P | connect tubing to device | tubing is connected to device according to manufacturers' specifications and engineered designs |
| B-10.01.06P | configure and calibrate device | device is configured and calibrated according to manufacturers' specifications, application and data sheets |
| B-10.01.07P | verify operation of device | device operation is verified within specified parameters by using test equipment and procedures |
| B-10.01.08P | back up and document configuration and calibration settings for future data recovery | configuration and calibration settings are backed up and documented for future data recovery |

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-10.01.01L | demonstrate knowledge of multiple variable computing devices, their ***components*** and operation | define terminology associated with multiple variable computing devices and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to multiple variable computing devices and their ***components*** |
| | | interpret information pertaining to multiple variable computing devices and their ***components*** found on drawings and specifications |
| | | identify multiple variable computing device ***components*** and describe their purpose and operation |
| | | identify ***types of multiple variable computing devices*** and their ***components***, and describe their protocols, features and limitations |
| | | describe operating parameters and configurations of multiple variable computing devices and their ***components*** |
| | | identify ***connection methods*** for multiple variable computing devices and their ***components*** |
| | | identify potential causes of interference |
| | | describe grounding methods |
| | | describe interaction of various loops |
| | | describe accuracy and repeatability limitations of multiple variable computing devices |
| | | describe required configuration parameters of multiple variable computing devices |
| | | explain compensation algorithms combining pressure, temperature, flow and level |
| B-10.01.02L | demonstrate knowledge of regulatory requirements pertaining to multiple variable computing devices and their ***components*** | interpret codes and regulations pertaining to multiple variable computing devices and their ***components*** |
| B-10.01.03L | demonstrate knowledge of procedures used to install multiple variable computing devices and their ***components*** | identify tools and equipment used to install multiple variable computing devices and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to select and install multiple variable computing devices and their ***components*** |

| | | |
|---|---|---|
| | | describe ***environmental conditions*** to address when installing variable computing devices and their ***components*** |
| B-10.01.04L | demonstrate knowledge of procedures used to calibrate multiple variable computing devices and their ***components*** | describe procedures used to calibrate multiple variable computing devices and their ***components*** |
| | | identify types of ***calibration equipment*** |
| | | interpret accuracy of ***calibration equipment*** and multiple variable computing devices |

## RANGE OF VARIABLES

***components*** include: circuit boards, power supplies, displays

***types of multiple variable computing devices*** include: flow computers, mass flow computers, density measurement

***connection methods*** include: hardwired, wireless

***environmental conditions*** include: ambient conditions, contamination

***calibration equipment*** includes: pressure, multimeters, software, temperature

## B-10.02 Maintains multiple variable computing devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-10.02.01P | perform preliminary backup of system data | system data is backed up prior to maintenance |
| B-10.02.02P | calibrate device during routine maintenance | devices are calibrated during routine maintenance according to manufacturers' specifications, regulatory requirements, process requirements and data sheets |
| B-10.02.03P | upgrade software and firmware | software and firmware are upgraded for ***reasons*** |
| B-10.02.04P | verify configuration of device | device configuration is verified according to applicable engineered and jurisdictional standards |
| B-10.02.05P | document configurations and calibrations | configurations and calibrations are documented to comply with regulatory requirements and to facilitate maintenance activities |

## RANGE OF VARIABLES

***reasons*** include: avoiding obsolescence, achieving optimal equipment efficiency and accuracy, meeting jurisdictional standards, following manufacturers' specifications

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-10.02.01L | demonstrate knowledge of multiple variable computing devices, their ***components*** and operation | define terminology associated with multiple variable computing devices and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to multiple variable computing devices and their ***components*** |
| | | interpret information pertaining to multiple variable computing devices and their ***components*** found on drawings and specifications |
| | | identify multiple variable computing device ***components*** and describe their purpose and operation |
| | | identify ***types of multiple variable computing devices*** and their ***components***, and describe their protocols, features and limitations |
| | | describe operating parameters and configurations of multiple variable computing devices and their ***components*** |
| | | identify ***connection methods*** for multiple variable computing devices and their ***components*** |
| | | identify potential causes of interference |
| | | describe grounding methods |
| | | describe interaction of various loops |
| | | describe accuracy and repeatability limitations of multiple variable computing devices |
| | | describe required configuration parameters of multiple variable computing devices |
| | | explain compensation algorithms combining pressure, temperature, flow and level |
| B-10.02.02L | demonstrate knowledge of regulatory requirements pertaining to multiple variable computing devices and their ***components*** | interpret codes and regulations pertaining to multiple variable computing devices and their ***components*** |

| | | |
|---|---|---|
| B-10.02.03L | demonstrate knowledge of procedures used to maintain multiple variable computing devices and their ***components*** | identify tools and equipment used to maintain multiple variable computing devices and their ***components***, and describe their applications and procedures for use |
| | | describe backup procedures before maintaining multiple variable computing devices and their ***components*** |
| | | describe procedures used to maintain multiple variable computing devices and their ***components*** |
| | | describe procedures used to document configurations and calibrations of multiple variable computing devices and their ***components*** |
| B-10.02.04L | demonstrate knowledge of procedures used to calibrate multiple variable computing devices and their ***components*** | describe procedures used to calibrate multiple variable computing devices and their ***components*** |
| | | identify types of ***calibration equipment*** |
| | | interpret accuracy of ***calibration equipment*** and multiple variable computing devices |

## RANGE OF VARIABLES

***components*** include: circuit boards, power supplies, displays

***types of multiple variable computing devices*** include: flow computers, mass flow computers, density measurement

***connection methods*** include: hardwired, wireless

***calibration equipment*** includes: pressure, multimeters, software, temperature

## B-10.03 Diagnoses multiple variable computing devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-10.03.01P | select and use ***diagnostic tools and equipment*** | ***diagnostic tools and equipment*** are selected and used according to manufacturers' specifications |
| B-10.03.02P | perform inspection | inspection is performed to detect ***faults*** |
| B-10.03.03P | check function of device | function of device is checked to identify ***problems*** |

| | | |
|---|---|---|
| B-10.03.04P | perform as-found calibration check | as-found calibration check is performed |
| B-10.03.05P | determine probable root cause and location of ***faults*** and identify required repairs | probable root cause and location of ***faults*** are determined and required repairs are identified |

## RANGE OF VARIABLES

***diagnostic tools and equipment*** include: multimeters, software, hand-held configurators
***faults*** include: faulty electrical connections, condition of primary elements, leaks
***problems*** include: loss of power and communication, erroneous results

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-10.03.01L | demonstrate knowledge of multiple variable computing devices, their ***components*** and operation | define terminology associated with multiple variable computing devices and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to multiple variable computing devices and their ***components*** |
| | | interpret information pertaining to multiple variable computing devices and their ***components*** found on drawings and specifications |
| | | identify multiple variable computing device ***components*** and describe their purpose and operation |
| | | identify ***types of multiple variable computing devices*** and their ***components***, and describe their protocols, features and limitations |
| | | describe operating parameters and configurations of multiple variable computing devices and their ***components*** |
| | | identify ***connection methods*** for multiple variable computing devices and their ***components*** |
| | | identify potential causes of interference |
| | | describe grounding methods |
| | | describe interaction of various loops |
| | | describe accuracy and repeatability limitations of multiple variable computing devices |
| | | describe required configuration parameters of multiple variable computing devices |
| | | explain compensation algorithms combining pressure, temperature, flow and level |

| | | |
|---|---|---|
| B-10.03.02L | demonstrate knowledge of regulatory requirements pertaining to multiple variable computing devices and their ***components*** | interpret codes and regulations pertaining to multiple variable computing devices and their ***components*** |
| B-10.03.03L | demonstrate knowledge of procedures used to diagnose multiple variable computing devices and their ***components*** | identify ***diagnostic tools and equipment*** used to diagnose multiple variable computing devices and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to diagnose multiple variable computing devices and their ***components*** |
| B-10.03.04L | demonstrate knowledge of procedures used to calibrate multiple variable computing devices and their ***components*** | describe procedures used to calibrate multiple variable computing devices and their ***components*** |
| | | identify types of ***calibration equipment*** |
| | | interpret accuracy of ***calibration equipment*** and multiple variable computing devices |

## RANGE OF VARIABLES

***components*** include: circuit boards, power supplies, displays

***types of multiple variable computing devices*** include: flow computers, mass flow computers, density measurement

***connection methods*** include: hardwired, wireless

***diagnostic tools and equipment*** include: multimeters, software, hand-held configurators

***calibration equipment*** includes: pressure, multimeters, software, temperature

## B-10.04 Repairs multiple variable computing devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| B-10.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to manufacturers' specifications |
| B-10.04.02P | replace ***components*** | ***components*** are replaced |
| B-10.04.03P | confirm restored configurations | restored configurations are confirmed |

| | | |
|---|---|---|
| B-10.04.04P | verify calibration of multiple input signals | calibration of multiple input signals are verified according to manufacturers' specifications |
| B-10.04.05P | verify operation and calibration before returning to service | operation and calibration are verified before returning to service |

## RANGE OF VARIABLES

***tools and equipment*** include: configurators, software
***components*** include: circuit boards, power supplies, displays

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| B-10.04.01L | demonstrate knowledge of multiple variable computing devices, their ***components*** and operation | define terminology associated with multiple variable computing devices and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to multiple variable computing devices and their ***components*** |
| | | interpret information pertaining to multiple variable computing devices and their ***components*** found on drawings and specifications |
| | | identify multiple variable computing device ***components*** and describe their purpose and operation |
| | | identify ***types of multiple variable computing devices*** and ***components***, and describe their protocols, features and limitations |
| | | describe operating parameters and configurations of multiple variable computing devices and their ***components*** |
| | | identify ***connection methods*** for multiple variable computing devices and their ***components*** |
| | | identify potential causes of interference |
| | | describe grounding methods |
| | | describe interaction of various loops |
| | | describe operational theory of multiple variable computing devices |
| | | describe accuracy and repeatability limitations of multiple variable computing devices |
| | | describe required configuration parameters of multiple variable computing devices |

| | | |
|---|---|---|
| | | explain compensation algorithms combining pressure, temperature, flow and level |
| B-10.04.02L | demonstrate knowledge of regulatory requirements pertaining to multiple variable computing devices and their ***components*** | interpret codes and regulations pertaining to multiple variable computing devices and their ***components*** |
| B-10.04.03L | demonstrate knowledge of procedures used to repair and replace multiple variable computing devices and their ***components*** | identify ***tools and equipment*** used to repair and replace multiple variable computing devices and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to repair and replace multiple variable computing devices and their ***components*** |
| B-10.04.04L | demonstrate knowledge of procedures used to calibrate multiple variable computing devices and their ***components*** | describe procedures used to calibrate multiple variable computing devices and their ***components*** |
| | | identify types of ***calibration equipment*** |
| | | interpret accuracy of ***calibration equipment*** and multiple variable computing devices |

## RANGE OF VARIABLES

***components*** include: circuit boards, power supplies, displays

***types of multiple variable computing devices*** include: flow computers, mass flow computers, density measurement

***connection methods*** include: hardwired, wireless

***tools and equipment*** include: configurators, software

***calibration equipment*** includes: pressure, multimeters, software, temperature

# MAJOR WORK ACTIVITY C

# Installs and services safety and security systems and devices

## TASK C-11 Installs and services safety systems and devices

### TASK DESCRIPTOR

Instrumentation and control technicians install, maintain, diagnose and repair safety systems and devices. Safety systems and devices are used to detect and react to hazards such as gas leaks, fires and spills. Reactions may range from alarms to plant shutdowns and evacuations. The proper installation, calibration and maintenance of these systems are imperative to the safety of the personnel, process operation, equipment and environment.

### C-11.01 Installs safety systems and devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| C-11.01.01P | identify hazard to be detected | hazard to be detected is identified |
| C-11.01.02P | select ***type of safety system*** | ***type of safety system*** is selected according to process applications, industry standards, codes and practices |
| C-11.01.03P | determine location for safety system and devices | location for safety system and devices is determined according to manufacturers' instructions, industry standards and codes |
| C-11.01.04P | select and use tools and equipment | tools and equipment are selected and used according to industry standards and practices |
| C-11.01.05P | select and mount device | device is selected and mounted according to industry practices, engineered designs, manufacturers' specifications and codes |
| C-11.01.06P | configure safety system | safety system is configured according to industry standards, codes and practices |
| C-11.01.07P | calibrate safety system components | safety system components are calibrated using calibration instruments |

| | | |
|---|---|---|
| C-11.01.08P | verify operation of safety systems, alarms and devices | operation of safety systems, alarms and devices are within specified process parameters by using test equipment and procedures |
| C-11.01.09P | back up and document configuration and calibration settings | configuration and calibration settings are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***types of safety systems*** include: gas detection, heat detection, fire detection, smoke detection, spill detection, leak detection, emission monitoring equipment, water quality, vibration, overspeed, burner management system (BMS), radiation, pressure

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-11.01.01L | demonstrate knowledge of safety systems and devices, their components and operation | define terminology associated with safety systems and devices, and their components |
| | | interpret information pertaining to safety systems found on drawings and specifications |
| | | identify ***types of safety systems*** and devices, and describe their components, characteristics and applications |
| | | identify types of ***hazardous materials*** and impact on area hazard classification |
| | | describe acceptable limits according to codes |
| | | describe accuracy limitations of safety systems and devices |
| | | describe interaction between safety systems and processes |
| C-11.01.02L | demonstrate knowledge of regulatory requirements pertaining to safety systems and devices, and their components | identify codes and regulations pertaining to safety systems and devices, and their components |
| C-11.01.03L | demonstrate knowledge of procedures used to install and configure safety systems and devices, and their components | describe procedures used to select and install safety systems and devices, and their components |
| | | describe procedures used to configure safety systems and devices, and their components |
| | | identify hazards and describe safe work practices pertaining to safety systems and devices, and their components |

| | | |
|---|---|---|
| | | identify tools and equipment used to install safety systems and devices, and describe their applications and procedures for use |
| | | validate certification requirements for calibration equipment |
| | | describe procedures used to back up and document configuration and calibration settings |
| C-11.01.04L | demonstrate knowledge of procedures used to calibrate safety systems and their devices | describe procedures used to calibrate safety systems and their devices |
| | | identify ***types of calibration instruments*** |
| | | identify required calibrating parameters of safety systems |
| | | validate that certified process standards are being used in calibration and tests |

## RANGE OF VARIABLES

***types of safety systems*** include: gas detection, heat detection, fire detection, smoke detection, spill detection, leak detection, emission monitoring equipment, water quality, vibration, overspeed, BMS, radiation, pressure

***hazardous materials*** include: gases (chlorine, hydrogen sulfide [$H_2S$], methane, ammonia), liquids (sulfuric acid, sodium hydroxide), solids (radioactive materials)

***types of calibration instruments*** include: multimeters, certified calibration gases, configuration software

## C-11.02 Maintains safety systems and devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| C-11.02.01P | select and use ***test equipment and materials*** | ***test equipment and materials*** are selected and used to verify protection system or device |
| C-11.02.02P | verify systems for proper operation using ***verification methods*** | systems are verified for proper operation according to jurisdictional regulations and manufacturers' specifications |
| C-11.02.03P | calibrate safety system components | safety system components are calibrated using calibration instruments |
| C-11.02.04P | perform routine function testing of entire safety loops | routine function testing of entire safety loops are performed according to regulatory requirements |

## RANGE OF VARIABLES

***test equipment and materials*** include: ultraviolet/infrared (UV/IR) source, calibration gases, filters, smoke generators, multimeters, dosimeters

***verification methods*** include: bump testing, dry run, sample gas application

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-11.02.01L | demonstrate knowledge of safety systems and devices, their components and operation | define terminology associated with safety systems and devices, and their components |
| | | identify codes and regulations pertaining to safety systems and devices, and their components |
| | | interpret information pertaining to safety systems found on drawings and specifications |
| | | identify ***types of safety systems*** and describe their components, characteristics and applications |
| | | identify types of ***hazardous materials*** and impact on area hazard classification |
| | | describe acceptable limits according to codes for ***conditions*** |
| | | describe accuracy limitations of safety systems |
| | | describe interaction between safety systems and processes |
| C-11.02.02L | demonstrate knowledge of regulatory requirements pertaining to safety systems and devices, and their components | identify applicable codes and regulations pertaining to safety systems and devices, and their components |
| C-11.02.03L | demonstrate knowledge of procedures used to maintain safety systems and devices, and their components | describe procedures used to maintain and troubleshoot safety systems and devices, and their components |
| | | identify hazards and describe safe work practices pertaining to safety systems and devices, and their components |
| | | identify tools and equipment used to maintain safety systems and describe their applications and procedures for use |
| | | describe shutdown procedures, actions and implications |
| | | validate certification requirements for calibration equipment |
| | | describe traceable process standards used in calibration and tests |
| | | identify types of ***test equipment and materials*** |

| | | |
|---|---|---|
| C-11.02.04L | demonstrate knowledge of procedures used to calibrate safety systems and devices, and their components | describe procedures used to calibrate safety systems, devices, and their components |
| | | identify ***types of calibration instruments*** |
| | | identify required calibrating parameters of safety systems |

## RANGE OF VARIABLES

***types of safety systems*** include: gas detection, heat detection, fire detection, smoke detection, spill detection, leak detection, emission monitoring equipment, water quality, vibration, overspeed, BMS, radiation, pressure

***hazardous materials*** include: gases (chlorine, $H_2S$ and methane, ammonia); liquids (sulfuric acid, sodium hydroxide); solids (radioactive materials)

***conditions*** include: oxygen levels, $H_2S$ levels, radiation levels, water quality

***test equipment and materials*** include: UV/IR source, calibration gases, filters, smoke generators, multimeters, dosimeters

***types of calibration instruments*** include: multimeters, certified calibration gases, configuration software

## C-11.03 Diagnoses safety systems and devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| C-11.03.01P | select and use ***test equipment and materials*** | ***test equipment and materials*** are selected and used according to regulatory requirements |
| C-11.03.02P | verify operation of safety systems and devices are within specified parameters | operation of safety systems and devices is verified that they are within specified parameters by using test equipment, documentation and procedures |
| C-11.03.03P | verify documentation, manufacturers' specifications and historical data to assist in determining probable root cause | documentation, manufacturers' specifications and historical data are verified to assist in determining probable root cause |
| C-11.03.04P | analyze ***process information*** | ***process information*** is analyzed |
| C-11.03.05P | perform as-found recorded calibration check | as-found recorded calibration check is performed |
| C-11.03.06P | identify probable root cause and location of faults | probable root cause and location of faults are identified |
| C-11.03.07P | determine steps required to address deficiencies | steps required to address deficiencies based on results of root cause are determined |

## RANGE OF VARIABLES

***test equipment and materials*** include: UV/IR source, calibration gases, filters, smoke generators, multimeters, dosimeters

***process information*** includes: trends and operator logs

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-11.03.01L | demonstrate knowledge of safety systems and devices, their components and operation | define terminology associated with safety systems |
| | | interpret information pertaining to safety systems found on drawings and specifications |
| | | identify ***types of safety systems*** and describe their components, characteristics and applications |
| | | identify types of ***hazardous materials*** and their impact on area hazard classification |
| | | describe acceptable limits according to codes for ***conditions*** |
| | | describe accuracy limitations of safety systems |
| | | describe interaction between safety systems and processes |
| C-11.03.02L | demonstrate knowledge of regulatory requirements pertaining to safety systems and devices, and their components | interpret codes and regulations pertaining to safety systems and devices, and their components |
| C-11.03.03L | demonstrate knowledge of procedures used to diagnose safety systems and devices and their components | describe procedures used to diagnose safety systems and devices and their components |
| | | identify ***test equipment and materials*** used to diagnose safety systems and describe their applications and procedures for use |
| | | identify hazards and describe safe work practices pertaining to safety systems |
| C-11.03.04L | demonstrate knowledge of procedures used to calibrate safety systems and devices and their components | describe procedures used to calibrate safety systems, devices and their components |
| | | identify ***types of calibration instruments*** |
| | | identify required calibrating parameters of safety systems |

| | |
|---|---|
| | describe traceable process standards used in calibration and tests |
| | describe certification requirements for calibration equipment |

## RANGE OF VARIABLES

***types of safety systems*** include: gas detection, heat detection, fire detection, smoke detection, spill detection, leak detection, emission monitoring equipment, water quality, vibration, overspeed, BMS, radiation

***hazardous materials*** include: gases (chlorine, $H_2S$ and methane, ammonia); liquids (sulfuric acid, sodium hydroxide); solids (radioactive materials)

***conditions*** include: oxygen levels, $H_2S$ levels, radiation levels, water quality

***test equipment and materials*** include: UV/IR source, calibration gases, filters, smoke generators, multimeters, dosimeters

***types of calibration instruments*** include: multimeters, calibrated gases, configuration software

## C-11.04 Repairs safety systems and devices

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| C-11.04.01P | select and use ***tools, equipment and materials*** | ***tools, equipment and materials*** are selected and used according to industry standards and practices |
| C-11.04.02P | select replacement components | replacement components are selected according to manufacturers' specifications |
| C-11.04.03P | replace faulty components | faulty components are replaced according to manufacturers' specifications |
| C-11.04.04P | calibrate and verify operation of safety systems and devices | operation of safety systems and devices are calibrated and verified according to manufacturers' specified parameters by using test equipment and procedures |

## RANGE OF VARIABLES

***tools, equipment and materials*** include: multimeters, calibration gases, smoke generators

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-11.04.01L | demonstrate knowledge of safety systems and devices, their components and operation | define terminology associated with safety systems |
| | | interpret information pertaining to safety systems found on drawings and specifications |
| | | identify ***types of safety systems*** and describe their components, characteristics and applications |
| | | identify types of ***hazardous materials*** and impact on area hazard classification |
| | | describe acceptable limits according to codes for ***conditions*** |
| | | describe accuracy limitations of safety systems |
| | | describe interaction between safety systems and processes |
| C-11.04.02L | demonstrate knowledge of regulatory requirements pertaining to safety systems and devices, and their components | interpret codes and regulations pertaining to safety systems and devices, and their components |
| C-11.04.03L | demonstrate knowledge of procedures used to repair safety systems and devices and their components | describe procedures used to repair safety systems and devices and their components |
| | | identify ***tools, equipment and materials*** used to repair safety systems and describe their applications and procedures for use |
| | | identify hazards and describe safe work practices pertaining to safety systems |
| C-11.04.04L | demonstrate knowledge of procedures used to calibrate safety systems and devices and their components | describe procedures used to calibrate safety systems and their components |
| | | identify ***types of calibration instruments*** |
| | | identify required calibrating parameters of safety systems |
| | | describe traceable process standards used in calibration and tests |
| | | describe certification requirements for calibration equipment |

## RANGE OF VARIABLES

***types of safety systems*** include: gas detection, heat detection, fire detection, smoke detection, spill detection, leak detection, emission monitoring equipment, water quality, vibration, overspeed, BMS, radiation

***hazardous materials*** include: gases (chlorine, $H_2S$ and methane, ammonia); liquids (sulfuric acid, sodium hydroxide); solids (radioactive materials)

***conditions*** include: oxygen levels, $H_2S$ levels, radiation levels, water quality

***tools, equipment and materials*** include: multimeters, calibration gases, smoke generators

***types of calibration instruments*** include: multimeters, configuration software

# TASK C-12 Installs and services facility security systems (NOT COMMON CORE)

## TASK DESCRIPTOR

Instrumentation and control technicians install, maintain, diagnose and repair facility security systems. Security systems are used to monitor and alarm security conditions such as intruder alerts. The proper installation and maintenance of these systems are imperative to the safety of facilities and personnel.

### C-12.01 Installs facility security systems (NOT COMMON CORE)

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no | yes | NV | yes | ND | no | yes | yes | yes | no | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| C-12.01.01P | select type of ***security system*** | type of ***security system*** is selected |
| C-12.01.02P | determine location for ***security system*** | location for ***security system*** is determined according to ***factors*** |
| C-12.01.03P | select and use tools and equipment | tools and equipment are selected and used according to industry standards and practices |
| C-12.01.04P | select mounting hardware for ***security system*** and devices | mounting hardware for ***security system*** and devices is selected |
| C-12.01.05P | mount and connect ***security system components*** | ***security system components*** are mounted and connected according to industry practices, manufacturers' specifications, engineered designs and codes |
| C-12.01.06P | configure and program ***security system*** | ***security system*** is configured and programmed according to manufacturers' specifications and engineered designs |

| | | |
|---|---|---|
| C-12.01.07P | verify operation of ***security system*** within specified parameters | operation of ***security system*** within specified parameters is verified by using test equipment and procedures |
| C-12.01.08P | back up and document system configuration | configuration settings are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***security systems*** include: closed-circuit television (CCTV), radio frequency identification (RFID) scanner, intrusion alarm, video recorder, card readers, process security camera, personnel tracking systems, computing device, firewall, password protection

***factors*** include: environmental conditions, ambient temperature, engineered designs, regulations

***components*** include: cables, cameras, network switches, gateways, media converters, wireless devices

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-12.01.01L | demonstrate knowledge of ***security systems***, their ***components*** and operation | define terminology associated with ***security systems*** and their ***components*** |
| | | interpret information pertaining to ***security systems*** found on drawings and specifications |
| | | identify types of ***security systems*** and their ***components***, and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to ***security systems*** and their ***components*** |
| C-12.01.02L | demonstrate knowledge of regulatory requirements pertaining to ***security systems*** and devices, and their ***components*** | interpret codes and regulations pertaining to ***security systems*** and devices, and their ***components*** |
| C-12.01.03L | demonstrate knowledge of procedures used to install and configure ***security systems*** and devices, and their ***components*** | describe procedures used to install ***security systems*** and devices, and their ***components*** |
| | | describe procedures used to configure ***security systems*** and their ***components*** |
| | | identify tools and equipment used to install ***security systems*** and their ***components***, and describe their applications and procedures for use |
| | | describe ***installation requirements*** |

## RANGE OF VARIABLES

***security systems*** include: CCTV, RFID scanner, intrusion alarm, video recorder, card readers, process security camera, personnel tracking systems, computing device, firewall, password protection
***components*** include: cables, cameras, network switches, gateways, media converters, wireless devices
***installation requirements*** include: ambient temperature, location, environmental conditions

## C-12.02 Maintains facility security systems (NOT COMMON CORE)

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no | yes | NV | yes | ND | no | yes | yes | yes | no | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| C-12.02.01P | select and use tools and equipment | tools and equipment are selected and used according to industry standards and practices |
| C-12.02.02P | inspect ***security system components*** | ***security system components*** are inspected |
| C-12.02.03P | verify ***security system*** operation | ***security system*** operation is verified according to jurisdictional regulations and manufacturers' specifications |
| C-12.02.04P | clean ***security system components*** | ***security system components*** are cleaned |

## RANGE OF VARIABLES

***security systems*** include: CCTV, RFID scanners, intrusion alarm, video recorder, card readers, process security camera, personnel tracking systems, computing device, firewall, password protection
***components*** include: cables, cameras, network switches, gateways, media converters, wireless devices

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-12.02.01L | demonstrate knowledge of ***security systems***, their ***components*** and operation | define terminology associated with ***security systems*** and their ***components*** |
| | | interpret information pertaining to ***security systems*** found on drawings and specifications |
| | | identify types of ***security systems*** and their ***components*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to ***security systems*** and their ***components*** |

| | | |
|---|---|---|
| C-12.02.02L | demonstrate knowledge of regulatory requirements pertaining to ***security systems*** and their ***components*** | interpret codes and regulations pertaining to ***security systems*** and their ***components*** |
| C-12.02.03L | demonstrate knowledge of procedures used to maintain ***security systems*** and their ***components*** | describe procedures used to maintain ***security systems*** and their ***components*** |
| | | identify tools and equipment used to maintain ***security systems*** and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to clean ***security system components*** |

## RANGE OF VARIABLES

***security systems*** include: CCTV, RFID scanners, intrusion alarm, video recorder, card readers, process security camera, personnel tracking systems, computing device, firewall, password protection

***components*** include: cables, cameras, network switches, gateways, media converters, wireless devices

## C-12.03 Diagnoses facility security systems (NOT COMMON CORE)

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no | yes | NV | yes | ND | no | yes | yes | yes | no | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| C-12.03.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| C-12.03.02P | select and use diagnostic software to determine system faults | diagnostic software is selected and used to determine system faults |
| C-12.03.03P | determine probable root cause and location of faults | probable root cause and location of faults are determined |
| C-12.03.04P | determine steps required to address ***deficiencies*** | steps required to address ***deficiencies*** based on results of probable root cause analysis are determined |

## RANGE OF VARIABLES

***tools and equipment*** include: multimeters, hand-held monitors

***deficiencies*** include: faulty power supply, damaged camera lens

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-12.03.01L | demonstrate knowledge of ***security systems***, their ***components*** and operation | define terminology associated with ***security systems*** and their ***components*** |
| | | interpret information pertaining to ***security systems*** found on drawings and specifications |
| | | identify types of ***security systems*** and their ***components***, and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to ***security systems*** and their ***components*** |
| C-12.03.02L | demonstrate knowledge of regulatory requirements pertaining to ***security systems*** and their ***components*** | interpret codes and regulations pertaining to ***security systems*** and their ***components*** |
| C-12.03.03L | demonstrate knowledge of procedures used to diagnose ***security systems*** and their ***components*** | describe procedures used to diagnose ***security systems*** and their ***components*** |
| | | identify ***tools and equipment*** used to diagnose ***security systems*** and their ***components***, and describe their applications and procedures for use |

## RANGE OF VARIABLES

***security systems*** include: CCTV, RFID scanners, intrusion alarm, video recorder, card readers, process security camera, personnel tracking systems, computing device, firewall, password protection

***components*** include: cables, cameras, network switches, gateways, media converters, wireless devices

***tools and equipment*** include: multimeters, hand-held monitors

## C-12.04 Repairs facility security systems (NOT COMMON CORE)

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no | yes | NV | yes | ND | no | yes | yes | yes | no | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| C-12.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| C-12.04.02P | select replacement ***components*** | replacement ***components*** are selected according to manufacturers' specifications |

| | | |
|---|---|---|
| C-12.04.03P | replace faulty ***components*** and devices | faulty ***components*** and devices are replaced according to manufacturers' specifications and procedures |
| C-12.04.04P | verify operation of ***security systems*** and devices are within specified parameters | operation of ***security systems*** and devices are verified to be within specified parameters by using test equipment and manufacturers' procedures |

## RANGE OF VARIABLES

***tools and equipment*** include: multimeters, hand-held monitors

***components*** include: cables, cameras, network switches, gateways, media converters, wireless devices

***security systems*** include: CCTV, RFID scanners, intrusion alarm, video recorder, card readers, process security camera, personnel tracking systems, computing device, firewall, password protection

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-12.04.01L | demonstrate knowledge of ***security systems***, their ***components*** and operation | define terminology associated with ***security systems*** |
| | | interpret codes and regulations pertaining to ***security systems*** |
| | | interpret information pertaining to ***security systems*** found on drawings and specifications |
| | | identify types of ***security systems*** and their ***components***, and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to ***security systems*** and their ***components*** |
| C-12.04.02L | demonstrate knowledge of regulatory requirements pertaining to ***security systems*** and their ***components*** | interpret codes and regulations pertaining to ***security systems*** and their ***components*** |
| C-12.04.03L | demonstrate knowledge of procedures used to repair ***security systems*** and their ***components*** | describe procedures used to repair ***security systems*** and their ***components*** |
| | | identify ***tools and equipment*** used to repair ***security systems*** and their ***components***, and describe their applications and procedures for use |
| | | identify types of test equipment used to verify operation of ***security systems*** and their ***components*** |

## RANGE OF VARIABLES

***security systems*** include: CCTV, RFID scanners, intrusion alarm, video recorder, card readers, process security camera, personnel tracking systems, computing device, firewall, password protection

***components*** include: cables, cameras, network switches, gateways, media converters, wireless devices

***tools and equipment*** include: multimeters, hand-held monitors

# TASK C-13 Installs and services safety instrumented systems (SIS)

## TASK DESCRIPTOR

Instrumentation and control technicians install, configure, maintain, diagnose and repair SIS. SIS are used to reduce the risk and eliminate the likelihood of a previously identified safety, health and environmental event ranging from minor equipment damage to the uncontrollable release of energy or material. The ultimate goal is to bring the process to a safe state in a timely manner.

The proper installation and maintenance of these systems are imperative to the safety of facilities, personnel and environment.

## C-13.01 Installs SIS

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| C-13.01.01P | identify ***hazardous condition*** of process | ***hazardous condition*** of process is identified |
| C-13.01.02P | label ***SIS components*** | ***SIS components*** are labelled due to importance of dedicated purpose |
| C-13.01.03P | verify accuracy and operation of ***SIS components*** | accuracy and operation of ***SIS components*** are verified according to specifications |
| C-13.01.04P | select mounting hardware for system and ***SIS components*** | mounting hardware for system and ***SIS components*** are selected according to manufacturers' specifications and engineered designs |
| C-13.01.05P | verify and determine location of ***SIS components*** | location of ***SIS components*** is verified and determined to ensure process can be brought to a safe state |
| C-13.01.06P | position and mount ***SIS components*** independently from process control components | ***SIS components*** are positioned and mounted independently from process control components according to industry practices, engineered designs, manufacturers' specifications and codes |

| | | |
|---|---|---|
| C-13.01.07P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| C-13.01.08P | verify operation of ***SIS*** and ***components*** are within specified parameters | operation of ***SIS*** and ***components*** are within specified parameters by using test equipment, documentation and established procedures |
| C-13.01.09P | back up and document configuration settings for future data recovery | configuration settings are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***hazardous conditions*** include: high pressure, low pressure, high level, low level, high temperature, low temperature, flow, fire, gas emissions

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices

***components*** include: valves, transmitters, controllers, switches

***tools and equipment*** include: stop watches, high accuracy process calibrators, special measurement devices

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-13.01.01L | demonstrate knowledge of ***SIS***, their ***components***, characteristics and applications | define terminology associated with ***SIS*** and their ***components*** |
| | | interpret information pertaining to ***SIS*** found on drawings and specifications |
| | | identify types of ***SIS*** and their ***components***, and describe their characteristics and applications |
| | | describe ***purpose and operation of SIS and their components*** |
| | | identify hazards and describe safe work practices pertaining to ***SIS*** and their ***components*** |
| C-13.01.02L | demonstrate knowledge of regulatory requirements pertaining to ***SIS*** and their ***components*** | interpret codes and regulations pertaining to ***SIS*** and their ***components*** |
| C-13.01.03L | demonstrate knowledge of procedures used to install ***SIS*** and their ***components*** | describe procedures used to select and install ***SIS*** and their ***components*** |
| | | identify ***tools and equipment*** used to install ***SIS*** and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to back up and document ***SIS*** configuration settings |
| | | describe ***installation requirements*** |

## RANGE OF VARIABLES

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices

***components*** include: valves, transmitters, controllers, switches

***purpose and operation of SIS and their components*** include: layers of protection analysis (LOPA), safety integrity level (SIL), safety instrumented functions (SIF)

***tools and equipment*** include: stop watches, high accuracy process calibrators, special measurement devices

***installation requirements*** include: ambient temperature, location, environmental conditions

## C-13.02 Configures SIS

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| C-13.02.01P | select and use tools, equipment and software | tools, equipment and software are selected and used according to manufacturers' recommendations |
| C-13.02.02P | update firmware | firmware is updated |
| C-13.02.03P | upload and download ***SIS*** controller programs | ***SIS*** controller programs are uploaded and downloaded |
| C-13.02.04P | program and verify ***SIS*** controllers and input/output (I/O) devices | ***SIS*** controllers and I/O devices are programmed and verified to achieve safe state according to ***factors*** |
| C-13.02.05P | configure external communication with other systems and devices | external communication with other systems and devices are configured |
| C-13.02.06P | back up and document programming, configuration and parameters | configuration and parameters are backed up and documented for future data recovery according to site specifications and standards |

## RANGE OF VARIABLES

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices

***factors*** include: predetermined hazardous conditions, codes, manufacturers' specifications, company and industry standards

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| C-13.02.01L | demonstrate knowledge of ***SIS***, their ***components***, characteristics and applications | define terminology associated with ***SIS*** and their ***components*** |
| | | interpret information pertaining to ***SIS*** found on drawings and specifications |

| | | |
|---|---|---|
| | | identify types of ***SIS*** and their ***components***, and describe their characteristics and applications |
| | | describe ***purpose and operation of SIS and their components*** |
| | | describe difference in commissioning and testing ***SIS*** versus other basic process control systems |
| | | identify hazards and describe safe work practices pertaining to ***SIS*** and their ***components*** |
| C-13.02.02L | demonstrate knowledge of regulatory requirements pertaining to ***SIS*** and their ***components*** | interpret codes and regulations pertaining to ***SIS*** and their ***components*** |
| C-13.02.03L | demonstrate knowledge of procedures used to configure ***SIS*** and their ***components*** | describe procedures used to configure ***SIS*** and their ***components*** |
| | | identify tools, equipment and software relating to ***SIS***, and describe their applications and procedures for use |
| | | identify types of ***programming languages*** used to configure ***SIS*** |
| | | describe ***voting structures*** |
| | | describe procedures used to back up and document ***SIS*** programming, configuration and parameters |

## RANGE OF VARIABLES

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices

***components*** include: valves, transmitters, controllers, switches

***purpose and operation of SIS and their components*** include: LOPA, SIL, SIF

***programming languages*** include: function block diagram (FBD), sequential function chart (SFC), ladder logic, Boolean, structured text (ST)

***voting structures*** include: 1 out of 1, 1 out of 1D, 1 out of 2, 1 out of 2D, 2 out of 2, 2 out of 3

## C-13.03 Maintains SIS

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| C-13.03.01P | select and use tools and equipment | tools and equipment are selected and used according to industry standards and practices |
| C-13.03.02P | visually inspect system ***components*** for faults | system ***components*** are visually inspected for faults |
| C-13.03.03P | perform self-diagnostics, observe alarm indicators and interpret results | self-diagnostics are performed, alarm indicators are observed, and results are interpreted |
| C-13.03.04P | perform function checks of ***components*** for ***factors*** | function checks of ***components*** are performed for ***factors*** |
| C-13.03.05P | perform routine function testing of ***SIS*** | routine function testing of ***SIS*** is performed |
| C-13.03.06P | back up and document programming, configuration and parameters for future data recovery | configuration and parameters are backed up and documented for future data recovery according to site specifications and standards |

### RANGE OF VARIABLES

***components*** include: valves, transmitters, controllers, switches
***factors*** include: response times, operation of power supplies, set points
***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| C-13.03.01L | demonstrate knowledge of ***SIS***, their ***components***, characteristics and applications | define terminology associated with ***SIS*** and their ***components*** |
| | | interpret information pertaining to ***SIS*** found on drawings and specifications |
| | | identify types of ***SIS*** and their ***components***, and describe their characteristics and applications |
| | | describe ***purpose and operation of SIS and their components*** |
| | | identify hazards and describe safe work practices pertaining to ***SIS*** |

| | | |
|---|---|---|
| C-13.03.02L | demonstrate knowledge of regulatory requirements pertaining to ***SIS*** and their ***components*** | interpret codes and regulations pertaining to ***SIS*** and their ***components*** |
| C-13.03.03L | demonstrate knowledge of procedures used to maintain ***SIS*** and their ***components*** | describe procedures used to maintain ***SIS*** and their ***components*** |
| | | describe ***maintenance requirements*** |
| | | identify tools and equipment used to maintain ***SIS*** and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to configure ***SIS*** and their ***components*** |
| | | identify types of ***programming languages*** used to configure ***SIS*** |
| | | describe SIL levels |
| | | describe ***voting structures*** |
| | | describe procedures used to back up and document ***SIS*** programming, configuration and parameters |
| | | describe importance of documentation when making changes and performing routine maintenance and testing |

## RANGE OF VARIABLES

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices
***components*** include: valves, transmitters, controllers, switches
***purpose and operation of SIS and their components*** include: LOPA, SIL, SIF
***maintenance requirements*** include: partial close times, valve close times, partial stroke testing
***programming languages*** include: FBD, SFC, ladder logic, Boolean, ST
***voting structures*** include: 1 out of 1, 1 out of 1D, 1 out of 2, 1 out of 2D, 2 out of 2, 2 out of 3

## C-13.04 Diagnoses SIS

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| C-13.04.01P | select and use diagnostic tools and equipment, documentation and procedures | diagnostic tools and equipment, documentation and procedures are selected and used |
| C-13.04.02P | verify operation and configuration of ***SIS*** are within specified parameters | operation and configuration of ***SIS*** are verified to be within specified parameters by using test equipment and procedures |
| C-13.04.03P | check ***SIS*** operations | ***SIS*** operations are checked to identify network and communication problems |
| C-13.04.04P | perform function checks of ***components*** for ***factors*** | function checks of ***components*** are performed for ***factors*** |
| C-13.04.05P | perform self-diagnostics, observe alarm indicators and interpret results | self-diagnostics are performed, alarm indicators are observed, and results are interpreted |
| C-13.04.06P | analyze ***process information*** | ***process information*** is analyzed |
| C-13.04.07P | identify probable root cause and location of faults | probable root cause and location of faults are identified |
| C-13.04.08P | determine steps required to address deficiencies | steps required to address deficiencies based on results of root cause are determined |

### RANGE OF VARIABLES

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices
***components*** include: valves, transmitters, controllers, switches
***factors*** include: response times, operation of power supplies, set points
***process information*** includes: trends, operator logs

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| C-13.04.01L | demonstrate knowledge of ***SIS***, their ***components***, characteristics and applications | define terminology associated with ***SIS*** and their ***components*** |
| | | interpret information pertaining to ***SIS*** found on drawings and specifications |
| | | identify types of ***SIS*** and their ***components***, and describe their characteristics and applications |

| | | |
|---|---|---|
| | | describe ***purpose and operation of SIS and their components*** |
| | | identify hazards and describe safe work practices pertaining to ***SIS*** |
| C-13.04.02L | demonstrate knowledge of regulatory requirements pertaining to ***SIS*** and their ***components*** | interpret codes and regulations pertaining to ***SIS*** and their ***components*** |
| C-13.04.03L | demonstrate knowledge of procedures used to diagnose ***SIS*** and their ***components*** | describe procedures used to diagnose ***SIS*** and their ***components*** |
| | | identify diagnostic tools and equipment used to diagnose ***SIS*** and describe their applications and procedures for use |
| | | describe SIL levels |
| | | describe ***voting structures*** |

## RANGE OF VARIABLES

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices
***components*** include: valves, transmitters, controllers, switches
***purpose and operation of SIS and their components*** include: LOPA, SIL, SIF
***voting structures*** include: 1 out of 1, 1 out of 1D, 1 out of 2, 1 out of 2D, 2 out of 2, 2 out of 3

## C-13.05 Repairs SIS

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| C-13.05.01P | select and use repair tools, equipment and software | repair tools, equipment and software are selected and used according to industry standards and practices |
| C-13.05.02P | replace defective ***SIS components*** | defective ***SIS components*** are replaced according to job procedures, documentation and manufacturers' recommendations |
| C-13.05.03P | restore program and configuration from backup | program and configuration are restored from backup |
| C-13.05.04P | select ***SIS*** replacement parts | ***SIS*** replacement parts are selected according to existing ***component*** specifications and SIF documentation |
| C-13.05.05P | perform function checks of repaired/replaced ***components*** for ***factors*** | function checks of repaired/replaced ***components*** are performed for ***factors*** |

| | | |
|---|---|---|
| C-13.05.06P | back up and document programming, configuration and parameters for future data recovery | configuration and parameters are backed up and documented for future data recovery according to site specifications and standards |
| C-13.05.07P | identify impact to processes for ***component*** to be repaired when working on ***SIS*** | impact to processes for ***component*** to be repaired is identified when working on ***SIS*** |

## RANGE OF VARIABLES

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices
***components*** include: valves, transmitters, controllers, switches
***factors*** include: response times, operation of power supplies, set points

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| C-13.05.01L | demonstrate knowledge of ***SIS***, their ***components***, characteristics and applications | define terminology associated with ***SIS*** and their ***components*** |
| | | interpret codes and regulations pertaining to ***SIS*** and their ***components*** |
| | | interpret information pertaining to ***SIS*** found on drawings and specifications |
| | | identify types of ***SIS*** and their ***components***, and describe their characteristics and applications |
| | | describe ***purpose and operation of SIS and their components*** |
| | | identify hazards and describe safe work practices pertaining to ***SIS*** |
| C-13.05.02L | demonstrate knowledge of regulatory requirements pertaining to ***SIS*** and their ***components*** | interpret codes and regulations pertaining to ***SIS*** and their ***components*** |
| C-13.05.03L | demonstrate knowledge of procedures used to repair ***SIS*** and their ***components*** | describe procedures used to repair ***SIS*** and their ***components*** |
| | | identify tools, equipment and software used to repair ***SIS*** and describe their applications and procedures for use |
| | | describe procedures used to configure ***SIS*** and their ***components*** |
| | | identify types of ***programming languages*** used to configure ***SIS*** |
| | | describe SIL levels |
| | | describe ***voting structures*** |

| | |
|---|---|
| | describe procedures used to back up and document ***SIS*** programming, configuration and parameters |
| | describe importance of documentation when performing repairs |

## RANGE OF VARIABLES

***SIS*** include: alarming, emergency stop monitoring, safety sensors and devices
***components*** include: valves, transmitters, controllers, switches
***purpose and operation of SIS and their components*** include: LOPA, SIL, SIF
***programming languages*** include: FBD, SFC, ladder logic, Boolean, ST
***voting structures*** include: 1 out of 1, 1 out of 1D, 1 out of 2, 1 out of 2D, 2 out of 2, 2 out of 3

# MAJOR WORK ACTIVITY D

## Installs and services hydraulic, pneumatic and electrical systems

### TASK D-14 Installs and services control devices for hydraulic systems

#### TASK DESCRIPTOR

Instrumentation and control technicians install, diagnose, maintain and repair control devices for hydraulic systems. Hydraulic equipment is used to supply energy and to control equipment and processes through the use of liquids. Hydraulic equipment is used for higher pressure applications.

#### D-14.01 Installs control devices for hydraulic systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| D-14.01.01P | select and use tools and ***components*** | tools and ***components*** are selected and used according to manufacturers' specifications, process requirements and data sheets |
| D-14.01.02P | determine location of ***components*** | location of ***components*** is determined according to industry standards, codes and practices, and manufacturers' specifications |
| D-14.01.03P | mount ***components*** | ***components*** are mounted according to industry practices, manufacturers' specifications, engineered designs and codes |
| D-14.01.04P | verify operation of hydraulic equipment and ***components*** | operation of hydraulic equipment and ***components*** are verified according to industry standards, codes and practices, and manufacturers' specifications |
| D-14.01.05P | update ***documentation*** | ***documentation*** is updated to reflect changes carried out as required |

## RANGE OF VARIABLES

***components*** include: hoses, piping, fittings, pumps, motors, actuators, valves, accumulators, control devices (solenoids, switches, gauges, actuators, transmitters, regulators)

***documentation*** includes: schematics, drawings, specifications, data sheets

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| D-14.01.01L | demonstrate knowledge of hydraulic systems, their ***components*** and operation | define terminology associated with hydraulic systems and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to hydraulic systems and their ***components*** |
| | | identify hydraulic system ***components*** and describe their applications and operation |
| | | describe hydraulic theories and equipment operation |
| | | identify ***types of tubing and piping systems*** and describe their applications |
| | | identify ***types of tube and pipe fittings*** and accessories and describe their characteristics and applications |
| | | identify ***types of valves used in tubing and piping systems*** and describe their applications and operation |
| D-14.01.02L | demonstrate knowledge of regulatory requirements pertaining to hydraulic systems and their ***components*** | interpret codes and regulations pertaining to hydraulic systems and their ***components*** |
| D-14.01.03L | demonstrate knowledge of ***documentation*** relating to hydraulic equipment and systems, their use and interpretation | interpret information pertaining to hydraulic systems found on ***documentation*** |
| | | identify fluid related symbols and abbreviations found on ***documentation*** |
| D-14.01.04L | demonstrate knowledge of hydraulic related calculations | perform hydraulic calculations |
| D-14.01.05L | demonstrate knowledge of principles and applications of fluids as it relates to hydraulic systems | define terminology associated with fluids |
| | | identify ***types of fluids*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to fluids |
| | | explain ***principles and theories of fluids*** |
| | | describe units of measure as they relate to fluids |

| | | |
|---|---|---|
| | | identify fluid-related formulas and describe their applications |
| D-14.01.06L | demonstrate knowledge of procedures used to install hydraulic ***components*** | identify tools and equipment used to install hydraulic ***components*** and describe their applications and procedures for use |
| | | describe procedures used to install hydraulic ***components*** |
| | | describe procedures used to cut, thread and ream rigid pipe |
| | | describe procedures used to make hose, tubing and piping connections |
| | | describe procedures used to perform a pressure test |
| | | describe tube bending techniques |

## RANGE OF VARIABLES

***components*** include: hoses, piping, fittings, pumps, motors, actuators, valves, accumulators, control devices (solenoids, switches, gauges, actuators, transmitters, regulators)

***hazards*** include: energy state awareness (accumulators, suspended loads), condition of hoses, piping and tubing (pressure, temperature)

***types of tubing and piping systems*** include: rigid, flexible, ferrous, non-ferrous

***types of tube and pipe fittings*** include: adapters, unions, elbows, tees, couplings

***types of valves used in tubing and piping systems*** include: isolation, throttling, regulating, directional control

***documentation*** includes: schematics, drawings, specifications, data sheets

***types of fluids*** include: synthetic, conventional

***principles and theories of fluids*** include: Pascal's law, Bernoulli's principle

## D-14.02 Diagnoses control devices for hydraulic systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| D-14.02.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to manufacturers' specifications, process requirements and data sheets |
| D-14.02.02P | identify probable root cause and location of faults | probable root cause and location of faults are identified using diagnostic tools and testing procedures |

| | | |
|---|---|---|
| D-14.02.03P | determine steps required to repair faults and address deficiencies | steps required to repair faults and address deficiencies are determined based on probable root cause |
| D-14.02.04P | verify documentation and historical data | documentation and historical data are verified to assist in root cause analysis |

## RANGE OF VARIABLES

***tools and equipment*** include: temperature sensors, pressure gauges, multimeters, flowmeters

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| D-14.02.01L | demonstrate knowledge of hydraulic systems, their ***components*** and operation | define terminology associated with hydraulic systems and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to hydraulic systems and their ***components*** |
| | | identify hydraulic system ***components*** and describe their applications and operation |
| | | describe hydraulic theories and equipment operation |
| | | identify ***types of tubing and piping systems*** and describe their applications |
| | | identify ***types of tube and pipe fittings*** and accessories and describe their characteristics and applications |
| | | identify ***types of valves used in tubing and piping systems*** and describe their applications and operation |
| D-14.02.02L | demonstrate knowledge of regulatory requirements pertaining to hydraulic systems and their ***components*** | interpret codes and regulations pertaining to hydraulic systems and their ***components*** |
| D-14.02.03L | demonstrate knowledge of ***documentation*** relating to hydraulic equipment and systems, their use and interpretation | interpret information pertaining to hydraulic systems found on ***documentation*** |
| | | identify fluid related symbols and abbreviations found on ***documentation*** |
| D-14.02.04L | demonstrate knowledge of hydraulic related calculations | perform hydraulic calculations |
| D-14.02.05L | demonstrate knowledge of principles and applications of fluids as it relates to hydraulic systems | define terminology associated with fluids |
| | | identify ***types of fluids*** and describe their characteristics and applications |

| | | |
|---|---|---|
| | | identify hazards and describe safe work practices pertaining to fluids |
| | | explain ***principles and theories of fluids*** |
| | | describe units of measure as they relate to fluids |
| | | identify fluid-related formulas and describe their applications |
| D-14.02.06L | demonstrate knowledge of procedures used to diagnose ***components*** for hydraulic systems | identify types of ***tools and equipment*** used to diagnose ***components*** for hydraulic systems and describe their applications and procedures for use |
| | | describe procedures used to diagnose ***components*** for hydraulic systems |

## RANGE OF VARIABLES

***components*** include: hoses, piping, fittings, pumps, motors, actuators, valves, accumulators, control devices (solenoids, switches, gauges, actuators, transmitters, regulators)

***hazards*** include: energy state awareness (accumulators, suspended loads), condition of hoses, piping and tubing (pressure, temperature)

***types of tubing and piping systems*** include: rigid, flexible, ferrous, non-ferrous,

***types of tube and pipe fittings*** include: adapters, unions, elbows, tees, couplings

***types of valves used in tubing and piping systems*** include: isolation, throttling, regulating, directional control

***documentation*** includes: schematics, drawings, specifications, data sheets

***types of fluids*** include: synthetic, conventional

***principles and theories of fluids*** include: Pascal's law, Bernoulli's principle

***tools and equipment*** include: temperature sensors, pressure gauges, multimeters, flowmeters

## D-14.03 Performs maintenance and repairs on control devices for hydraulic systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| D-14.03.01P | select and use tools and ***test equipment*** | tools and ***test equipment*** are selected and used to maintain and repair according to manufacturers' specifications, process requirements and data sheets |
| D-14.03.02P | replace ***components*** and ***materials*** | ***components*** and ***materials*** are replaced according to manufacturers' specifications, process requirements and data sheets |

| | | |
|---|---|---|
| D-14.03.03P | repair faulty ***components*** | faulty ***components*** are repaired according to manufacturers' specifications, process requirements and data sheets |
| D-14.03.04P | calibrate and adjust ***components*** (control devices) | ***components*** (control devices) are calibrated and adjusted according to manufacturers' specifications and maintenance schedules |
| D-14.03.05P | test and verify ***components*** | ***components*** are tested and verified according to manufacturers' specifications, process requirements and data sheets |
| D-14.03.06P | verify system operation | system operation is verified before returning to service |
| D-14.03.07P | update ***documentation*** | ***documentation*** is updated to reflect changes carried out as required |

## RANGE OF VARIABLES

***test equipment*** includes: infrared thermometers, pressure gauges, multimeters, flowmeters

***components*** include: hoses, piping, fittings, pumps, motors, actuators, valves, accumulators, control devices (solenoids, switches, gauges, actuators, transmitters, regulators)

***materials*** include: filters, fluids

***documentation*** includes: schematics, drawings, specifications, data sheets

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| D-14.03.01L | demonstrate knowledge of hydraulic systems, their ***components*** and operation | define terminology associated with hydraulic systems and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to hydraulic systems and their ***components*** |
| | | identify hydraulic system ***components*** and describe their applications and operation |
| | | describe hydraulic theories and equipment operation |
| | | identify ***types of tubing and piping systems*** and describe their applications |
| | | identify ***types of tube and pipe fittings*** and accessories and describe their characteristics and applications |
| | | identify ***types of valves used in tubing and piping systems*** and describe their applications and operation |

| | | |
|---|---|---|
| D-14.03.02L | demonstrate knowledge of regulatory requirements pertaining to hydraulic systems and their ***components*** | interpret codes and regulations pertaining to hydraulic systems and their ***components*** |
| D-14.03.03L | demonstrate knowledge of ***documentation*** relating to hydraulic equipment and systems, their use and interpretation | interpret information pertaining to hydraulic systems found on ***documentation*** |
| | | identify fluid-related symbols and abbreviations found on ***documentation*** |
| D-14.03.04L | demonstrate knowledge of hydraulic related calculations | perform hydraulic calculations |
| D-14.03.05L | demonstrate knowledge of principles and applications of fluids as it relates to hydraulic systems | define terminology associated with fluids |
| | | identify ***types of fluids*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to fluids |
| | | explain ***principles and theories of fluids*** |
| | | describe units of measure as they relate to fluids |
| | | identify fluid-related formulas and describe their applications |
| D-14.03.06L | demonstrate knowledge of procedures used to repair and ***maintain hydraulic systems and components*** | identify tools and ***test equipment*** relating to maintenance and repair of hydraulic systems and describe their applications and procedures for use |
| | | describe procedures used to ***maintain hydraulic systems and components*** |
| | | describe procedures used to repair hydraulic systems and their ***components*** |
| | | describe cleanliness and filtering standards required for hydraulic systems |

## RANGE OF VARIABLES

***components*** include: hoses, piping, fittings, pumps, motors, actuators, valves, accumulators, control devices (solenoids, switches, gauges, actuators, transmitters, regulators)

***hazards*** include: energy state awareness (accumulators, suspended loads), condition of hoses, piping and tubing (pressure, temperature)

***types of tubing and piping systems*** include: rigid, flexible, ferrous, non-ferrous

***types of tube and pipe fittings*** include: adapters, unions, elbows, tees, couplings

***types of valves used in tubing and piping systems*** include: isolation, throttling, regulating, directional control

***documentation*** includes: schematics, drawings, specifications, data sheets

***types of fluids*** include: synthetic, conventional

***principles and theories of fluids*** include: Pascal's law, Bernoulli's principle

***maintain hydraulic systems and components*** include: check hoses, piping and tubing; check fluids (condition and level); check/change filters; determine operating parameters; adjust system pressure, temperature and flow

***test equipment*** includes: infrared thermometers, pressure gauges, multimeters, flowmeters

# TASK D-15 Installs and services pneumatic equipment

## TASK DESCRIPTOR

Instrumentation and control technicians install, maintain, diagnose and repair pneumatic equipment. Pneumatic equipment is used to supply energy and to control equipment and processes through the use of compressed air, nitrogen and process gases.

### D-15.01 Installs pneumatic equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| D-15.01.01P | determine ***system requirements*** | ***system requirements*** are determined according to site specifications, industry standards, codes and practices |
| D-15.01.02P | select system ***components*** and tools | system ***components*** and tools are selected according to site specifications, industry standards, codes and practices |
| D-15.01.03P | determine location of ***pneumatic equipment*** | location of ***pneumatic equipment*** is determined according to site specifications, industry standards, codes and practices |

| | | |
|---|---|---|
| D-15.01.04P | connect system ***components*** | system ***components*** are connected according to site specifications, industry practices, manufacturers' specifications, engineered designs and codes |
| D-15.01.05P | calibrate pneumatic ***control devices*** | pneumatic ***control devices*** are calibrated according to industry standards and practices |
| D-15.01.06P | verify operation of ***pneumatic equipment*** | operation of ***pneumatic equipment*** is verified according to site specifications and standards |
| D-15.01.07P | update ***documentation*** | ***documentation*** is updated to reflect changes carried out as required |

## RANGE OF VARIABLES

***system requirements*** include: pressure, volume, capacity

***components*** include: regulators, separators, tubing, actuators, solenoids, pumps, positioners, accumulators, compressors, tanks, coolers, filters, dryers, automated oilers

***pneumatic equipment*** includes: transmitters, converters, positioners, controllers, relays

***control devices*** include: pressure switches, regulators, gauges, transmitters

***documentation*** includes: schematics, manufacturers' manuals, drawings, specifications, data sheets

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| D-15.01.01L | demonstrate knowledge of ***pneumatic equipment, systems***, their ***components*** and operation | define terminology associated with ***pneumatic equipment, systems*** and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to ***pneumatic equipment, systems*** and their ***components*** |
| | | identify types of ***pneumatic equipment***, ***systems*** and their ***components*** and describe their applications and operation |
| | | describe ***methods of air treatment*** in pneumatic systems |
| | | identify ***classifications and types of compressors***, their specifications and applications |
| | | identify ***types of tubing and piping systems*** and describe their applications |
| | | identify ***types of tube and pipe fittings*** and accessories, and describe their characteristics and applications |
| | | identify ***types of valves used in tubing and piping systems***, and describe their applications and operation |

| | | |
|---|---|---|
| D-15.01.02L | demonstrate knowledge of regulatory requirements pertaining to ***pneumatic equipment, systems*** and their ***components*** | interpret codes and regulations pertaining to ***pneumatic equipment, systems*** and their ***components*** |
| D-15.01.03L | demonstrate knowledge of documentation relating to ***pneumatic equipment*** and ***systems***, their use and interpretation | interpret information pertaining to ***pneumatic equipment*** and ***systems*** found on ***documentation*** |
| | | interpret ***documentation*** to determine operation of ***pneumatic systems*** |
| D-15.01.04L | demonstrate knowledge of ***pneumatic-related calculations*** | perform ***pneumatic-related calculations*** |
| D-15.01.05L | demonstrate knowledge of principles and applications of fluids as it relates to pneumatic systems | define terminology associated with fluids |
| | | identify ***types of fluids*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to fluids |
| | | explain ***principles and theories of fluids*** |
| | | describe units of measure as they relate to fluids |
| | | identify fluid-related formulas and describe their applications |
| | | describe ***compressed gas qualities*** |
| | | describe venting practices relating to combustible and inert gases |
| D-15.01.06L | demonstrate knowledge of procedures used to install ***pneumatic equipment, systems***, and their ***components*** | identify tools and equipment used to install ***pneumatic equipment, systems*** and their ***components*** and describe their applications and procedures for use |
| | | describe procedures used to install ***pneumatic equipment, systems*** and their ***components*** |
| | | describe installation of tubing |
| | | describe tube bending techniques |
| | | describe procedures used to cut, thread and ream rigid pipe |
| | | describe procedures used to make hose, tubing and piping connections |
| | | describe procedures used to perform a pressure test |

| | | |
|---|---|---|
| D-15.01.07L | demonstrate knowledge of procedures used to calibrate ***control devices*** for ***pneumatic systems*** | identify tools, equipment and software used to calibrate ***control devices*** for ***pneumatic systems***, and describe their applications and procedures for use |
| | | describe procedures used to calibrate ***control devices*** for ***pneumatic systems*** |

## RANGE OF VARIABLES

***pneumatic equipment*** includes: transmitters, converters, positioners, controllers, relays

***pneumatic systems*** include: instrument air, instrument gas, service/utility air

***components*** include: regulators, separators, tubing, actuators, solenoids, pumps, positioners, accumulators, compressors, tanks, coolers, filters, dryers, automated oilers

***hazards*** include: energy state awareness (accumulators, suspended loads), temperature, pressure, flammability/venting

***methods of air treatment*** include: filters, dryers, after-coolers, de-icers, receivers

***classifications and types of compressors*** include: dynamic/centrifugal, positive displacement

***types of tubing and piping systems*** include: rigid, flexible, ferrous, non-ferrous

***types of tube and pipe fittings*** include: adapters, unions, elbows, tees, couplings

***types of valves used in tubing and piping systems*** include: isolation, throttling, regulating, directional control

***documentation*** includes: schematics, manufacturers' manuals, drawings, specifications, data sheets

***pneumatic-related calculations*** include: unit conversion, volume (ideal gas law)

***types of fluids*** include: compressed air, nitrogen, process gases

***principles and theories of fluids*** include: Pascal's law, Boyle's law, Charles' law, combined gas law, Bernoulli's principle

***compressed gas qualities*** include: dew point, presence of particulates, oil contamination

***control devices*** include: pressure switches, regulators, gauges, transmitters

## D-15.02 Diagnoses pneumatic equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| D-15.02.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to manufacturers' specifications, process requirements and data sheets |
| D-15.02.02P | identify probable root cause and location of faults | probable root cause and location of faults are identified using diagnostic tools and testing procedures |

| | | |
|---|---|---|
| D-15.02.03P | determine steps required to repair faults and address deficiencies | steps required to repair faults and address deficiencies are determined based on probable root cause |
| D-15.02.04P | verify documentation and historical data | documentation and historical data are verified to assist in determining probable root cause |

## RANGE OF VARIABLES

***tools and equipment*** include: temperature sensors, pressure gauges, multimeters, leak detection solution

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| D-15.02.01L | demonstrate knowledge of ***pneumatic equipment, systems***, their ***components*** and operation | define terminology associated with ***pneumatic equipment, systems***, and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to ***pneumatic equipment, systems*** and their ***components*** |
| | | identify types of ***pneumatic equipment***, ***systems*** and their ***components*** and describe their applications and operation |
| | | describe ***methods of air treatment*** in pneumatic systems |
| | | identify ***classifications and types of compressors***, their specifications and applications |
| | | identify ***types of tubing and piping systems*** and describe their applications |
| | | identify ***types of tube and pipe fittings*** and accessories and describe their characteristics and applications |
| | | identify ***types of valves used in tubing and piping systems*** and describe their applications and operation |
| | | describe venting practices relating to combustible and inert gases |
| D-15.02.02L | demonstrate knowledge of regulatory requirements pertaining to ***pneumatic equipment, systems*** and their ***components*** | interpret codes and regulations pertaining to ***pneumatic equipment, systems*** and their ***components*** |
| D-15.02.03L | demonstrate knowledge of documentation relating to ***pneumatic equipment*** and ***systems***, their use and interpretation | interpret information pertaining to ***pneumatic equipment*** and ***systems*** found on ***documentation*** |
| | | interpret ***documentation*** to determine operation of ***pneumatic systems*** |

| | | |
|---|---|---|
| D-15.02.04L | demonstrate knowledge of ***pneumatic-related calculations*** | perform ***pneumatic-related calculations*** |
| D-15.02.05L | demonstrate knowledge of procedures used to diagnose ***pneumatic equipment*** | identify types of ***tools and equipment*** used for diagnosing ***pneumatic equipment*** and describe their applications and procedures for use |
| | | describe procedures used to diagnose ***pneumatic equipment*** |

## RANGE OF VARIABLES

***pneumatic equipment*** includes: transmitters, converters, positioners, controllers, relays

***pneumatic systems*** include: instrument air, instrument gas, service/utility air

***components*** include: separators, tubing, actuators, pumps, positioners, accumulators, compressors, tanks, coolers, filters, dryers, automated oilers, gauges, control devices (safety valves, switches, solenoids, regulators)

***hazards*** include: energy state awareness (accumulators, suspended loads), temperature, pressure, flammability/venting

***methods of air treatment*** include: filters, dryers, after-coolers, de-icers, receivers

***classifications and types of compressors*** include: dynamic/centrifugal, positive displacement

***types of tubing and piping systems*** include: rigid, flexible, ferrous, non-ferrous

***types of tube and pipe fittings*** include: adapters, unions, elbows, tees, couplings

***types of valves used in tubing and piping systems*** include: isolation, throttling, regulating, directional control

***documentation*** includes: schematics, manufacturers' manuals, drawings, specifications, data sheets

***pneumatic-related calculations*** include: unit conversion, volume (ideal gas law)

***tools and equipment*** include: temperature sensors, pressure gauges, multimeters, leak detection solution

## D-15.03 Performs maintenance and repairs on pneumatic equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| D-15.03.01P | select and use tools and ***test equipment*** | tools and ***test equipment*** are selected and used to maintain and repair according to manufacturers' specifications, process requirements and data sheets |
| D-15.03.02P | replace ***components*** and ***materials*** | ***components*** and ***materials*** are replaced according to manufacturers' specifications, process requirements and data sheets |

| | | |
|---|---|---|
| D-15.03.03P | repair faulty ***components*** | faulty ***components*** are repaired according to manufacturers' specifications, process requirements and data sheets |
| D-15.03.04P | calibrate and adjust ***components*** (control devices) | ***components*** (control devices) are calibrated and adjusted according to manufacturers' specifications and maintenance schedules |
| D-15.03.05P | test and verify ***components*** (control devices) | ***components*** (control devices) are tested and verified according to manufacturers' specifications, process requirements and data sheets |
| D-15.03.06P | verify system operation | system operation is verified before returning to service |
| D-15.03.07P | update ***documentation*** | ***documentation*** is updated to reflect changes carried out as required |

## RANGE OF VARIABLES

***test equipment*** includes: infrared thermometers, pressure gauges, dew point testers, ultrasonic leak detectors

***components*** include: separators, tubing, actuators, pumps, positioners, accumulators, compressors, tanks, coolers, filters, dryers, automated oilers, gauges, control devices (safety valves, switches, solenoids, regulators)

***materials*** include: filters, desiccant, deliquescent

***documentation*** includes: schematics, manufacturers' manuals, drawings, specifications, data sheets

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| D-15.03.01L | demonstrate knowledge of ***pneumatic equipment, systems***, their ***components*** and operation | define terminology associated with ***pneumatic equipment, systems*** and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to ***pneumatic equipment, systems*** and their ***components*** |
| | | identify types of ***pneumatic equipment***, ***systems*** and their ***components*** and describe their applications and operation |
| | | describe ***methods of air treatment*** in pneumatic systems |
| | | identify ***classifications and types of compressors***, their specifications and applications |
| | | identify ***types of tubing and piping systems*** and describe their applications |
| | | identify ***types of tube and pipe fittings*** and accessories and describe their characteristics and applications |

| | | |
|---|---|---|
| | | identify ***types of valves used in tubing and piping systems*** and describe their applications and operation |
| | | describe venting practices relating to combustible and inert gases |
| D-15.03.02L | demonstrate knowledge of regulatory requirements pertaining to ***pneumatic equipment, systems*** and their ***components*** | interpret codes and regulations pertaining to ***pneumatic equipment, systems*** and their ***components*** |
| D-15.03.03L | demonstrate knowledge of documentation relating to ***pneumatic equipment*** and ***systems***, their use and interpretation | interpret information pertaining to ***pneumatic equipment*** and ***systems*** found on ***documentation*** |
| | | interpret ***documentation*** to determine operation of ***pneumatic systems*** |
| D-15.03.04L | demonstrate knowledge of ***pneumatic-related calculations*** | perform ***pneumatic-related calculations*** |
| D-15.03.05L | demonstrate knowledge of procedures used to maintain and repair ***pneumatic equipment, systems*** and ***components*** | identify tools and ***test equipment*** relating to maintenance and repair of pneumatic ***systems***, and describe their applications and procedures for use |
| | | describe procedures used to maintain and repair ***pneumatic equipment, systems*** and their ***components*** |
| | | describe procedures used to cut, thread and ream rigid pipe |
| | | describe installation of tubing |
| | | describe tube bending techniques |
| | | describe procedures used to perform a pressure test |
| D-15.03.06L | demonstrate knowledge of procedures used to calibrate ***components*** (control devices) for ***pneumatic systems*** | identify tools, equipment and software used to calibrate ***components*** (control devices) for ***pneumatic systems*** and describe their applications and procedures for use |
| | | describe procedures used to calibrate ***components (control devices)*** |

## RANGE OF VARIABLES

***pneumatic equipment*** includes: transmitters, converters, positioners, controllers, relays

***pneumatic systems*** include: instrument air, instrument gas, service/utility air

***components*** include: separators, tubing, actuators, pumps, positioners, accumulators, compressors, tanks, coolers, filters, dryers, automated oilers, gauges, control devices (safety valves, switches, solenoids, regulators)

***hazards*** include: energy state awareness (accumulators, suspended loads), temperature, pressure, flammability/venting

***methods of air treatment*** include: filters, dryers, after-coolers, de-icers, receivers

***classifications and types of compressors*** include: dynamic/centrifugal, positive displacement

***types of tubing and piping systems*** include: rigid, flexible, ferrous, non-ferrous

***types of tube and pipe fittings*** include: adapters, unions, elbows, tees, couplings

***types of valves used in tubing and piping systems*** include: isolation, throttling, regulating, directional control

***documentation*** includes: schematics, manufacturers' manuals, drawings, specifications, data sheets

***pneumatic-related calculations*** include: unit conversion, volume (ideal gas law)

***test equipment*** includes: infrared thermometers, pressure gauges, dew point testers, ultrasonic leak detectors

# TASK D-16 Installs and services electrical and electronic equipment

## TASK DESCRIPTOR

Instrumentation and control technicians install, diagnose, maintain and repair electrical and electronic equipment. Electrical and electronic equipment is used to supply energy and to control equipment and processes through the use of electricity. Instrumentation and control technicians work on electrical and electronic equipment directly related to process control and often in conjunction with electricians on electrical power sources.

## D-16.01 Installs electrical and electronic equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| D-16.01.01P | determine ***system requirements*** | ***system requirements*** are determined according to industry standards, codes, practices and engineered designs |
| D-16.01.02P | select ***electrical*** and ***electronic components*** | ***electrical*** and ***electronic components*** are selected according to ***hazards***, industry standards, codes, practices and engineered designs |

| | | |
|---|---|---|
| D-16.01.03P | determine location of system equipment | location of system equipment is determined according to industry standards, codes, practices and engineered designs |
| D-16.01.04P | connect ***electrical*** and ***electronic components*** | ***electrical*** and ***electronic components*** are connected according to industry practices, engineered designs, manufacturers' specifications and codes |
| D-16.01.05P | verify operation of ***electrical*** and ***electronic components*** | operation of ***electrical*** and ***electronic components*** is verified according to industry standards, codes, practices and engineered designs |
| D-16.01.06P | back up settings | settings are backed up for future reference or data recovery |
| D-16.01.07P | update ***documentation*** | ***documentation*** is updated to reflect changes carried out as required |

## RANGE OF VARIABLES

***system requirements*** include: voltage, current, resistance, power

***electrical components*** include: power supplies (alternating current/direct current [AC/DC], uninterruptible power supplies [UPS]), batteries, fuses, resistors, capacitors, inductors, control devices (push buttons, switches [limit, proximity, centrifugal, thermal], photo sensors, relays), intrinsic barriers and current limiting

***electronic components*** include: diodes, transistors, op amps, thyristors, rectifiers, circuit boards

***hazards*** include: energy state awareness, static electricity discharge, area classification (environment, hazardous locations), voltage levels

***documentation*** includes: drawings, specifications

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| D-16.01.01L | demonstrate knowledge of ***electrical components***, their characteristics and applications | define terminology associated with ***electrical components***, and describe their characteristics and applications |
| | | identify ***hazards*** and describe safe work practices pertaining to ***electrical components*** |
| | | identify ***system requirements*** and describe their relationship to process control systems |
| | | identify tools and equipment relating to ***electrical components*** and describe their applications and procedures for use |
| | | identify types of ***conductors and raceways*** and describe their characteristics and applications |
| | | interpret information pertaining to ***electrical components*** found on ***documentation*** |

| | | |
|---|---|---|
| | | identify types of power supplies and describe their characteristics and operating principles |
| D-16.01.02L | demonstrate knowledge of electrical fundamentals | explain ***electrical theories and formulas*** and describe their applications |
| | | explain atomic structure of matter |
| | | identify ***forms of energy that produce electricity*** and describe their associated principles |
| | | identify units of measure and symbols relating to AC and DC electricity |
| | | explain ***AC generation*** |
| | | identify types of devices used in ***AC generation*** and describe their characteristics and applications |
| | | explain effects of resistance/ inductance/capacitance (RLC) on AC and DC circuits |
| | | identify instruments used for measuring electricity and describe their applications and procedures for use |
| | | perform calculations used to determine ***electrical-related values*** |
| | | identify types of ***transformers*** used in control circuitry, and describe their characteristics and applications |
| | | perform calculations pertaining to single-phase and basic three-phase electrical concepts |
| D-16.01.03L | demonstrate knowledge of ***electronic components***, their characteristics and applications | explain conventional current flow vs. electron flow theory in electronics |
| | | identify ***number systems used in electronics*** and describe their applications |
| | | describe procedures used to perform conversions between number systems |
| | | identify types of logic gates and describe their applications |
| | | identify semiconductor materials used in electronics and describe their characteristics and applications |
| | | perform ***calculations pertaining to electronics*** |
| D-16.01.04L | demonstrate knowledge of regulatory requirements pertaining to electrical and electronic equipment, and their ***components*** | interpret ***codes*** pertaining to electrical and electronic equipment, and their ***components*** |

| | | |
|---|---|---|
| D-16.01.05L | demonstrate knowledge of circuits, their characteristics and operation | identify ***types of circuits***, and describe their characteristics and operation |
| | | identify ***elements of an electric circuit*** and describe the procedures used to analyze them |
| | | perform calculations to determine circuit-related values |
| | | explain voltage drop and power loss and its impact on a circuit |
| | | perform calculations to determine voltage drop and power loss |
| | | identify units of measure used to describe conductor size |
| | | identify types of insulators and describe their characteristics and applications |
| | | explain procedures used to determine conductor resistance and its effect on a circuit |
| | | identify types of ***components*** (control devices) and describe their characteristics and operation |
| | | identify types of DC circuits and describe their characteristics and applications |
| | | identify ***types of AC circuits*** and describe their characteristics and applications |
| | | identify ***methods of circuit protection*** and describe their characteristics and applications |
| D-16.01.06L | demonstrate knowledge of procedures used to install electrical and electronic equipment and their ***components*** | describe procedures used to install electrical and electronic equipment and their ***components*** |
| | | identify types of tools and equipment used to install electrical and electronic equipment and their ***components***, and describe their procedures for use |
| | | describe procedures used to install ***conductors and raceways*** |
| | | describe procedures used to ground, bond and shield ***conductors and raceways*** |
| | | describe procedures used to ground, bond and shield electrical and electronic equipment and their ***components*** |

| | |
|---|---|
| | describe ***methods used to terminate conductors*** |
| | describe procedures used to select and install power supplies |

## RANGE OF VARIABLES

***electrical components*** include: power supplies (AC/DC, UPS), batteries, fuses, resistors, capacitors, inductors, control devices (push buttons, switches [limit, proximity, centrifugal, thermal], photo sensors, relays), intrinsic barriers and current limiting

***hazards*** include: energy state awareness, static electricity discharge, area classification (environment, hazardous locations), voltage levels

***system requirements*** include: voltage, current, resistance, power

***conductors and raceways*** include: power/distribution, signal/control, communication/data, connectors, supports, cable tray (power, instrument), conduit (rigid, polyvinyl chloride [PVC], flexible), electrical metallic tubing

***documentation*** includes: drawings, specifications

***electrical theories and formulas*** include: Ohm's Law, Kirchhoff's Law, Faraday's Law

***forms of energy that produce electricity*** include: chemical action, piezoelectric effect, magnetism, heat, light and solar, friction, electromagnetism, electromagnetic induction

***AC generation*** includes: single-phase, three-phase

***electrical-related values*** include: voltage, resistance, current, power

***transformers*** include: control (current, voltage), single-phase, three-phase

***electronic components*** include: diodes, transistors, op amps, thyristors, rectifiers, circuit boards

***number systems used in electronics*** include: binary, decimal, hexadecimal, octal, binary-coded decimal (BCD)

***calculations pertaining to electronics*** include: power, current, voltage, frequency (timing), logic

***codes*** include: CEC

***types of circuits*** include: series, parallel, complex

***elements of an electric circuit*** include: closed circuit, open circuit, short circuit, load, source, control

***types of AC circuits*** include: resistance/capacitance (RC), resistance/inductance (RL), RLC

***methods of circuit protection*** include: fuses, circuit breakers

***methods used to terminate conductors*** include: terminal blocks, conical springs (twist-on wire connectors, wire nuts), crimp lugs, solder joints

## D-16.02 Diagnoses electrical and electronic equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| D-16.02.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to manufacturers' specifications, process requirements and data sheets |
| D-16.02.02P | perform visual and physical inspection to detect ***issues*** | visual and physical inspection is performed to detect ***issues*** |
| D-16.02.03P | perform battery load test | battery load test is performed to indicate conditions of battery performance |
| D-16.02.04P | identify probable root cause and location of faults | probable root cause and location of faults are identified using diagnostic tools, testing procedures and electrical formulas and theories |
| D-16.02.05P | determine steps required to repair faults | steps required to repair faults are determined according to manufacturers' specifications, process requirements and data sheets |
| D-16.02.06P | review ***documentation*** and historical data | ***documentation*** and historical data is reviewed to assist in determining probable root cause |

### RANGE OF VARIABLES

***tools and equipment*** include: multimeters, oscilloscopes, diagnostic software, clamp-on ammeters
***issues*** include: abnormal noises, heat, odours
***documentation*** includes: drawings, specifications, data sheets

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| D-16.02.01L | demonstrate knowledge of ***electrical components*** and describe their characteristics and associated applications | define terminology associated with ***electrical components*** and describe their characteristics and associated applications |
| | | identify ***hazards*** and describe safe work practices pertaining to ***electrical components*** |
| | | identify ***system requirements*** and describe their relationship to process control system |

| | | |
|---|---|---|
| | | identify tools and equipment relating to ***electrical components*** and describe their applications and procedures for use |
| | | interpret information pertaining to ***electrical components*** found on ***documentation*** |
| | | identify types of power supplies and describe their characteristics and operating principles |
| D-16.02.02L | demonstrate knowledge of electrical fundamentals | explain ***electrical theories and formulas*** and describe their applications |
| | | identify ***forms of energy that produce electricity*** and describe their associated principles |
| | | identify units of measure and symbols relating to AC and DC electricity |
| | | explain effects of RLC on AC and DC circuits |
| | | identify instruments used for measuring electricity and describe their applications and procedures for use |
| | | identify types of ***transformers*** used in control circuitry and describe their characteristics and applications |
| | | perform calculations pertaining to single-phase and basic three-phase electrical concepts |
| D-16.02.03L | demonstrate knowledge of ***electronic components***, their characteristics and applications | explain conventional current flow vs. electron flow theory in electronics |
| | | identify ***number systems used in electronics*** and describe their applications |
| | | describe procedures used to perform conversions between number systems |
| | | identify types of logic gates and describe their applications |
| | | perform ***calculations pertaining to electronics*** |
| D-16.02.04L | demonstrate knowledge of regulatory requirements pertaining to electrical and electronic equipment, and their ***components*** | interpret ***codes*** pertaining to electrical and electronic equipment, and their ***components*** |
| D-16.02.05L | demonstrate knowledge of circuits, their characteristics and operation | identify ***types of circuits***, and describe their characteristics and operation |
| | | identify ***elements of an electric circuit*** and describe procedures used to analyze them |

| | | |
|---|---|---|
| | | perform calculations to determine circuit related values |
| | | perform calculations to determine voltage drop and power loss |
| | | identify units of measure used to describe conductor size |
| | | identify types of insulators and describe their characteristics and applications |
| | | identify types of ***components*** and describe their characteristics, operation and applications |
| | | identify types of DC circuits and describe their characteristics and applications |
| | | identify ***types of AC circuits*** and describe their characteristics and applications |
| | | identify ***methods of circuit protection*** and describe their characteristics and applications |
| D-16.02.06L | demonstrate knowledge of procedures used to diagnose electrical and electronic equipment and their ***components*** | describe procedures used to diagnose electrical and electronic equipment, and their ***components*** |
| | | identify types of ***tools and equipment*** used to diagnose electrical and electronic equipment and their ***components*** |
| | | describe procedures used to diagnose electronic circuitry |

## RANGE OF VARIABLES

***electrical components*** include: power supplies (AC/DC, UPS), batteries, fuses, resistors, capacitors, inductors, control devices (push buttons, switches [limit, proximity, centrifugal, thermal], photo sensors, relays), intrinsic barriers and current limiting

***hazards*** include: energy state awareness, static electricity discharge, area classification (environment, hazardous locations), voltage levels

***system requirements*** include: voltage, current, resistance, power

***documentation*** includes: drawings, specifications, data sheets

***electrical theories and formulas*** include: Ohm's Law, Kirchhoff's Law, Faraday's Law

***forms of energy that produce electricity*** include: chemical action, piezoelectric effect, magnetism, heat, light and solar, friction, electromagnetism, electromagnetic induction

***transformers*** include: control (current, voltage), single-phase, three-phase

***electronic components*** include: diodes, transistors, op amps, thyristors, rectifiers, circuit boards

***number systems used in electronics*** include: binary, decimal, hexadecimal, octal, BCD

***calculations pertaining to electronics*** include: power, current, voltage, frequency (timing), logic

***codes*** include: CEC

***types of circuits*** include: series, parallel, complex

***elements of an electric circuit*** include: closed circuit, open circuit, short circuit, load, source, control

***types of AC circuits*** include: RC, RL, RLC

***methods of circuit protection*** include: fuses, circuit breakers

***tools and equipment*** include: multimeters, oscilloscopes, diagnostic software, clamp-on ammeters

## D-16.03 Performs maintenance and repairs for electrical and electronic equipment

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| D-16.03.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to manufacturers' specifications, process requirements and data sheets |
| D-16.03.02P | inspect ***electrical*** and ***electronic components*** | ***electrical*** and ***electronic components*** are inspected for conditions according to specifications and maintenance schedules |
| D-16.03.03P | verify system ***operating parameters*** and specifications | system ***operating parameters*** and specifications are verified according to electrical formulas and theories |
| D-16.03.04P | perform ***battery maintenance activities*** | ***battery maintenance activities*** are performed according to specifications and maintenance schedules |
| D-16.03.05P | select replacement ***electrical*** and ***electronic components*** | replacement ***electrical*** and ***electronic components*** are selected according to manufacturers' specifications, process requirements and data sheets |

| | | |
|---|---|---|
| D-16.03.06P | remove and replace faulty ***electrical*** and ***electronic components*** | faulty ***electrical*** and ***electronic components*** are removed and replaced according to manufacturers' specifications, process requirements and data sheets |
| D-16.03.07P | verify operation and calibration | operation and calibration is verified before returning to service |
| D-16.03.08P | update ***documentation*** | ***documentation*** is updated to reflect changes carried out as required |

## RANGE OF VARIABLES

***tools and equipment*** include: multimeters, oscilloscopes, clamp-on ammeters

***electrical components*** include: power supplies (AC/DC, UPS), batteries, fuses, resistors, capacitors, inductors, control devices (push buttons, switches [limit, proximity, centrifugal, thermal], photo sensors, relays), intrinsic barriers and current limiting

***electronic components*** include: diodes, transistors, op amps, thyristors, rectifiers, circuit boards

***operating parameters*** include: voltage, current

***battery maintenance activities*** include: checking voltage, checking fluid level and specific gravity, cleaning terminal corrosion

***documentation*** includes: drawings, specifications, data sheets

## KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| D-16.03.01L | demonstrate knowledge of ***electrical components*** and describe their characteristics and associated applications | define terminology associated with ***electrical components*** and describe their characteristics and associated applications |
| | | identify ***hazards*** and describe safe work practices pertaining to ***electrical components*** |
| | | identify ***system requirements*** and describe their relationship to process control system |
| | | identify tools and equipment relating to ***electrical components*** and describe their applications and procedures for use |
| | | interpret information pertaining to ***electrical components*** found on ***documentation*** |
| | | identify types of power supplies and describe their characteristics and operating principles |
| D-16.03.02L | demonstrate knowledge of electrical fundamentals | explain ***electrical theories and formulas*** and describe their applications |
| | | identify ***forms of energy that produce electricity*** and describe their associated principles |

| | | |
|---|---|---|
| | | identify units of measure and symbols relating to AC and DC electricity |
| | | identify types of devices used in ***AC generation*** and describe their characteristics and applications |
| | | explain effects of RLC on AC and DC circuits |
| | | identify instruments used for measuring electricity and describe their applications and procedures for use |
| | | identify types of ***transformers*** used in control circuitry and describe their characteristics and applications |
| | | perform calculations pertaining to single-phase and basic three-phase electrical concepts |
| D-16.03.03L | demonstrate knowledge of ***electronic components***, their characteristics and applications | explain conventional current flow vs. electron flow theory in electronics |
| | | identify ***number systems used in electronics*** and describe their applications |
| | | describe procedures used to perform conversions between number systems |
| | | identify types of logic gates and describe their applications |
| | | perform ***calculations pertaining to electronics*** |
| D-16.03.04L | demonstrate knowledge of regulatory requirements pertaining to electrical and electronic equipment, and their ***components*** | interpret ***codes*** pertaining to electrical and electronic equipment, and their ***components*** |
| D-16.03.05L | demonstrate knowledge of circuits, their characteristics and operation | identify ***types of circuits***, and describe their characteristics and operation |
| | | identify ***elements of an electric circuit*** and describe procedures used to analyze them |
| | | perform calculations to determine circuit related values |
| | | perform calculations to determine voltage drop and power loss |
| | | identify units of measure used to describe conductor size |
| | | identify types of insulators and describe their characteristics and applications |
| | | identify types of DC circuits and describe their characteristics and applications |

| | | |
|---|---|---|
| | | identify ***types of AC circuits*** and describe their characteristics and applications |
| | | identify ***methods of circuit protection*** and describe their characteristics and applications |
| D-16.03.06L | demonstrate knowledge of procedures used to maintain and repair ***electrical*** and ***electronic components*** | describe procedures used to maintain and repair ***electrical*** and ***electronic components*** |
| | | identify types of ***tools and equipment*** used to maintain and repair ***electrical*** and ***electronic components*** |
| | | describe procedures used to maintain and repair electronic circuitry |

## RANGE OF VARIABLES

***electrical components*** include: power supplies (AC/DC, UPS), batteries, fuses, resistors, capacitors, inductors, control devices (push buttons, switches [limit, proximity, centrifugal, thermal], photo sensors, relays), intrinsic barriers and current limiting

***hazards*** include: energy state awareness, static electricity discharge, area classification (environment, hazardous locations), voltage levels

***system requirements*** include: voltage, current, resistance, power

***documentation*** includes: drawings, specifications, data sheets

***electrical theories and formulas*** include: Ohm's Law, Kirchhoff's Law, Faraday's Law

***forms of energy that produce electricity*** include: chemical action, piezoelectric effect, magnetism, heat, light and solar, friction, electromagnetism, electromagnetic induction

***AC generation*** includes: single-phase, three-phase

***transformers*** include: control (current, voltage), single-phase, three-phase

***electronic components*** include: diodes, transistors, op amps, thyristors, rectifiers, circuit boards

***number systems used in electronics*** include: binary, decimal, hexadecimal, octal, BCD

***calculations pertaining to electronics*** include: power, current, voltage, frequency (timing), logic

***codes*** include: CEC

***types of circuits*** include: series, parallel, complex

***elements of an electric circuit*** include: closed circuit, open circuit, short circuit, load, source, control

***types of AC circuits*** include: RC, RL, RLC

***methods of circuit protection*** include: fuses, circuit breakers

***tools and equipment*** include: multimeters, oscilloscopes, clamp-on ammeters

# MAJOR WORK ACTIVITY E

# Installs, configures and services final control elements

## TASK E-17 Installs and services valves

### TASK DESCRIPTOR

Instrumentation and control technicians must install and maintain valves correctly to ensure system efficiency, optimum production and safety of operations and equipment. Valves, in conjunction with actuators and positioners, manipulate the process medium. Maintenance of valves includes routine and preventative maintenance. Diagnosis includes troubleshooting and locating faults such as leaks and wear.

### E-17.01 Installs valves

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| E-17.01.01P | select ***type of valve*** | ***type of valve*** is selected according to application, engineered designs and manufacturers' specifications |
| E-17.01.02P | select and use tools and equipment | tools and equipment are selected and used according to application requirements, torque specifications and size of valves |
| E-17.01.03P | select and install gasket material and mounting hardware | gasket material and mounting hardware are selected and installed according to application |
| E-17.01.04P | mount valve | valve is mounted using ***methods*** according to industry practices, engineered designs, manufacturers' specifications and codes |
| E-17.01.05P | orientate valve | valve is orientated according to manufacturers' specifications in order to prevent premature valve failure, and ensure proper function and ease of access |

| | | |
|---|---|---|
| E-17.01.06P | verify operation of valve | operation of valve is verified to be within specified parameters by using test equipment and calibration procedures |
| E-17.01.07P | verify operation and calibration after installation | operation and calibration is verified after installation |

## RANGE OF VARIABLES

***types of valve*** includes: sliding stem (globe, gate valve, pinch), rotary (butterfly, e-disc, ball, v-ball)
***methods*** include: bolting, welding, flanging, threading

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-17.01.01L | demonstrate knowledge of valves, their ***components***, ***characteristics*** and ***applications*** | define terminology associated with valves and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to valves |
| | | interpret information pertaining to valves found on drawings, specifications, nameplates and data sheets |
| | | identify ***types of valves*** and their ***components***, and describe their ***characteristics*** and ***applications*** |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | identify ***types of valve packing*** and describe their applications |
| | | describe principles of friction, and coefficient of friction, associated with fluids in motion |
| E-17.01.02L | demonstrate knowledge of regulatory requirements pertaining to valves and their ***components*** | interpret codes and regulations pertaining to valves and their ***components*** |
| E-17.01.03L | demonstrate knowledge of procedures used to install valves | identify tools and equipment used to install valves and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to select, size and install valves |

| | |
|---|---|
| | describe ***methods*** used to mount valves |
| | explain importance of isolating valve from process |
| | describe ***procedures used for testing valves*** |
| | describe possible ***faults of valves*** |
| | identify types of test equipment relating to installation of valves |
| | describe procedures used to calibrate valves |

## RANGE OF VARIABLES

***components*** include: cages, plugs, seats, stems, packing, bonnet, body

***characteristics*** include: quick opening, linear, equal percentage, on/off

***applications*** include: metallurgy, seal/shut off requirements

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation/lock-out/tag-out

***types of valves*** include: sliding stem (globe, gate valve, pinch), rotary (butterfly, e-disc, ball, v-ball)

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, variable speed drives (VSD)

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), positioners (electric, pneumatic, smart), air supply regulators, switches, hand-wheel

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***types of valve packing*** include: graphite, rings, rope, Polytetrafluoroethylene (PTFE)

***methods*** include: bolting, welding, flanging, threading

***procedures used for testing valves*** include: stroking to ensure proper operation, performing valve signature test, performing leak test

***faults of valves*** include: leaks, valve passing, damaged parts

## E-17.02 Maintains valves

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-17.02.01P | inspect valves | valves are inspected for ***faults*** according to specifications and maintenance schedule |
| E-17.02.02P | lubricate valve stems, bushings and bearings | valve stems, bushings and bearings are lubricated according to manufacturers' specifications |
| E-17.02.03P | verify valve assembly strokes smoothly throughout travel | valve assembly strokes smoothly throughout travel |

| | | |
|---|---|---|
| E-17.02.04P | adjust open and close positions of valves | open and close positions of valves are adjusted |
| E-17.02.05P | document ***information*** | ***information*** is recorded for future reference |

## RANGE OF VARIABLES

***faults*** include: packing leaks, worn and damaged parts, stem wear, leaks, valve passing
***information*** includes: valve stroke, wear, overall condition, maintenance record

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-17.02.01L | demonstrate knowledge of valves, their ***components***, ***characteristics*** and ***applications*** | define terminology associated with valves and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to valves |
| | | interpret information pertaining to valves found on drawings, specifications, nameplates and data sheets |
| | | identify ***types of valves*** and their ***components***, and describe their ***characteristics*** and ***applications*** |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | identify ***types of valve packing*** and describe their applications |
| | | describe principles of friction, and coefficient of friction, associated with fluids in motion |
| E-17.02.02L | demonstrate knowledge of regulatory requirements pertaining to valves and their ***components*** | interpret codes and regulations pertaining to valves and their ***components*** |
| E-17.02.03L | demonstrate knowledge of procedures used to maintain valves | identify tools and equipment used to maintain valves and describe their applications and procedures for use |
| | | describe procedures used to maintain valves |
| | | describe procedures used to inspect valves |

| | |
|---|---|
| | describe methods used to isolate valves for maintenance |
| | describe procedures used to clean and lubricate valves |
| | describe possible ***faults*** of valves |
| | describe importance of documenting ***information*** |

## RANGE OF VARIABLES

***components*** include: cages, plugs, seats, stems, packing, bonnet, body

***characteristics*** include: quick opening, linear, equal percentage, on/off

***applications*** include: metallurgy, seal/shut off requirements

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation/lock-out/tag-out

***types of valves*** include: sliding stem (globe, gate valve, pinch), rotary (butterfly, e-disc, ball, v- ball)

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), positioners (electric, pneumatic, smart), air supply regulators, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***types of valve packing*** include: graphite, rings, rope, PTFE

***faults*** include: packing leaks, worn and damaged parts, stem wear, leaks, valve passing

***information*** includes: valve stroke, wear, overall condition, maintenance record

## E-17.03 Diagnoses valves

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-17.03.01P | select and use ***diagnostic tools and equipment*** | ***diagnostic tools and equipment*** are selected and used according to industry standards and practices |
| E-17.03.02P | interpret valve signature from diagnostic software | valve signature is interpreted from diagnostic software to assess ***conditions*** |
| E-17.03.03P | determine probable root cause and location of faults and identify required repairs | probable root cause and location of faults are determined and required repairs are identified |
| E-17.03.04P | inspect valve trim for ***conditions*** | valve trim is inspected for ***conditions*** |

## RANGE OF VARIABLES

***diagnostic tools and equipment*** include: valve diagnostic software, dial gauges, pressure gauges
***conditions*** include: seat load, sticking valves, galling, cavitation, flashing

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-17.03.01L | demonstrate knowledge of valves, their ***components***, ***characteristics*** and ***applications*** | define terminology associated with valves and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to valves |
| | | interpret information pertaining to valves found on drawings, specifications, nameplates and data sheets |
| | | identify ***types of valves*** and their ***components***, and describe their ***characteristics*** and ***applications*** |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | identify ***types of valve packing*** and describe their applications |
| | | describe principles of friction, and coefficient of friction, associated with fluids in motion |
| E-17.03.02L | demonstrate knowledge of regulatory requirements pertaining to valves and their ***components*** | interpret codes and regulations pertaining to valves and their ***components*** |
| E-17.03.03L | demonstrate knowledge of procedures used to diagnose valves | identify ***diagnostic tools and equipment*** used to diagnose valves and describe their applications and procedures for use |
| | | describe procedures used to diagnose valves |
| | | describe possible ***faults*** of valves |
| E-17.03.04L | demonstrate knowledge of valve trim ***conditions*** | identify valve trim ***conditions*** |

## RANGE OF VARIABLES

***components*** include: cages, plugs, seats, stems, packing, bonnet, body
***characteristics*** include: quick opening, linear, equal percentage, on/off
***applications*** include: metallurgy, seal/shut off requirements
***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation/lock-out/tag-out
***types of valves*** include: sliding stem (globe, gate valve, pinch), rotary (butterfly, e-disc, ball, v- ball)
***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD
***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), positioners (electric, pneumatic, smart), air supply regulators, switches, hand wheels
***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation
***types of valve packing*** include: graphite, rings, rope, PTFE
***diagnostic tools and equipment*** include: valve diagnostic software, dial gauges, pressure gauges
***faults*** include: packing leaks, worn and damaged parts, stem wear, leaks, valve passing
***conditions*** include: seat load, sticking valves, galling, cavitation, flashing

## E-17.04 Repairs valves

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-17.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| E-17.04.02P | disassemble valve | valve is disassembled according to job procedures and manufacturers' recommendations |
| E-17.04.03P | select ***replacement parts*** | ***replacement parts*** are selected according to valve specifications and process applications |
| E-17.04.04P | repair ***components*** | ***components*** are repaired according to manufacturers' recommendations |
| E-17.04.05P | reassemble valve | valve is reassembled according to job procedures and manufacturers' recommendations |

## RANGE OF VARIABLES

***tools and equipment*** include: packing pullers, seat pullers, torque wrench
***replacement parts*** include: cage, plug, seat, packing
***components*** include: cages, plugs, seats, stems, packing, bonnet, body

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-17.04.01L | demonstrate knowledge of valves, their ***components***, ***characteristics*** and ***applications*** | define terminology associated with valves and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to valves |
| | | interpret information pertaining to valves found on drawings, specifications and nameplates |
| | | identify ***types of valves*** and their ***components***, and describe their ***characteristics*** and ***applications*** |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | identify ***types of valve packing*** and describe their applications |
| | | describe principles of friction, and coefficient of friction, associated with fluids in motion |
| E-17.04.02L | demonstrate knowledge of regulatory requirements pertaining to valves and their ***components*** | interpret codes and regulations pertaining to valves and their ***components*** |
| E-17.04.03L | demonstrate knowledge of procedures used to repair valves | identify ***tools and equipment*** used to repair valves and describe their applications and procedures for use |
| | | describe procedures used to disassemble and reassemble valves |
| | | describe procedures used to repair valves |
| | | describe possible ***faults*** of valves |

## RANGE OF VARIABLES

***components*** include: cages, plugs, seats, stems, packing, bonnet, body

***characteristics*** include: quick opening, linear, equal percentage, on/off

***applications*** include: metallurgy, seal/shut off requirements

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation/lock-out/tag-out

***types of valves*** include: sliding stem (globe, gate valve, pinch), rotary (butterfly, e-disc, ball, v- ball)

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), positioners (electric, pneumatic, smart), air supply regulators, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***types of valve packing*** include: graphite, rings, rope, PTFE

***tools and equipment*** include: packing pullers, seat pullers, torque wrench

***faults*** include: packing leaks, worn and damaged parts, stem wear, leaks, valve passing

# TASK E-18 Installs and services actuators

## TASK DESCRIPTOR

Instrumentation and control technicians install, maintain, diagnose and repair actuators to ensure the proper operation of valves and other final control elements. Actuators adjust the position of valves and other final control elements.

### E-18.01 Installs actuators

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| E-18.01.01P | select actuator | actuator is selected according to valve or final control element type, application and manufacturers' specifications |
| E-18.01.02P | select and use tools and equipment | tools and equipment are selected and used according to application requirements and size of actuator |
| E-18.01.03P | select, orientate and mount actuator | actuator is selected, orientated and mounted according to industry practices engineered designs, manufacturers' specifications and codes |

| | | |
|---|---|---|
| E-18.01.04P | connect and terminate actuator | actuator is connected and terminated using ***methods*** according to industry practices, engineered designs, manufacturers' specifications and codes |
| E-18.01.05P | benchset actuator | actuator is benchset to overcome static process pressure and ensure seat load |
| E-18.01.06P | verify that actuator is within specified parameters | actuator is verified to be within specified parameters by using test equipment and calibration procedures |

## RANGE OF VARIABLES

***methods*** include: wiring, tubing, bolting

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-18.01.01L | demonstrate knowledge of actuators, their ***components***, characteristics, ***actions*** and ***applications*** | define terminology associated with actuators and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to actuators and their ***components*** |
| | | interpret information pertaining to actuators found on drawings, specifications and nameplates |
| | | identify ***types of actuators*** and their ***components***, and describe their characteristics, ***actions*** and ***applications*** |
| | | identify considerations and requirements for selecting final control elements, their ***components*** and accessories |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | describe principles of friction, and coefficient of friction, associated with fluids in motion |
| E-18.01.02L | demonstrate knowledge of regulatory requirements pertaining to actuators and their ***components*** | interpret codes and regulations pertaining to actuators and their ***components*** |
| E-18.01.03L | demonstrate knowledge of procedures used to install actuators and their ***components*** | identify tools and equipment used to install actuators and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to select, size and install actuators |

| | | |
|---|---|---|
| | | describe possible ***faults*** of actuators |
| E-18.01.04L | demonstrate knowledge of procedures used to calibrate actuators | describe procedures used to calibrate actuators |

## RANGE OF VARIABLES

***components*** include: diaphragms, plates, couplings, springs, bushings, o-rings, circuit boards, motors
***actions*** include: spring return, double-acting, rotary, direct, reverse
***applications*** include: fail-open, fail-close, fail-last
***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation, lock-out/tag-out
***types of actuators*** include: pneumatic, hydraulic, electric, mechanical
***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation
***faults*** include: leaking diaphragms, broken springs, damaged or worn o-rings

## E-18.02 Maintains actuators

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-18.02.01P | inspect actuator | actuator is inspected for ***conditions*** according to specifications and maintenance schedule |
| E-18.02.02P | lubricate actuator stems, bushings and bearings | actuator stems, bushings and bearings are lubricated according to manufacturers' specifications |
| E-18.02.03P | verify that assembly strokes smoothly throughout travel | assembly strokes smoothly throughout travel |
| E-18.02.04P | document ***information*** | ***information*** is documented |

## RANGE OF VARIABLES

***conditions*** include: damaged diaphragms and o-ring seals, scored shafts, water in instrument air
***information*** includes: valve stroke, wear, overall condition, maintenance record

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| E-18.02.01L | demonstrate knowledge of actuators, their ***components***, characteristics, ***actions*** and ***applications*** | define terminology associated with actuators and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to actuators and their ***components*** |

| | | |
|---|---|---|
| | | interpret information pertaining to actuators found on drawings, specifications and nameplates |
| | | identify ***types of actuators*** and their ***components***, and describe their characteristics, ***actions*** and ***applications*** |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify considerations and requirements for selecting final control elements, their ***components*** and accessories |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | describe principles of friction, and coefficient of friction, associated with fluids in motion |
| | | describe ***environmental conditions*** |
| E-18.02.02L | demonstrate knowledge of regulatory requirements pertaining to actuators and their ***components*** | interpret codes and regulations pertaining to actuators and their ***components*** |
| E-18.02.03L | demonstrate knowledge of procedures used to maintain actuators | identify tools and equipment used to maintain actuators and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to maintain actuators |
| | | describe possible ***faults*** of actuators |
| | | describe procedures used to lubricate actuators |
| | | describe importance of documenting ***information*** |

## RANGE OF VARIABLES

***components*** include: diaphragms, plates, couplings, springs, bushings, o-rings, circuit boards, motors

***actions*** include: spring return, double-acting, rotary, direct, reverse

***applications*** include: fail-open, fail-close, fail-last

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation, lock-out/tag-out

***types of actuators*** include: pneumatic, hydraulic, electric, mechanical

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), positioners (electric, pneumatic, smart), air supply regulators, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***environmental conditions*** include: ambient temperature, location, contamination

***faults*** include: leaking diaphragms, broken springs, damaged or worn o-rings

***information*** includes: valve stroke, wear, overall condition, maintenance record

## E-18.03 Diagnoses actuators

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-18.03.01P | select and use ***diagnostic tools and equipment*** | ***diagnostic tools and equipment*** are selected and used according to industry standards and practices |
| E-18.03.02P | interpret actuator travel | actuator travel is interpreted to assess ***faults*** |
| E-18.03.03P | determine probable root cause and location of ***faults*** and identify required repairs | probable root cause and location of ***faults*** are determined and required repairs are identified |

## RANGE OF VARIABLES

***diagnostic tools and equipment*** include: diagnostic software, dial gauges, pressure gauges

***faults*** include: faulty springs, limits, leaking diaphragms, damaged o-rings

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| E-18.03.01L | demonstrate knowledge of actuators, their ***components***, characteristics, ***actions*** and ***applications*** | define terminology associated with actuators and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to actuators and their ***components*** |

| | | |
|---|---|---|
| | | interpret information pertaining to actuators found on drawings, specifications and nameplates |
| | | identify ***types of actuators*** and their ***components***, and describe their characteristics, ***actions*** and ***applications*** |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify considerations and requirements for selecting final control elements, their ***components*** and accessories |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | describe principles of friction, and coefficient of friction, associated with fluids in motion |
| | | describe ***environmental conditions*** |
| E-18.03.02L | demonstrate knowledge of regulatory requirements pertaining to actuators and their ***components*** | interpret codes and regulations pertaining to actuators and their ***components*** |
| E-18.03.03L | demonstrate knowledge of procedures used to diagnose actuators | identify ***diagnostic tools and equipment*** used to diagnose actuators and describe their applications and procedures for use |
| | | describe procedures used to diagnose actuators |
| | | explain actuator travel |
| | | describe possible ***faults*** of actuators |

## RANGE OF VARIABLES

***components*** include: diaphragms, plates, couplings, springs, bushings, o-rings, circuit boards, motors

***actions*** include: spring return, double-acting, rotary, direct, reverse

***applications*** include: fail-open, fail-close, fail-last

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation, lock-out/tag-out

***types of actuators*** include: pneumatic, hydraulic, electric, mechanical

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), positioners (electric, pneumatic, smart), air supply regulators, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***environmental conditions*** include: ambient temperature, location, contamination

***diagnostic tools and equipment*** include: diagnostic software, dial gauges, pressure gauges

***faults*** include: faulty springs, limits, leaking diaphragms, damaged o-rings

## E-18.04 Repairs actuators

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| E-18.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| E-18.04.02P | disassemble actuator | actuator is disassembled according to job procedures and manufacturers' specifications |
| E-18.04.03P | select replacement ***components*** | replacement ***components*** are selected according to manufacturers' specifications and process applications |
| E-18.04.04P | lubricate actuators | actuators are lubricated according to manufacturers' specifications |
| E-18.04.05P | reassemble actuator with replacement ***components*** | actuator is reassembled with replacement ***components*** according to job procedures and manufacturers' specifications |
| E-18.04.06P | verify operation and calibration before returning to service | operation and calibration are verified before returning to service |

## RANGE OF VARIABLES

***tools and equipment*** include: spring compressors, seal pullers

***components*** include: diaphragms, plates, couplings, springs, bushings, o-rings, circuit boards, motors

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-18.04.01L | demonstrate knowledge of actuators, their ***components***, characteristics, ***actions*** and ***applications*** | define terminology associated with actuators and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to actuators and their ***components*** |
| | | interpret information pertaining to actuators found on drawings, specifications and nameplates |
| | | identify ***types of actuators*** and their ***components***, and describe their characteristics, ***actions*** and ***applications*** |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify considerations and requirements for selecting final control elements, their ***components*** and accessories |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | describe ***environmental conditions*** |
| E-18.04.02L | demonstrate knowledge of regulatory requirements pertaining to actuators and their ***components*** | interpret codes and regulations pertaining to actuators and their ***components*** |
| E-18.04.03L | demonstrate knowledge of procedures used to repair actuators | identify ***tools and equipment*** used to repair actuators and describe their applications and procedures for use |
| | | describe procedures used to disassemble and reassemble actuators |
| | | describe procedures used to repair actuators |
| | | describe procedures used to lubricate actuators |
| E-18.04.04L | demonstrate knowledge of procedures used to calibrate actuators | describe procedures used to calibrate actuators |

## RANGE OF VARIABLES

***components*** include: diaphragms, plates, couplings, springs, bushings, o-rings, circuit boards, motors

***actions*** include: spring return, double-acting, rotary, direct, reverse

***applications*** include: fail-open, fail-close, fail-last

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation, lock-out/tag-out

***types of actuators*** include: pneumatic, hydraulic, electric, mechanical

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), positioners (electric, pneumatic, smart), air supply regulators, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***environmental conditions*** include: ambient temperature, location, contamination

***tools and equipment*** include: spring compressors, seal pullers

# TASK E-19 Installs and services positioners

## TASK DESCRIPTOR

Instrumentation and control technicians install, maintain, diagnose and repair positioners. Positioners are used for the precise positioning of final control elements. They must be properly installed, calibrated and maintained to ensure system efficiency and reliability.

## E-19.01 Installs positioners

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| E-19.01.01P | select positioner | positioner is selected according to application and manufacturers' specifications |
| E-19.01.02P | select positioner ***action*** | positioner ***action*** is selected according to process and engineered designs |
| E-19.01.03P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| E-19.01.04P | select mounting hardware | mounting hardware is selected according to application |

| | | |
|---|---|---|
| E-19.01.05P | orientate and mount positioner to actuator | positioner is orientated and mounted according to access and egress requirements, industry practices, engineered designs, manufacturers' specifications and codes |
| E-19.01.06P | connect and terminate positioner | positioner is connected and terminated using ***methods*** according to industry practices, engineered designs, manufacturers' specifications and codes |
| E-19.01.07P | configure and calibrate positioner | positioner is configured and calibrated according to specifications |
| E-19.01.08P | check positioner to verify operation is within specified parameters | positioner is verified to be within specified parameters by using test equipment and ***calibration procedures*** |
| E-19.01.09P | document ***information*** | ***information*** is documented |

## RANGE OF VARIABLES

***action*** includes: fail-close, fail-open, direct, reverse

***tools and equipment*** include: hand-held configurators, loop calibrators, pressure calibrators, hand tools

***methods*** include: wiring, tubing, bolting

***calibration procedures*** include: connecting calibration instruments, interpreting calibration results, evaluating causes and effects of calibration errors

***information*** includes: valve stroke, wear, overall condition, range of operation

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-19.01.01L | demonstrate knowledge of positioners, their ***components***, ***auxiliaries***, ***actions***, ***applications*** and parameters | define terminology associated with positioners and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to positioners and their ***components*** |
| | | interpret information pertaining to positioner devices found on drawings, specifications and nameplates |
| | | identify ***types of positioners***, their ***components*** and ***auxiliaries***, and describe their ***actions***, ***applications*** and parameters |
| | | describe relation of positioners to actuator type and application |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |

| | | |
|---|---|---|
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | identify considerations and requirements for selecting final control elements, their components and accessories |
| E-19.01.02L | demonstrate knowledge of regulatory requirements pertaining to positioners and their ***components*** | interpret codes and regulations pertaining to positioners and their ***components*** |
| E-19.01.03L | demonstrate knowledge of procedures used to install positioners, their ***components*** and ***auxiliaries*** | identify ***tools and equipment*** used to install positioners, their ***components*** and ***auxiliaries***, and describe their applications and procedures for use |
| | | describe procedures used to select and install positioners and their ***components*** |
| | | describe ***procedures used to configure positioners*** |
| | | describe importance of documenting information |
| E-19.01.04L | demonstrate knowledge of procedures used to calibrate positioners | describe ***calibration procedures*** |

## RANGE OF VARIABLES

***components*** include: levers, nozzles, flappers, diaphragms, feedback devices, current-to-pneumatic (I/P) transducers and bellows, magnets/pick-ups

***auxiliaries*** include: position switches, boosters, locks, speed controls

***actions*** include: fail-close, fail-open, direct, reverse

***applications*** include: sliding stem/rotary, piston/diaphragm

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation, lock-out/tag-out

***types of positioners*** include: rotary, pneumatic, electronic, digital, electro-hydraulic, electromechanical, smart

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), air supply regulators, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***tools and equipment*** include: hand-held configurators, loop calibrators, pressure calibrators, hand tools

***procedures used to configure positioners*** include: setting stroke, setting pressures, matching to actuator

***calibration procedures*** include: connecting calibration instruments, interpreting calibration results, evaluating causes and effects of calibration errors

## E-19.02 Maintains positioners

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-19.02.01P | inspect positioner for ***problems*** | positioner is inspected for ***problems*** according to specifications and maintenance schedule |
| E-19.02.02P | clean positioner ***components*** | positioner ***components*** are cleaned according to manufacturers' specifications |
| E-19.02.03P | verify that assembly strokes smoothly and does not oscillate throughout travel | assembly strokes smoothly and does not oscillate throughout travel |
| E-19.02.04P | calibrate and tune positioner | positioner is calibrated and tuned according to valve specifications and process application |
| E-19.02.05P | document ***information*** | ***information*** is documented |

### RANGE OF VARIABLES

***problems*** include: air leaks, feedback faults

***components*** include: levers, nozzles, flappers, diaphragms, feedback devices, I/P transducers and bellows, magnets/pick-ups

***information*** includes: valve stroke, wear, overall condition, range of operation

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| E-19.02.01L | demonstrate knowledge of positioners, their ***components***, ***auxiliaries***, ***actions***, ***applications*** and parameters | define terminology associated with positioners and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to positioners and their ***components*** |
| | | interpret information pertaining to positioners found on drawings, specifications and nameplates |
| | | identify ***types of positioners***, their ***components*** and ***auxiliaries***, and describe their ***actions***, ***applications*** and parameters |
| | | describe relation of positioners to actuator type and application |
| | | identify ***types of final control elements*** and describe their components, ***applications*** and operation |

| | | |
|---|---|---|
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify ***types of energy systems*** used to operate final control elements, and describe their characteristics and applications |
| | | identify considerations and requirements for selecting final control elements, their components and accessories |
| E-19.02.02L | demonstrate knowledge of regulatory requirements pertaining to positioners and their ***components*** | interpret codes and regulations pertaining to positioners and their ***components*** |
| E-19.02.03L | demonstrate knowledge of procedures used to maintain positioners, their ***components*** and ***auxiliaries*** | identify tools and equipment used to maintain positioners, their ***components*** and ***auxiliaries***, and describe their applications and procedures for use |
| | | describe procedures used to inspect positioners |
| | | describe procedures used to clean positioners |
| | | describe importance of documenting ***information*** |
| E-19.02.04L | demonstrate knowledge of procedures used to calibrate and tune positioners | describe procedures used to calibrate and tune positioners |

## RANGE OF VARIABLES

***components*** include: levers, nozzles, flappers, diaphragms, feedback devices, I/P transducers and bellows, magnets/pick-ups

***auxiliaries*** include: position switches, boosters, locks, speed controls

***actions*** include: fail-close, fail-open

***applications*** include: sliding stem/rotary, piston/diaphragm

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation, lock-out/tag-out

***types of positioners*** include: rotary, pneumatic, electronic, digital, electro-hydraulic, electromechanical, smart

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), air supply regulators, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***information*** includes: valve stroke, wear, overall condition, range of operation

## E-19.03 Diagnoses positioners

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-19.03.01P | select and use ***diagnostic tools and equipment*** | ***diagnostic tools and equipment*** are selected and used according to industry standards and practices |
| E-19.03.02P | verify positioner operation and configuration | positioner operation and configuration are verified to assess ***faults*** |
| E-19.03.03P | determine probable root cause and location of ***faults*** and identify required repairs | probable root cause and location of ***faults*** are determined and required repairs are identified |

### RANGE OF VARIABLES

***diagnostic tools and equipment*** include: smart communicators, hand-held configurators, diagnostic software, dial gauges, pressure gauges, pressure calibrators, current calibrators

***faults*** include: plugged nozzles, defective I/P transducer

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| E-19.03.01L | demonstrate knowledge of positioners, their ***components***, ***auxiliaries***, ***actions***, ***applications*** and parameters | define terminology associated with positioners and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to positioners and their ***components*** |
| | | interpret ***information*** pertaining to positioner devices found on drawings, specifications and nameplates |
| | | identify ***types of positioners***, their ***components*** and ***auxiliaries***, and describe their ***actions***, ***applications*** and parameters |
| | | describe relation of positioners to actuator type and application |
| | | identify ***types of final control elements*** and describe their components, applications and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |

| | | |
|---|---|---|
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | identify considerations and requirements for selecting final control elements, their components and accessories |
| | | describe relation of positioners to actuator type and application |
| | | identify use of diagnostic information found in smart positioners for troubleshooting |
| | | identify use of raw data found in smart positioners for device setup |
| E-19.03.02L | demonstrate knowledge of regulatory requirements pertaining to positioners and their ***components*** | interpret codes and regulations pertaining to positioners and their ***components*** |
| E-19.03.03L | demonstrate knowledge of procedures used to diagnose positioners, their ***components*** and ***auxiliaries*** | identify ***diagnostic tools and equipment*** used to diagnose positioners, their ***components*** and ***auxiliaries***, and describe their applications and procedures for use |
| | | describe procedures used to diagnose positioners |
| | | describe possible ***faults*** of positioners |

## RANGE OF VARIABLES

***components*** include: levers, nozzles, flappers, diaphragms, feedback devices, I/P transducers and bellows, magnets/pick-ups

***auxiliaries*** include: position switches, boosters, locks, speed controls

***actions*** include: fail-close, fail-open, direct, reverse

***applications*** include: sliding stem/rotary, piston/diaphragm

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored mechanical energy (spring compression, compressed air), chemical, isolation, lock-out/tag-out

***information*** includes: valve stroke, wear, overall condition, range of operation

***types of positioners*** include: rotary, pneumatic, electronic, digital, electro-hydraulic, electromechanical, smart

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), air supply regulators, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***diagnostic tools and equipment*** include: smart communicators, hand-held configurators, diagnostic software, dial gauges, pressure gauges, pressure calibrators, current calibrators

***faults*** include: plugged nozzles, defective I/P transducer

## E-19.04 Repairs positioners

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-19.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| E-19.04.02P | disassemble positioner | positioner is disassembled according to job procedures and manufacturers' specifications |
| E-19.04.03P | select replacement ***components*** | replacement ***components*** are selected according to positioner specifications and applications |
| E-19.04.04P | reassemble positioner with replacement ***components*** | positioner is reassembled with replacement ***components*** according to job procedures and manufacturers' recommendations |

### RANGE OF VARIABLES

***tools and equipment*** include: smart communicators, hand-held configurators, diagnostic software, dial gauges, pressure gauges, pressure calibrators, loop calibrators

***components*** include: levers, nozzles, flappers, diaphragms, feedback devices, I/P transducers and bellows, magnets/pick-ups

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| E-19.04.01L | demonstrate knowledge of positioners, their ***components*** and ***auxiliaries***, and describe their ***actions***, ***applications*** and parameters | define terminology associated with positioners and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to positioners and their ***components*** |
| | | interpret information pertaining to positioner devices found on drawings, specifications and nameplates |
| | | identify ***types of positioners***, their ***components*** and ***auxiliaries***, and describe their ***actions***, ***applications*** and parameters |
| | | describe relation of positioners to actuator type and application |

| | | |
|---|---|---|
| | | identify ***types of final control elements*** and describe their components, ***applications*** and operation |
| | | identify ***types of final control element accessories*** and describe their purpose and operation |
| | | identify ***types of energy systems*** used to operate final control elements and describe their characteristics and applications |
| | | identify considerations and requirements for selecting final control elements, their components and accessories |
| | | describe relation of positioners to actuator type and application |
| E-19.04.02L | demonstrate knowledge of regulatory requirements pertaining to positioners and their ***components*** | interpret codes and regulations pertaining to positioners and their ***components*** |
| E-19.04.03L | demonstrate knowledge of procedures used to repair positioners, their ***components*** and ***auxiliaries*** | identify ***tools and equipment*** used to repair positioners, their ***components*** and ***auxiliaries***, and describe their applications and procedures for use |
| | | describe procedures used to disassemble and reassemble positioners |
| | | describe procedures used to repair positioners |

## RANGE OF VARIABLES

***components*** include: levers, nozzles, flappers, diaphragms, feedback devices, I/P transducers and bellows, magnets/pick-ups

***auxiliaries*** include: position switches, boosters, locks, speed controls

***actions*** include: fail-close, fail-open, direct, reverse

***applications*** include: sliding stem/rotary, piston/diaphragm

***hazards*** include: energy state awareness (pressure, voltage, mechanical, temperature), stored

***types of positioners*** include: rotary, pneumatic, electronic, digital, electro-hydraulic, electromechanical, smart

***types of final control elements*** include: valves, dampers/louvres, adjustable positive displacement pumps, motors, process regulators, VSD

***types of final control element accessories*** include: actuators (hydraulic, pneumatic, electric), boosters (volume, pressure), air supply regulator, switches, hand wheels

***types of energy systems*** include: hydraulic, pneumatic, electric, manual operation

***tools and equipment*** include: smart communicators, hand-held configurators, diagnostic software, dial gauges, pressure gauges, pressure calibrators, loop calibrators

mechanical energy (spring compression, compressed air), chemical, isolation, lock-out/tag-out

# TASK E-20 Configures and services variable speed drives (VSD)

## TASK DESCRIPTOR

Instrumentation and control technicians configure, maintain, diagnose and repair VSD to ensure system efficiency and reliability. VSD are used for the precise control of drives. For the purpose of this standard, VSD include variable frequency drives (VFD).

## E-20.01 Configures VSD

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| E-20.01.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| E-20.01.02P | calibrate VSD | VSD are calibrated according to manufacturers' instructions, application and data sheets |
| E-20.01.03P | set initial parameters and settings of VSD | initial parameters and settings of VSD are set according to engineered designs, manufacturers' instructions, application and data sheets |
| E-20.01.04P | back up and document configuration and calibration settings for future data recovery | configuration and calibration settings are backed up and documented for future data recovery |
| E-20.01.05P | test and verify operation of VSD is within specified parameters | operation of VSD is within specified parameters by using operational and maintenance procedures |

## RANGE OF VARIABLES

***tools and equipment*** include: software, configurators, frequency generator, oscilloscope, tachometer, multimeter, thermal imaging camera

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-20.01.01L | demonstrate knowledge of VSD and their components, characteristics, ***operating principles***, ***parameters and applications*** | define terminology associated with VSD and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to VSD |

| | | |
|---|---|---|
| | | interpret information pertaining to VSD found on ***documentation*** |
| | | identify ***power degradation considerations*** with VSD |
| | | identify ***types of VSD*** and their components, and describe their characteristics and ***operating principles*** |
| | | describe VSD configurations, interfaces, ***parameters and applications*** |
| | | identify ***types of motors*** used with VSD and describe their characteristics and operating principles |
| | | describe ***diagnostic features*** of VSD |
| E-20.01.02L | demonstrate knowledge of regulatory requirements pertaining to VSD and their components | interpret codes and regulations pertaining to VSD and their components |
| E-20.01.03L | demonstrate knowledge of procedures used to configure VSD and their components | identify ***tools and equipment*** used to configure VSD and their components, and describe their applications and procedures for use |
| | | describe procedures used to configure VSD and their components |
| | | describe importance of documenting configuration information |
| E-20.01.04L | demonstrate knowledge of procedures used to calibrate VSD and their components | identify ***tools and equipment*** used to calibrate VSD and their components, and describe their applications and procedures for use |
| | | describe procedures used to calibrate VSD and their components |
| | | describe importance of documenting calibration information |

## RANGE OF VARIABLES

***operating principles*** include: tuning parameter identification, signal isolation DCS/VFD

***parameters and applications*** include: power requirements, amperage, limitations, input and output devices

***hazards*** include: energy state awareness, capacitors, electrostatic discharge

***documentation*** includes: drawings, specifications, nameplates

***power degradation considerations*** include: power quality/harmonics, filters, cable routing, motor compatibility

***types of VSD*** include: AC drives, DC drives, VFDs, turbines

***types of motors*** include: DC control (servo, stepping), AC single-phase, AC three-phase, inverter rated

***diagnostic features*** include: fault codes, error codes, indicator lights

***tools and equipment*** include: software, configurators, frequency generator, oscilloscope, tachometer, multimeter, thermal imaging camera

## E-20.02 Maintains VSD

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-20.02.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| E-20.02.02P | inspect VSD for ***abnormal conditions*** | VSD are inspected for ***abnormal conditions*** according to manufacturers' specifications |
| E-20.02.03P | verify inputs and outputs | inputs and outputs are verified |
| E-20.02.04P | upgrade software and firmware | software and firmware are upgraded to avoid obsolescence and to resolve existing or previous software and firmware deficiencies |
| E-20.02.05P | follow recommended maintenance practices and schedules | recommended maintenance practices and schedules are followed according to manufacturers' specifications |
| E-20.02.06P | back up and document configuration settings for future data recovery | configuration settings are backed up and documented for future data recovery |

### RANGE OF VARIABLES

***tools and equipment*** include: multimeters, software, configurators, loop calibrators, frequency generator, oscilloscope, tachometer, thermal imaging camera

***abnormal conditions*** include: contamination, loose connections, excessive heat

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| E-20.02.01L | demonstrate knowledge of VSD and their components, characteristics, ***operating principles***, ***parameters and applications*** | define terminology associated with VSD and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to VSD and their components |
| | | interpret information pertaining to VSD found on ***documentation*** |
| | | identify ***power degradation considerations*** with VSD |
| | | identify ***types of VSD*** and their components, and describe their characteristics and ***operating principles*** |

| | | |
|---|---|---|
| | | describe VSD configurations, interfaces, ***parameters and applications*** |
| | | identify ***types of motors*** used with VSD and describe their characteristics and operating principles |
| | | describe ***diagnostic features*** of VSD |
| E-20.02.02L | demonstrate knowledge of regulatory requirements pertaining to VSD and their components | interpret codes and regulations pertaining to VSD and their components |
| E-20.02.03L | demonstrate knowledge of procedures used to maintain VSD and their components | identify ***tools and equipment*** used to maintain VSD and their components, and describe their applications and procedures for use |
| | | describe procedures used to inspect VSD for ***abnormal conditions*** |
| | | describe procedures used to upgrade software and firmware |
| | | describe importance of documenting configuration settings |

## RANGE OF VARIABLES

***operating principles*** include: tuning parameter identification, signal isolation DCS/VFD

***parameters and applications*** include: power requirements, amperage, limitations, input and output devices

***hazards*** include: energy state awareness, capacitors, electrostatic discharge

***documentation*** includes: drawings, specifications, nameplates

***power degradation considerations*** include: power quality/harmonics, filters, cable routing, motor compatibility

***types of VSD*** include: AC drives, DC drives, VFDs, turbines

***types of motors*** include: DC control (servo, stepping), AC single-phase, AC three-phase, inverter rated

***diagnostic features*** include: fault codes, error codes, indicator lights

***tools and equipment*** include: multimeters, software, configurators, loop calibrators, frequency generator, oscilloscope, tachometer, thermal imaging camera

***abnormal conditions*** include: contamination, loose connections, excessive heat

## E-20.03 Diagnoses VSD

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-20.03.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| E-20.03.02P | interpret VSD fault codes and indicator lights | VSD fault codes and indicator lights are interpreted to identify ***conditions*** |
| E-20.03.03P | determine probable root cause and location of faults and identify required repairs | probable root cause and location of faults are determined and required repairs are identified |

### RANGE OF VARIABLES

***tools and equipment*** include: tachometers, megohmmeters, computers, multimeters, configurators, frequency generator, oscilloscope, thermal imaging camera

***conditions*** include: overcurrent, under-voltage, ground faults

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| E-20.03.01L | demonstrate knowledge of VSD and their components, characteristics, ***operating principles***, ***parameters and applications*** | define terminology associated with VSD and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to VSD |
| | | interpret information pertaining to VSD found on ***documentation*** |
| | | identify ***power degradation considerations*** with VSD |
| | | identify ***types of VSD*** and their components, and describe their characteristics and ***operating principles*** |
| | | describe VSD configurations, interfaces, ***parameters and applications*** |
| | | identify ***types of motors*** used with VSD and describe their characteristics and operating principles |
| | | describe ***diagnostic features*** of VSD |
| E-20.03.02L | demonstrate knowledge of regulatory requirements pertaining to VSD and their components | interpret codes and regulations pertaining to VSD and their components |

| | | |
|---|---|---|
| E-20.03.03L | demonstrate knowledge of procedures used to diagnose VSD and their components | identify ***tools and equipment*** used to diagnose VSD and their components, and describe their applications and procedures for use |
| | | describe procedures used to diagnose VSD and their components |
| | | interpret VSD ***diagnostic features*** |
| | | describe possible ***conditions*** of VSD |

## RANGE OF VARIABLES

***operating principles*** include: tuning parameter identification, signal isolation DCS/VFD

***parameters and applications*** include: power requirements, amperage, limitations, input and output devices

***hazards*** include: energy state awareness, capacitors, electrostatic discharge, arc flash

***documentation*** includes: drawings, specifications, nameplates

***power degradation considerations*** include: power quality/harmonics, filters, cable routing, motor compatibility

***types of VSD*** include: AC drives, DC drives, VFDs, turbines

***types of motors*** include: DC control (servo, stepping), AC single-phase, AC three-phase, inverter rated

***diagnostic features*** include: fault codes, error codes, indicator lights

***tools and equipment*** include: tachometers, megohmmeters, computers, multimeters, configurators, frequency generator, oscilloscope, thermal imaging camera

***conditions*** include: overcurrent, under-voltage, ground faults

## E-20.04 Repairs VSD

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| E-20.04.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to industry standards and practices |
| E-20.04.02P | select replacement components | replacement components are selected according to applications and manufacturers' specifications |
| E-20.04.03P | replace defective components | defective components are replaced according to job procedures and manufacturers' recommendations |

| | | |
|---|---|---|
| E-20.04.04P | test and adjust operating parameters | operating parameters are tested and adjusted according to application requirements |
| E-20.04.05P | verify operation before returning to service | operation is verified before returning to service |

## RANGE OF VARIABLES

***tools and equipment*** include: software, configurators, frequency generator, oscilloscope, tachometer, multimeter, thermal imaging camera

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| E-20.04.01L | demonstrate knowledge of VSD and their components, characteristics, ***operating principles***, ***parameters and applications*** | define terminology associated with VSD and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to VSD |
| | | interpret information pertaining to VSD found on ***documentation*** |
| | | identify ***power degradation considerations*** with VSD |
| | | identify ***types of VSD*** and their components, and describe their characteristics and ***operating principles*** |
| | | describe VSD configurations, interfaces, ***parameters and applications*** |
| | | identify ***types of motors*** used with VSD and describe their characteristics and operating principles |
| | | describe ***diagnostic features*** of VSD |
| E-20.04.02L | demonstrate knowledge of regulatory requirements pertaining to VSD and their components | interpret codes and regulations pertaining to VSD and their components |
| E-20.04.03L | demonstrate knowledge of procedures used to repair VSD and their components | identify ***tools and equipment*** used to repair VSD and their components, and describe their applications and procedures for use |
| | | describe procedures used to test and adjust operating parameters of VSD |

## RANGE OF VARIABLES

***operating principles*** include: tuning parameter identification, signal isolation DCS/VFD

***parameters and applications*** include: power requirements, amperage, limitations, input and output devices

***hazards*** include: energy state awareness, capacitors, electrostatic discharge

***documentation*** includes: drawings, specifications, nameplates

***power degradation considerations*** include: power quality/harmonics, filters, cable routing, motor compatibility

***types of VSD*** include: AC drives, DC drives, VFDs, turbines

***types of motors*** include: DC control (servo, stepping), AC single-phase, AC three-phase, inverter rated

***diagnostic features*** include: fault codes, error codes, indicator lights

***tools and equipment*** include: software, configurators, frequency generator, oscilloscope, tachometer, multimeter, thermal imaging camera

# MAJOR WORK ACTIVITY F

# Installs and services communication systems and devices

## TASK F-21 Installs and services control network systems

### TASK DESCRIPTOR

Instrumentation and control technicians install, configure, diagnose, maintain and repair control network systems and their components. Control network systems transfer process information in a digital format.

### F-21.01 Performs installation and configuration on control network systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| F-21.01.01P | select ***control network system components*** | ***control network system components*** are selected according to application and environment |
| F-21.01.02P | mount ***control network system components*** | ***control network system components*** are mounted according to industry practices, engineered designs, manufacturers' specifications and codes |
| F-21.01.03P | terminate and label connections | connections are terminated and labelled using connectors, tools and supplies according to ***communications media*** and network equipment being used |
| F-21.01.04P | connect network equipment | network equipment is connected using ***communications media*** according to industry practices, engineered designs, manufacturers' specifications and codes |
| F-21.01.05P | verify operation of system | operation of system is verified to be within specified parameters by testing signal strength of each loop and throughout, and checking error counters |

| | | |
|---|---|---|
| F-21.01.06P | configure network equipment | network equipment is configured using software and hardware to meet ***system design criteria*** |
| F-21.01.07P | back up and document configuration settings | configuration settings are backed up and documented for future reference or data recovery |

## RANGE OF VARIABLES

***control network system components*** include: switches, repeaters, hubs, routers, antennas, converters, transducers, multiplexers, modems, cables (fibre optic, coaxial, twisted pair, armoured, non-armoured), filters, cards, software, firmware, links (radio, cellular, satellite), power supplies

***communications media*** include: fibre optics (multimode/single mode transmission), wireless (satellite, cellular, Bluetooth, radio frequency [RF], IR), wired (coaxial, shielded twisted pair [STP], unshielded twisted pairs [UTP])

***system design criteria*** include: setting device addresses, port parameters

| KNOWLEDGE | | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| F-21.01.01L | demonstrate knowledge of control network systems, their ***components***, characteristics and operation | identify types of ***communications media*** and describe their characteristics and applications |
| | | identify types of ***communication topologies*** and describe their characteristics and applications |
| | | identify types of ***communication protocols*** and describe their characteristics, applications and limitations |
| | | identify ***control network system components***, and describe their characteristics and operation |
| | | define terminology associated with ***communications media, communication topologies, communication protocols*** and ***control network system components*** |
| | | identify hazards and describe safe work practices pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** |
| | | interpret information pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** found on drawings and specifications |

| | | |
|---|---|---|
| | | identify types of programming languages and describe their characteristics, applications and limitations |
| | | describe potential causes of ***interference*** |
| | | describe importance of documenting configuration settings and changes |
| F-21.01.02L | demonstrate knowledge of regulatory requirements pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** | interpret ***standards, codes and regulations*** pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** |
| | | identify types of ***communication standards*** and describe their characteristics, applications and limitations |
| F-21.01.03L | demonstrate knowledge of procedures used to install and configure control network systems | describe procedures used to select ***control network system components*** and ***communication protocols*** |
| | | identify tools and equipment used to install, upgrade and configure ***control network system components***, and describe their applications and procedures for use |
| | | describe procedures to configure ***communication protocols*** |
| | | describe ***wiring installation requirements*** |
| | | describe ***procedures used to minimize electromagnetic interference (EMI) and attenuation*** |

## RANGE OF VARIABLES

***control network system components*** include: switches, repeaters, hubs, routers, antennas, converters, transducers, multiplexers, modems, cables (fibre optic, coaxial, twisted pair, armoured, non-armoured), filters, cards, software, firmware, links (radio, cellular, satellite), power supplies

***communications media*** include: fibre optics (multimode/single mode transmission), wireless (satellite, cellular, Bluetooth, radio frequency [RF], IR), wired (coaxial, shielded twisted pair [STP], unshielded twisted pairs [UTP])

***communication topologies*** include: ring, bus, star, tree, mesh, hybrid

***communication protocols*** include: Fieldbus, Profibus, Modbus, Transport Control Protocol/Internet Protocol (TCP/IP), Highway Addressable Remote Transducer (HART), DeviceNet/ControlNet, BACnet, open systems interconnection (OSI)

***interference*** includes: overlapping channels, Wi-Fi, electromagnetic interference

***standards, codes and regulations*** include: CEC, ISA, IEEE, CSA, CRTC

***communication standards*** include: RS232, RS422, RS423, RS485, Ethernet, Universal Serial Bus (USB), North American Electric Reliability Corporation (NERC)

***wiring installation requirements*** include: connections (crimping, terminal blocks, soldering, protection, connectors), shielding, grounding, sizing, routing of runs, stripping, labelling/colour-coding

***procedures used to minimize EMI and attenuation*** include: grounding, shielding, electromagnetic compatibility (EMC)

## F-21.02 Diagnoses control network systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| F-21.02.01P | perform visual inspection of network equipment | visual inspection of network equipment is performed to detect signs of ***faults*** |
| F-21.02.02P | perform physical inspection of cabling and connections | physical inspection of cabling and connections is performed by cleaning and reseating connections |
| F-21.02.03P | observe indicator and status lights | indicator and status lights are observed to identify normal and abnormal operation |
| F-21.02.04P | test system components for ***faults*** | system components are tested for ***faults*** using ***diagnostic tools and equipment*** |
| F-21.02.05P | review configuration to ensure no corruption exists | configuration is reviewed using software and documentation to ensure no corruption exists |
| F-21.02.06P | determine steps required to address deficiencies | steps required to address deficiencies are determined based on probable root cause |
| F-21.02.07P | review documentation and historical data | documentation and historical data is reviewed to assist in determining probable root cause |

## RANGE OF VARIABLES

***faults*** include: physical damage, faulty connections, faulty lights, error codes
***diagnostic tools and equipment*** include: analyzers, multimeters, laptop, breakout boxes

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| F-21.02.01L | demonstrate knowledge of control network systems, their ***components***, characteristics and operation | identify types of ***communications media*** and describe their characteristics and applications |
| | | identify types of ***communication topologies*** and describe their characteristics and applications |
| | | identify types of ***communication protocols*** and describe their characteristics, applications and limitations |
| | | identify ***control network system components***, and describe their characteristics and operation |
| | | define terminology associated with ***communications media, communication topologies, communication protocols*** and ***control network system components*** |
| | | identify hazards and describe safe work practices pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** |
| | | interpret information pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** found on drawings and specifications |
| | | identify types of programming languages and describe their characteristics, applications and limitations |
| | | describe potential causes of ***interference*** |
| | | describe importance of documenting configuration settings and changes |
| F-21.02.02L | demonstrate knowledge of regulatory requirements pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** | interpret ***standards, codes and regulations*** pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** |

| | | |
|---|---|---|
| | | identify types of ***communication standards*** and describe their characteristics, applications and limitations |
| F-21.02.03L | demonstrate knowledge of procedures used to diagnose control network systems | identify ***diagnostic tools and equipment*** used to diagnose control network systems, and describe their applications and procedures for use |
| | | describe procedures used to diagnose ***control network system components*** and ***communication protocols*** |
| | | describe possible ***faults*** of network equipment |

## RANGE OF VARIABLES

***control network system components*** include: switches, repeaters, hubs, routers, antennas, converters, transducers, multiplexers, modems, cables (fibre optic, coaxial, twisted pair, armoured, non-armoured), filters, cards, software, firmware, links (radio, cellular, satellite), power supplies

***communications media*** include: fibre optics (multimode/single mode transmission), wireless (satellite, cellular, Bluetooth, RF, IR), wired (coaxial, STP, UTP)

***communication topologies*** include: ring, bus, star, tree, mesh, hybrid

***communication protocols*** include: Fieldbus, Profibus, Modbus, TCP/IP, HART, DeviceNet/ControlNet, BACnet, OSI

***interference*** includes: overlapping channels, Wi-Fi, electromagnetic interference

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***communication standards*** include: RS232, RS422, RS423, RS485, Ethernet, USB, NERC

***diagnostic tools and equipment*** include: analyzers, multimeters, laptop, breakout boxes

***faults*** include: physical damage, faulty connections, faulty lights, error codes

## F-21.03 Performs maintenance and repairs on control network systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| F-21.03.01P | use software to check error logs, signal strength and counter-reading | software is used to check error logs, signal strength and counter readings to identify eventual issues through data analysis of patterns |
| F-21.03.02P | clean network equipment and ***connectors*** | network equipment and ***connectors*** are cleaned according to manufacturers' specifications |
| F-21.03.03P | repair or replace ***control network system components*** | ***control network system components*** are repaired or replaced according to results of root cause diagnostics |

| | | |
|---|---|---|
| F-21.03.04P | verify operation before returning to service | operation is verified before returning to service |
| F-21.03.05P | back up and document configuration settings | configuration settings are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***connectors*** include: USB, FireWire, serial, RJ45, RJ11, M12, M10, Bayonet Neill Concelman (BNC), cannon plugs, fibre optics

***control network system components*** include: switches, repeaters, hubs, routers, antennas, converters, transducers, multiplexers, modems, cables (fibre optic, coaxial, twisted pair, armoured, non-armoured), filters, cards, software, firmware, links (radio, cellular, satellite), power supplies

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| F-21.03.01L | demonstrate knowledge of control network systems and their ***components***, their characteristics and operation | identify types of ***communications media*** and describe their characteristics and applications |
| | | identify types of ***communication topologies*** and describe their characteristics and applications |
| | | identify types of ***communication protocols*** and describe their characteristics, applications and limitations |
| | | identify ***control network system components***, and describe their characteristics and operation |
| | | define terminology associated with ***communications media, communication topologies, communication protocols*** and ***control network system components*** |
| | | identify hazards and describe safe work practices pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** |
| | | interpret information pertaining to ***communication media, communication topologies, communication protocols*** and ***control network system components*** found on drawings and specifications |
| | | identify types of programming languages and describe their characteristics, applications and limitations |
| | | describe potential causes of ***interference*** |

| | | |
|---|---|---|
| | | describe importance of documenting configuration settings and changes |
| F-21.03.02L | demonstrate knowledge of regulatory requirements pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** | interpret ***standards, codes and regulations*** pertaining to ***communications media, communication topologies, communication protocols*** and ***control network system components*** |
| | | identify types of ***communication standards*** and describe their characteristics, applications and limitations |
| F-21.03.03L | demonstrate knowledge of procedures used to maintain and repair control network systems and their ***components*** | identify ***diagnostic tools and equipment*** used to maintain and repair control network systems and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to maintain and repair control network systems and their ***components*** |

## RANGE OF VARIABLES

***control network system components*** include: switches, repeaters, hubs, routers, antennas, converters, transducers, multiplexers, modems, cables (fibre optic, coaxial, twisted pair, armoured, non-armoured), filters, cards, software, firmware, links (radio, cellular, satellite), power supplies

***communications media*** include: fibre optics (multimode/single mode transmission), wireless (satellite, cellular, Bluetooth, RF, IR), wired (coaxial, STP, UTP)

***communication topologies*** include: ring, bus, star, tree, mesh, hybrid

***communication protocols*** include: Fieldbus, Profibus, Modbus, TCP/IP, HART, DeviceNet/ControlNet, BACnet, OSI

***interference*** includes: overlapping channels, Wi-Fi, electromagnetic interference

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***communication standards*** include: RS232, RS422, RS423, RS485, Ethernet, USB, NERC

***diagnostic tools and equipment*** include: analyzers, multimeters, laptop

# TASK F-22 Installs and services signal converters

## TASK DESCRIPTOR

Instrumentation and control technicians install, configure, calibrate, diagnose, maintain, repair and replace signal converters. Analogue-to-analogue signals are covered in the task related to signal transducers. Communication systems use signal converters to convert one signal to another that will be understood by the process control system. This could include converting analogue-to-digital signals or digital-to-analogue signals.

## F-22.01 Performs installation and configuration of signal converters

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| F-22.01.01P | select signal converters | signal converters are selected according to required functionality and environment |
| F-22.01.02P | select wiring | wiring is selected according to industry standards, codes and practices |
| F-22.01.03P | mount signal converters | signal converters are mounted according to industry practices, engineered designs, manufacturers' specifications and codes |
| F-22.01.04P | terminate wiring | wiring is terminated according to industry practices, engineered designs, manufacturers' specifications and codes |
| F-22.01.05P | configure signal converters | signal converters are configured according to manufacturers' specifications, process requirements and data sheets |
| F-22.01.06P | calibrate signal converters | signal converters are calibrated to required specifications using ***calibration instruments*** according to manufacturers' specifications, process requirements and data sheets |
| F-22.01.07P | back up and document settings | settings are backed up and documented for future reference or data recovery |

## RANGE OF VARIABLES

***calibration instruments*** include: hand-held configurators, laptop

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| F-22.01.01L | demonstrate knowledge of signal converters, their characteristics and applications | define terminology associated with signal converters |
| | | identify ***types of signal converters*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to installation and configuration of signal converters |
| | | interpret information pertaining to signal converters found on drawings and specifications |
| | | describe potential causes of interference |
| F-22.01.02L | demonstrate knowledge of regulatory requirements pertaining to signal converters | interpret ***standards, codes and regulations*** pertaining to signal converters |
| F-22.01.03L | demonstrate knowledge of procedures used to install and configure signal converters | identify tools and equipment used to install and configure signal converters and describe their applications and procedures for use |
| | | describe procedures used to select, install and configure signal converters |
| | | describe ***wiring installation requirements*** |
| F-22.01.04L | demonstrate knowledge of procedures used to calibrate signal converters | describe procedures and ***parameters*** to calibrate signal converters |
| | | perform ***conversions and calculations*** for signal converters |

## RANGE OF VARIABLES

***types of signal converters*** include: digital-to-analogue (D/A), analogue-to-digital (A/D)

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***wiring installation requirements*** include: connections (crimping, terminal blocks, soldering, protection, connectors), shielding, grounding, sizing, routing of runs, stripping, labelling/colour-coding

***parameters*** include: zero, span, range, accuracy, trim adjustments

***conversions and calculations*** include: A/D, D/A

## F-22.02 Diagnoses signal converters

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| F-22.02.01P | perform inspection of signal converters | inspection of signal converters is performed to detect ***problems*** |
| F-22.02.02P | check function of signal converters | function of signal converters is checked to isolate ***problems*** |
| F-22.02.03P | check calibration and configuration of signal converters | calibration and configuration of signal converters are checked using ***diagnostic tools and equipment*** |
| F-22.02.04P | determine steps required to address deficiencies | steps required to address deficiencies are determined based on probable root cause |
| F-22.02.05P | review documentation and historical data | documentation and historical data are reviewed to assist in determining probable root cause |

### RANGE OF VARIABLES

***problems*** include: inadequate power, physical damage, faulty connections, contamination, corrosion
***diagnostic tools and equipment*** include: multimeters, hand-held configurators, laptop

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| F-22.02.01L | demonstrate knowledge of signal converters, their characteristics and applications | define terminology associated with signal converters |
| | | identify ***types of signal converters*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to diagnosis of signal converters |
| | | interpret information pertaining to signal converters found on drawings and specifications |
| | | describe potential causes of interference |
| F-22.02.02L | demonstrate knowledge of regulatory requirements pertaining to signal converters | interpret ***standards, codes and regulations*** pertaining to signal converters |

| | | |
|---|---|---|
| F-22.02.03L | demonstrate knowledge of procedures used to diagnose signal converters | identify ***diagnostic tools and equipment*** used to diagnose signal converters, and describe their applications and procedures for use |
| | | describe procedures used to inspect and diagnose signal converters |
| | | describe possible ***problems*** of signal converters |
| | | perform ***conversions and calculations*** for signal converters |

## RANGE OF VARIABLES

***types of signal converters*** include: D/A, A/D
***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC
***diagnostic tools and equipment*** include: multimeters, hand-held configurators, laptop
***problems*** include: inadequate power, physical damage, faulty connections, contamination, corrosion
***conversions and calculations*** include: A/D, D/A

## F-22.03 Performs maintenance and repairs on signal converters

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| F-22.03.01P | perform inspection of signal converters | inspection of signal converters is performed to detect ***problems*** |
| F-22.03.02P | perform function check of signal converters | function check of signal converters is performed to confirm proper operation |
| F-22.03.03P | perform scheduled maintenance activities | scheduled maintenance activities are performed according to maintenance specifications and procedures |
| F-22.03.04P | repair or replace signal converters | signal converters are repaired or replaced according to results of root cause analysis |
| F-22.03.05P | verify operation and calibration | operation and calibration are verified before returning to service |
| F-22.03.06P | back up and document settings | settings are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***problems*** include: inadequate power, physical damage, faulty connections, contamination, corrosion

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| F-22.03.01L | demonstrate knowledge of signal converters, their characteristics and applications | define terminology associated with signal converters |
| | | identify ***types of signal converters*** and describe their characteristics and applications |
| | | identify hazards and describe safe work practices pertaining to diagnosis of signal converters |
| | | interpret information pertaining to signal converters found on drawings and specifications |
| | | describe potential causes of interference |
| | | describe importance of documenting settings and changes |
| F-22.03.02L | demonstrate knowledge of regulatory requirements pertaining to signal converters | interpret ***standards, codes and regulations*** pertaining to signal converters |
| F-22.03.03L | demonstrate knowledge of procedures used to maintain, repair and replace signal converters | identify tools and equipment and software used to maintain and repair signal converters and describe their applications and procedures for use |
| | | describe procedures used to inspect signal converters |
| | | describe procedures used to maintain, repair and replace signal converters |
| | | describe possible ***problems*** of signal converters |
| F-22.03.04L | demonstrate knowledge of procedures used to calibrate signal converters | describe procedures used to calibrate signal converters |
| | | perform ***conversions and calculations*** for signal converters |

## RANGE OF VARIABLES

***types of signal converters*** include: D/A, A/D
***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC
***problems*** include: inadequate power, physical damage, faulty connections, contamination, corrosion
***conversions and calculations*** include: A/D, D/A

# TASK F-23 Installs and services gateways, bridges and media converters

## TASK DESCRIPTOR

Instrumentation and control technicians install, configure, maintain, diagnose and repair gateways, bridges and media converters. Gateways, bridges and media converters convert process information between media types, devices and systems.

## F-23.01 Performs installation and configuration of gateways, bridges and media converters

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| F-23.01.01P | select gateways, bridges and media converters | gateways, bridges and media converters are selected according to application requirements and ***communication protocols*** |
| F-23.01.02P | mount gateways, bridges and media converters | gateways, bridges and media converters are mounted according to industry practices, engineered designs, and manufacturers' specifications and codes |
| F-23.01.03P | select cabling | cabling is selected according to application requirements, industry ***standards, codes and regulations*** |
| F-23.01.04P | connect gateways, bridges and media converters | gateways, bridges and media converters are connected according to industry practices, engineered designs, manufacturers' specifications and codes |
| F-23.01.05P | select and use tools, equipment and software | tools, equipment and software are selected and used according to manufacturers' specifications |
| F-23.01.06P | set protocols, addressing, port parameters and I/O configurations | protocols, addressing, port parameters and I/O are set according to engineered designs, documentation and manufacturers' specifications |
| F-23.01.07P | back up and document configuration settings | configuration settings are backed up and documented for future reference or data recovery |

## RANGE OF VARIABLES

***communication protocols*** include: Fieldbus, Profibus, Modbus, TCP/IP, HART, DeviceNet/ControlNet, BACnet, OSI

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| F-23.01.01L | demonstrate knowledge of gateways, bridges and media converters, their characteristics, applications and ***limitations*** | define terminology associated with gateways, bridges and media converters |
| | | identify types of gateways, bridges and media converters, and describe their characteristics, applications and ***limitations*** |
| | | identify ***communications media*** and describe their characteristics and applications |
| | | interpret information pertaining to gateways, bridges and media converters found on drawings and specifications |
| | | identify types of network, ***communication protocols*** and addressing structures |
| | | identify data structures and system formats |
| F-23.01.02L | demonstrate knowledge of regulatory requirements pertaining to gateways, bridges and media converters | interpret ***standards, codes and regulations*** pertaining to gateways, bridges and media converters |
| F-23.01.03L | demonstrate knowledge of procedures used to install and configure gateways, bridges and media converters | identify tools and equipment used to install and configure gateways, bridges and media converters, and describe their applications and procedures for use |
| | | describe procedures used to select, install and configure gateways, bridges and media converters |
| | | identify types of cables used in installation of gateways, bridges and media converters |
| | | describe procedures used to set protocols, addressing and port parameters |

## RANGE OF VARIABLES

***limitations*** include: memory size, transmission speed, distance

***communications media*** include: fibre optics (multimode/single mode transmission), wireless (satellite, cellular, Bluetooth, RF, IR), wired (coaxial, STP, UTP), Ethernet I/O

***communication protocols*** include: Fieldbus, Profibus, Modbus, TCP/IP, HART, DeviceNet/ControlNet, BACnet, OSI

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

## F-23.02 Diagnoses gateways, bridges and media converters

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| F-23.02.01P | perform visual inspection of gateways, bridges and media converters | visual inspection of gateways, bridges and media converters is performed to detect signs of ***faults*** |
| F-23.02.02P | perform physical inspection of cabling and connections | physical inspection of cabling and connections to gateways, bridges and media converters is performed using ***methods*** |
| F-23.02.03P | test system components for ***faults*** | system components are tested for ***faults*** using ***diagnostic tools and equipment*** |
| F-23.02.04P | verify configuration | configuration is verified using software and documentation to ensure no corruption exists |
| F-23.02.05P | determine steps required to address ***faults*** | steps required to address ***faults*** are determined based on probable root cause |
| F-23.02.06P | review documentation and historical data | documentation and historical data is verified to assist in determining probable root cause |

## RANGE OF VARIABLES

***faults*** include: physical damage, faulty connections, fault lights, error codes, response time of data transfer

***methods*** include: cleaning, reseating connections

***diagnostic tools and equipment*** include: protocol analyzers, software, multimeters, hand-held communicators, laptop

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| F-23.02.01L | demonstrate knowledge of gateways, bridges and media converters, their characteristics, applications and ***limitations*** | define terminology associated with gateways, bridges and media converters |
| | | identify types of gateways, bridges and media converters, and describe their characteristics, applications and ***limitations*** |
| | | identify ***communications media*** and describe their characteristics and applications |
| | | interpret information pertaining to gateways, bridges and media converters found on drawings and specifications |
| | | identify types of network, ***communication protocols*** and addressing structures |
| | | identify data structures and system formats |
| F-23.02.02L | demonstrate knowledge of regulatory requirements pertaining to gateways, bridges and media converters | interpret ***standards, codes and regulations*** pertaining to gateways, bridges and media converters |
| F-23.02.03L | demonstrate knowledge of procedures used to diagnose gateways, bridges and media converters | identify ***diagnostic tools and equipment*** used to diagnose gateways, bridges and media converters, and describe their applications and procedures for use |
| | | describe procedures used to inspect gateways, bridges and media converters and their cabling and connections |
| | | describe possible ***faults*** of gateways, bridges and media converters |

## RANGE OF VARIABLES

***limitations*** include: memory size, transmission speed, distance

***communications media*** include: fibre optics (multimode/single mode transmission), wireless (satellite, cellular, Bluetooth, RF, IR), wired (coaxial, STP, UTP), Ethernet I/O

***communication protocols*** include: Fieldbus, Profibus, Modbus, TCP/IP, HART, DeviceNet/ControlNet, BACnet, OSI

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***diagnostic tools and equipment*** include: protocol analyzers, software, multimeters, hand-held communicators, laptop

***faults*** include: physical damage, faulty connections, fault lights, error codes, response time of data transfer

## F-23.03 Performs maintenance and repairs on gateways, bridges and media converters

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| F-23.03.01P | perform inspection of gateways, bridges and media converters | inspection of gateways, bridges and media converters is performed to detect ***faults*** |
| F-23.03.02P | check error logs, tables and registers | software is used to check error logs, tables and registers to identify issues through data analysis of patterns |
| F-23.03.03P | observe indicator lights | indicator lights are observed to ensure proper operation |
| F-23.03.04P | clean gateways, bridges, media converters and connectors (fibre optics) | gateways, bridges, media converters and connectors (fibre optics) are cleaned according to manufacturers' specifications |
| F-23.03.05P | review maintenance documentation and historical data | maintenance documentation and historical data are reviewed to assist in determining probable root cause |
| F-23.03.06P | replace ***components*** | ***components*** are replaced according to manufacturers' specifications |
| F-23.03.07P | restore and verify configuration | configuration is restored and verified |
| F-23.03.08P | verify operation | operation is verified before returning to service |
| F-23.03.09P | back up and document configuration settings | configuration settings are backed up and documented for future data recovery |

### RANGE OF VARIABLES

***faults*** include: heat build-up, humidity, contamination
***components*** include: modules, circuit boards

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| F-23.03.01L | demonstrate knowledge of gateways, bridges and media converters, their characteristics, applications and ***limitations*** | define terminology associated with gateways, bridges and media converters |
| | | identify types of gateways, bridges and media converters, and describe their characteristics, applications and ***limitations*** |

| | | |
|---|---|---|
| | | identify ***communications media*** and describe their characteristics and applications |
| | | interpret information pertaining to gateways, bridges and media converters found on drawings and specifications |
| | | identify types of network, ***communication protocols*** and addressing structures |
| | | identify data structures and system formats |
| | | describe importance of documenting settings |
| F-23.03.02L | demonstrate knowledge of regulatory requirements pertaining to gateways, bridges and media converters | interpret ***standards, codes and regulations*** pertaining to gateways, bridges and media converters |
| F-23.03.03L | demonstrate knowledge of procedures used to maintain, repair and replace gateways, bridges and media converters and their ***components*** | identify tools and equipment and software used to maintain, repair and replace gateways, bridges and media converters, and describe their applications and procedures for use |
| | | describe procedures used to maintain, repair and replace gateways, bridges and media converters, their cabling, connections and ***components*** |
| | | describe possible ***faults*** of gateways, bridges and media converters |
| | | describe procedures used to clean gateways, bridges, media converters and connectors (fibre optics) |

## RANGE OF VARIABLES

***limitations*** include: memory size, transmission speed, distance

***communications media*** include: fibre optics (multimode/single mode transmission), wireless (satellite, cellular, Bluetooth, RF, IR), wired (coaxial, STP, UTP), ethernet I/O

***communication protocols*** include: Fieldbus, Profibus, Modbus, TCP/IP, HART, DeviceNet/ControlNet, BACnet, OSI

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC

***components*** include: modules, circuit boards

***faults*** include: heat build-up, humidity, contamination

# MAJOR WORK ACTIVITY G

## Installs and services control systems and process control

## TASK G-24 Establishes and optimizes process control strategies

### TASK DESCRIPTOR

Instrumentation and control technicians determine and optimize process control strategies. Process control strategies are employed and selected to maintain and control the performance of the process.

### G-24.01 Determines process control strategy

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| G-24.01.01P | determine control, process parameters and manipulated variables | control, process parameters and manipulated variables are determined according to process requirements |
| G-24.01.02P | determine applicable ***control strategy*** | applicable ***control strategy*** is determined according to process requirements and engineered designs |
| G-24.01.03P | develop loop diagram as basis for implementation | loop diagram is developed as basis for implementation according to engineering practices |
| G-24.01.04P | determine ***controller action*** | ***controller action*** is determined according to process requirements |
| G-24.01.05P | determine ***controller functions*** | ***controller functions*** are determined according to process requirements |

### RANGE OF VARIABLES

***control strategy*** includes: feedback, feedforward, feedforward indexed, cascade, gap, duplex, selective, ratio, multivariable, floating, relation

***controller action*** is: direct, reverse

***controller functions*** include: modulating (proportional-integral [PI], PID, proportional [P]), on/off

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-24.01.01L | demonstrate knowledge of process control and its limitations, ***purpose and applications*** | define terminology associated with process control |
| | | identify hazards and describe safe work practices pertaining to process control |
| | | interpret ***information*** pertaining to basic process control |
| | | explain process control and its limitations, ***purpose and applications*** |
| | | identify ***methods of basic process control*** and describe their applications |
| | | identify ***methods of advanced process control*** and describe their applications |
| | | identify ***controller functions*** and describe their applications and operation |
| | | explain process dynamics and their impact on process control |
| | | explain ***process loop interactions*** and their impact on process control |
| | | explain control theory, actions and operational modes |
| G-24.01.02L | demonstrate knowledge of regulatory requirements pertaining to process control | interpret codes and regulations pertaining to process control |
| G-24.01.03L | demonstrate knowledge of procedures used to determine process ***control strategies*** | identify types of ***control strategies*** and describe their purpose and applications |
| | | explain ***control strategies, controller action*** and ***controller functions*** |
| | | describe methods of tuning using proportional-integral-derivative (PID) equations |

## RANGE OF VARIABLES

***purpose and applications*** include: control variable, manipulated variable, manual/local control, automatic/remote control, open loop, closed loop

***information*** includes: ISA symbols, SAMA symbols, P&ID, loop diagrams, instrument index, schematic diagrams, wiring diagrams, control narratives (functional description)

***methods of basic process control*** include: feedback, manual/auto selection

***methods of advanced process control*** include: ratio, feedforward, adaptive, cascade, split ranging, relation, gap action, model predictive control, multiple input single output (MISO)/multiple input multiple output (MIMO)

***controller functions*** include: modulating (proportional-integral [PI], PID, proportional [P]), on/off

***process loop interactions*** include: boiler control systems (sympathetic loop interactions)

***control strategies*** include: feedback, feedforward, feedforward indexed, cascade, gap, duplex, selective, ratio, multivariable, floating, relation

***controller action*** is: direct, reverse

## G-24.02 Optimizes process control

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-24.02.01P | identify process loop for optimization | process loop for optimization is identified |
| G-24.02.02P | evaluate strategy's ability to control process | strategy's ability to control process is evaluated |
| G-24.02.03P | initiate a change in process | a change in process is initiated to observe how process control reacts to change |
| G-24.02.04P | gather process data | process data is gathered to evaluate process stability and reactions |
| G-24.02.05P | analyze data and observations | data and observations are analyzed to determine effectiveness of strategy |
| G-24.02.06P | recognize control and process limitations | control and process limitations are recognized |
| G-24.02.07P | tune process control loop | process control loop is tuned according to analysis of data and observations |
| G-24.02.08P | use software to optimize tuning parameters | software is used to optimize tuning parameters |
| G-24.02.09P | identify and set ***alarming requirements*** | ***alarming requirements*** are identified and set |

## RANGE OF VARIABLES

***alarming requirements*** include: process alarms, SIS safety alarms, high/low limits, alarming priority levels

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-24.02.01L | demonstrate knowledge of process control and its limitations, ***purpose and applications*** | define terminology associated with process control |
| | | identify hazards and describe safe work practices pertaining to process control |
| | | interpret ***information*** pertaining to basic process control |
| | | explain process control and its limitations, ***purpose and applications*** |
| | | identify ***methods of basic process control*** and describe their applications |
| | | identify ***methods of advanced process control*** and describe their applications |
| | | identify ***controller functions*** and describe their applications and operation |
| | | explain process dynamics and their impact on process control |
| | | explain ***process loop interactions*** and their impact on process control |
| | | explain control theory, actions and operational modes |
| G-24.02.02L | demonstrate knowledge of regulatory requirements pertaining to process control | interpret codes and regulations pertaining to process control |
| G-24.02.03L | demonstrate knowledge of procedures used to optimize process control systems | identify tools, equipment and software used to optimize process control systems, and describe their applications and procedures for use |
| | | describe procedures used to optimize process control systems |
| | | describe ***procedures used to tune control loops*** |
| | | describe procedures used to identify and set ***alarming requirements*** |

## RANGE OF VARIABLES

***purpose and applications*** include: control variable, manipulated variable, manual control, automatic control, open loop, closed loop

***information*** includes: ISA symbols, SAMA symbols, P&ID, loop diagrams, instrument index, schematic diagrams, wiring diagrams, control narratives (functional description)

***methods of basic process control*** include: feedback, manual/auto selection

***methods of advanced process control*** include: ratio, feedforward, adaptive, cascade, split ranging, relation, gap action, model predictive control, MISO/ MIMO

***controller functions*** include: modulating (PI, PID, P), on/off

***process loop interactions*** include: boiler control systems (sympathetic loop interactions)

***procedures used to tune control loops*** include: closed loop methods, open loop methods

***alarming requirements*** include: process alarms, SIS safety alarms, high/low limits, alarming priority levels

# TASK G-25 Installs and services stand-alone controllers (SAC)

## TASK DESCRIPTOR

Instrumentation and control technicians install and service SAC. SAC such as electronic and pneumatic controllers employ control strategies. They control a specific process variable typically for single loop applications rather than multiple processes or large control schemes. They may be configured to receive remote set points. They are not required to be connected to other plant networks.

## G-25.01 Installs SAC

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| G-25.01.01P | select controller | controller is selected according to application, process requirements, control strategy and signal requirements |
| G-25.01.02P | determine mounting requirements and locations | mounting requirements and locations are determined according to codes, environmental conditions and area classifications |

| | | |
|---|---|---|
| G-25.01.03P | select and use tools and equipment | tools and equipment are selected and used according to installation requirements and manufacturers' specifications |
| G-25.01.04P | connect wiring and tubing to controller | wiring and tubing are connected to controller according to industry practices, engineered designs, manufacturers' specification and codes |

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-25.01.01L | demonstrate knowledge of SAC, their limitations, purpose and applications | define terminology associated with SAC |
| | | identify ***types of SAC***, and describe their limitations, purpose and applications |
| | | describe ***SAC functions and modes*** |
| | | identify hazards and describe safe work practices pertaining to SAC |
| | | interpret ***information*** pertaining to SAC found on drawings and specifications |
| | | describe operating theory and parameters of SAC |
| G-25.01.02L | demonstrate knowledge of procedures used to install SAC | identify tools and equipment used to install SAC, and describe their applications and procedures for use |
| | | describe procedures used to install SAC |
| | | explain SAC ***installation requirements*** |
| | | describe methods used to connect SAC |

## RANGE OF VARIABLES

***types of SAC*** include: analogue, electronic, pneumatic, microprocessor (single loop, cascade loop)

***SAC functions and modes*** include: direct/reverse action, auto/manual, PID, on/off, local/remote

***information*** includes: ISA symbols, SAMA symbols, P&ID, loop diagrams, instrument index, schematic diagrams, wiring diagrams, control narratives (functional description)

***installation requirements*** include: ambient conditions, area classification

## G-25.02 Configures SAC

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-25.02.01P | select and use ***tools, equipment*** and software for configuration and adjustments | ***tools, equipment*** and software for configuration and adjustments are selected and used according to manufacturers' specifications |
| G-25.02.02P | develop controller configuration | controller configuration is developed according to process control strategy |
| G-25.02.03P | implement configuration | configuration is implemented |
| G-25.02.04P | calibrate inputs/outputs (electronic or pneumatic) | inputs/outputs (electronic or pneumatic) are calibrated according to manufacturers' specifications and process requirements |
| G-25.02.05P | tune and verify controller | controller is tuned and verified to determine if controller configuration controls process according to operational requirements |
| G-25.02.06P | back up and document configurations, adjustments, settings, diagrams and tuning parameters for future data recovery | configurations, adjustments, settings, diagrams and tuning parameters are backed up and documented for future data recovery |

### RANGE OF VARIABLES

***tools and equipment*** include: hand-held programmers, pneumatic and electrical test equipment

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| G-25.02.01L | demonstrate knowledge of SAC, their limitations, purpose and applications | define terminology associated with SAC |
| | | identify ***types of SAC***, and describe their limitations, purpose and applications |
| | | describe ***SAC functions and modes*** |
| | | identify hazards and describe safe work practices pertaining to SAC |
| | | interpret ***information*** pertaining to SAC |
| G-25.02.02L | demonstrate knowledge of procedures used to configure SAC | identify ***tools, equipment*** and software used to configure SAC, and describe their applications and procedures for use |
| | | describe procedures and techniques used to configure and tune SAC |

| | | |
|---|---|---|
| | | describe importance of backing up and documenting program and configuration before and after service |
| G-25.02.03L | demonstrate knowledge of procedures used to calibrate SAC | identify ***tools, equipment*** and software used to calibrate SAC, and describe their applications and procedures for use |
| | | describe procedures and techniques used to calibrate SAC |

## RANGE OF VARIABLES

***types of SAC*** include: analogue, electronic, pneumatic, microprocessor (single loop, cascade loop)
***SAC functions and modes*** include: direct/reverse action, auto/manual, PID, on/off, local/remote
***information*** includes: ISA symbols, SAMA symbols, P&ID, loop diagrams, instrument index, schematic diagrams, wiring diagrams, control narratives (functional description)
***tools and equipment*** include: hand-held programmers, pneumatic and electrical test equipment

## G-25.03 Performs maintenance, diagnostics and repairs on SAC

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| G-25.03.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to manufacturers' specifications |
| G-25.03.02P | perform routine ***maintenance*** | routine ***maintenance*** is performed according to schedule |
| G-25.03.03P | diagnose error codes and status lights | error codes and status lights are diagnosed to identify problems |
| G-25.03.04P | identify probable root cause of faults | probable root cause is identified by investigating symptoms and conditions to determine location of faults |
| G-25.03.05P | determine steps required to address faults | steps required to address faults are determined based on probable root cause |
| G-25.03.06P | repair and replace ***electronic components*** | ***electronic components*** are repaired and replaced according to job procedures and manufacturers' recommendations |
| G-25.03.07P | repair and replace ***pneumatic components*** | ***pneumatic components*** are repaired and replaced according to job procedures and manufacturers' recommendations |
| G-25.03.08P | perform controller alignment | controller is aligned according to manufacturers' recommendations |

| | | |
|---|---|---|
| G-25.03.09P | restore program and configuration from backup and return controller to service | program and configuration is restored from backup and controller is returned to service |
| G-25.03.10P | verify SAC tuning, programming and configuration | SAC tuning, programming and configuration is verified |
| G-25.03.11P | back up and document SAC program, settings and configuration | SAC program, settings and configuration are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***tools and equipment*** include: multimeters, software, calibration equipment

***maintenance*** includes: replacing filters, restrictors and backup batteries, checking indicating lights, verifying environmental conditions (temperature, cleanliness)

***electronic components*** include: I/O modules, power supplies, digital displays

***pneumatic components*** include: flappers, nozzles, relays

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-25.03.01L | demonstrate knowledge of SAC, their limitations, purpose and applications | define terminology associated with SAC |
| | | identify ***types of SAC***, and describe their limitations, purpose and applications |
| | | describe ***SAC functions and modes*** |
| | | identify hazards and describe safe work practices pertaining to SAC |
| | | interpret ***information*** pertaining to SAC found on drawings and specifications |
| | | describe operating theory and parameters of SAC |
| G-25.03.02L | demonstrate knowledge of procedures used to maintain, diagnose, repair and replace SAC and their components | identify ***tools and equipment*** used to maintain, diagnose, repair and replace SAC and their components, and describe their applications and procedures for use |
| | | describe procedures used to maintain, diagnose, repair and replace SAC and their components |
| | | describe importance of backing up and documenting program and configuration before and after service |

## RANGE OF VARIABLES

***types of SAC*** include: analogue, electronic, pneumatic, microprocessor (single loop, cascade loop)
***SAC functions and modes*** include: direct/reverse action, auto/manual, PID, on/off, local/remote
***information*** includes: ISA symbols, SAMA symbols, P&ID, loop diagrams, instrument index, schematic diagrams, wiring diagrams, control narratives (functional description)
***tools and equipment*** include: multimeters, software, calibration equipment

# TASK G-26 Installs and services programmable logic controllers (PLC)

## TASK DESCRIPTOR

Instrumentation and control technicians install and service PLC. PLC employ control strategies and user-created programs to control multiple loops and systems. These can be used individually or networked with other control systems to operate equipment and facilities efficiently and safely.

## G-26.01 Installs PLC

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| G-26.01.01P | select and use tools and equipment | tools and equipment are selected and used according to manufacturers' specifications |
| G-26.01.02P | determine PLC to be installed | PLC to be installed is determined according to codes, engineered designs, application and control strategy |
| G-26.01.03P | confirm installation details of PLC | installation details of PLC are confirmed |
| G-26.01.04P | mount racks and ***components*** | racks and ***components*** are mounted according to industry practices, engineered designs and manufacturers' specifications |
| G-26.01.05P | connect wiring and network to PLC | wiring and network are connected to PLC according to industry practices, engineered drawings, manufacturers' specifications and codes |
| G-26.01.06P | address ***environmental conditions*** | ***environmental conditions*** are addressed |

## RANGE OF VARIABLES

***components*** include: cards (I/O, processor, network, memory), racks, power supplies, battery backup
***environmental conditions*** include: ambient conditions, contamination, hazardous locations

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-26.01.01L | demonstrate knowledge of PLC, their ***components***, operation, architecture and capabilities | define terminology associated with PLC and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to PLC |
| | | interpret information pertaining to PLC found on drawings and specifications |
| | | identify types of PLC, their ***components*** and describe their operation, architecture and capabilities |
| | | explain digital, discrete and analogue signals |
| | | explain importance of compatibility with other process control systems |
| | | explain licensing and service contract requirements pertaining to PLC |
| | | identify communication systems used by PLC |
| G-26.01.02L | demonstrate knowledge of regulatory requirements pertaining to PLC | interpret ***standards, codes and regulations*** pertaining to PLC |
| G-26.01.03L | demonstrate knowledge of procedures used to install PLC and their ***components*** | identify tools and equipment used to install PLC and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to select and install PLC and their ***components*** |
| | | explain grounding/bonding methods |
| | | describe ***environmental conditions*** to address when installing PLC |

## RANGE OF VARIABLES

***components*** include: cards (I/O, processor, network, memory), racks, power supplies, battery backup
***hazards*** include: online vs. offline applications, forces, jumpers, interlocks
***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC, NERC
***environmental conditions*** include: ambient conditions, contamination, hazardous locations

## G-26.02 Configures PLC

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-26.02.01P | select and use tools, equipment and software | tools, equipment and software are selected and used according to manufacturers' specifications and engineered designs |
| G-26.02.02P | update firmware | firmware is updated according to manufacturers' recommendations |
| G-26.02.03P | upload and download PLC programs | PLC programs are uploaded and downloaded |
| G-26.02.04P | validate PLC configuration | PLC configuration is validated according to card and rack layout |
| G-26.02.05P | program PLC including comments | PLC including comments is programmed according to process control strategy |
| G-26.02.06P | configure external communication with other systems and devices | external communication is configured with other systems and devices |
| G-26.02.07P | verify tuning, configuration and programming | tuning, configuration and programming are verified to determine if PLC controls process according to operational requirements |
| G-26.02.08P | back up and document programming, configuration, settings and parameters | programming, configuration, settings and parameters are backed up and documented for future data recovery |

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| G-26.02.01L | demonstrate knowledge of PLC, their ***components***, operation, architecture and capabilities | define terminology associated with PLC and their components |
| | | identify ***hazards*** and describe safe work practices pertaining to PLC |
| | | interpret information pertaining to PLC found on drawings and specifications |
| | | identify types of PLC, their ***components*** and describe their operation, architecture and capabilities |
| | | explain digital, discrete and analogue signals |
| | | explain importance of compatibility with other process control systems |

| | | |
|---|---|---|
| | | explain licensing and service contract requirements pertaining to PLC |
| | | identify communication systems used by PLC |
| G-26.02.02L | demonstrate knowledge of ***programming languages*** used to program PLC | identify ***programming languages*** used to program PLC |
| | | describe PLC ladder logic programs that use timers and counters |
| | | describe PLC ladder logic programs that use math instructions and PID control |
| | | describe PLC function block, sequential logic and ST programs |
| | | describe PLC programs that use subroutines |
| | | describe PLC mixed language programs |
| | | describe PLC integration with various Fieldbus devices |
| | | identify ***types of data*** |
| | | describe software and hardware limitations |
| G-26.02.03L | demonstrate knowledge of procedures used to configure PLC and their ***components*** | identify tools, equipment and software used to configure PLC and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to configure PLC and their ***components*** |
| | | describe configuration parameters |
| | | explain cause and effects of forcing and bypassing I/Os |
| | | describe importance of backing up and documenting program and configuration before and after service |
| | | describe alarm management and history management concepts for a PLC |

## RANGE OF VARIABLES

***components*** include: cards (I/O, processor, network, memory), racks, power supplies, battery backup

***hazards*** include: online vs. offline applications, forces, jumpers, interlocks

***programming languages*** include: ladder diagram (LD), FBD, ST, instruction list (IL), SFC, Boolean logic diagrams

***types of data*** include: binary, integer, floating point

## G-26.03 Performs maintenance, diagnostics and repairs on PLC

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-26.03.01P | select and use ***tools and equipment*** | ***tools and equipment*** are selected and used according to manufacturers' specifications |
| G-26.03.02P | perform routine ***maintenance*** | routine ***maintenance*** is performed according to schedule |
| G-26.03.03P | diagnose error codes, logs and status lights | error codes, logs and status lights are diagnosed to identify problems |
| G-26.03.04P | identify probable root cause of faults | probable root cause is identified by investigating symptoms and conditions to determine location of faults |
| G-26.03.05P | perform ***diagnostic procedures*** | ***diagnostic procedures*** are performed |
| G-26.03.06P | determine steps required to address faults | steps required to address faults are determined based on probable root cause |
| G-26.03.07P | replace ***components*** | ***components*** are replaced according to job procedures and manufacturers' recommendations |
| G-26.03.08P | restore program and configuration from backup | program and configuration are restored from backup |
| G-26.03.09P | verify PLC programming and configuration | PLC programming and configuration are verified |
| G-26.03.10P | back up and document PLC program and configuration | PLC program and configuration are backed up and documented for future data recovery |

### RANGE OF VARIABLES

***tools and equipment*** include: software, multimeters, hand-held programmers, computer

***maintenance*** includes: replacing backup batteries, observing indicator lights, verifying environmental conditions (temperature, cleanliness)

***diagnostic procedures*** include: forcing I/O, setting traps (first out logic) and counters

***components*** include: cards (I/O, processor, network, memory), racks, power supplies, battery backup

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-26.03.01L | demonstrate knowledge of PLC, their ***components***, operation, architecture and capabilities | define terminology associated with PLC and their ***components*** |
| | | identify ***hazards*** and describe safe work practices pertaining to PLC |
| | | interpret information pertaining to PLC found on drawings and specifications |
| | | identify types of PLC and their ***components***, and describe their operation, architecture and capabilities |
| | | explain digital, discrete and analogue signals |
| | | explain importance of compatibility with other process control systems |
| | | explain licensing and service contract requirements pertaining to PLC |
| | | identify communication systems used by PLC |
| | | identify ***types of data*** |
| G-26.03.02L | demonstrate knowledge of ***programming languages*** used to program PLC | interpret PLC ***programming languages*** |
| G-26.03.03L | demonstrate knowledge of procedures used to maintain, diagnose and repair and replace PLC and their ***components*** | identify tools, equipment and software used to maintain, diagnose, repair and replace PLC and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to maintain, diagnose, repair and replace PLC and their ***components*** |
| | | describe obsolescence issues |
| | | describe hot standby and redundancy applications |
| | | describe importance of backing up and documenting PLC program and configuration before and after service |

## RANGE OF VARIABLES

***components*** include: cards (I/O, processor, network, memory), racks, power supplies, battery backup
***hazards*** include: online vs. offline applications, forces, jumpers, interlocks
***types of data*** include: binary, integer, floating point
***programming languages*** include: LD, FBD, ST, SFC, Boolean logic diagrams

# TASK G-27 Installs and services distributed control systems (DCS)

## TASK DESCRIPTOR

Instrumentation and control technicians install and service DCS. DCS employ control strategies and user-created programs to control multiple loops and systems. They usually incorporate their own operator interface functionality or graphical user station. These can be used individually or networked with other control systems to operate equipment and facilities efficiently and safely.

## G-27.01 Installs DCS

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| G-27.01.01P | select and use tools and equipment | tools and equipment are selected and used according to manufacturers' specifications |
| G-27.01.02P | assist in determining DCS to be installed | DCS to be installed is determined according to codes, ***engineered designs***, application, control strategy and company requirements |
| G-27.01.03P | confirm installation details of DCS ***components*** | installation details of DCS ***components*** are confirmed according to manufacturers' specifications and ***engineered designs*** |
| G-27.01.04P | select and install DCS ***components*** | DCS ***components*** are selected and installed according to system requirements |
| G-27.01.05P | connect wiring and network to DCS | wiring and network are connected to DCS according to industry practices, ***engineered designs***, manufacturers' specifications and codes |
| G-27.01.06P | address ***environmental conditions*** | ***environmental conditions*** are addressed |

## RANGE OF VARIABLES

***engineered designs*** include: loop drawings, logic diagrams, P&ID, control narratives, SAMA

***components*** include: cabinets, operator stations, servers (memory, historian, security), clients, cards (I/O, network, processor), power supplies, memory, UPS, annunciators

***environmental conditions*** include: ambient conditions, contamination, hazardous locations

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-27.01.01L | demonstrate knowledge of DCS, their ***components***, operation, architecture and capabilities | define terminology associated with DCS and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to DCS |
| | | interpret information pertaining to DCS found on drawings and specifications |
| | | identify DCS ***components***, buses and systems, and describe their purpose and operation |
| | | explain digital, discrete and analogue signals |
| | | describe different software programs of a DCS |
| | | describe data flow, scan cycle and databases of a DCS |
| | | describe security and access privileges for a DCS |
| | | describe redundancy as it applies to DCS |
| | | explain importance of compatibility with other process control systems |
| | | explain licensing and service contract requirements pertaining to DCS |
| | | describe tag descriptors and addressing |
| G-27.01.02L | demonstrate knowledge of regulatory requirements pertaining to DCS and their ***components*** | interpret ***standards, codes and regulations*** pertaining to DCS and their ***components*** |
| G-27.01.03L | demonstrate knowledge of procedures used to install DCS and their ***components*** | identify tools and equipment used to install DCS and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to select and install DCS and their ***components*** |
| | | describe ***environmental conditions*** to address when installing DCS |
| | | describe methods used to install cabling and grounding/bonding |

## RANGE OF VARIABLES

***components*** include: cabinets, operator stations, servers (memory, historian, security), clients, cards (I/O, network, processor), power supplies, memory, UPS, annunciators

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC, NERC

***environmental conditions*** include: ambient conditions, contamination, hazardous locations

## G-27.02 Configures DCS

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-27.02.01P | select and use tools, equipment and software for configuration | tools, equipment and software are selected and used for configuration according to manufacturers' specifications and engineered designs |
| G-27.02.02P | update operating software | operating software is updated |
| G-27.02.03P | validate DCS configuration | DCS configuration is validated according to rack and cabinet layout |
| G-27.02.04P | program DCS, including comments and displays | DCS, including comments and displays, is programmed according to process control strategy and company standards |
| G-27.02.05P | configure external communication with other systems and devices | external communication is configured with other systems and devices |
| G-27.02.06P | verify tuning, configuration and programming | tuning, configuration and programming are verified to determine if DCS controls process according to operational requirements |
| G-27.02.07P | back up and document configuration, settings and parameters | configuration, settings and parameters are backed up and documented for future data recovery |

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| G-27.02.01L | demonstrate knowledge of DCS, their ***components***, operation, architecture and capabilities | define terminology associated with DCS and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to DCS |
| | | interpret information pertaining to DCS found on drawings and specifications |
| | | identify DCS ***components***, buses and systems and describe their purpose and operation |
| | | explain digital, discrete and analogue signals |
| | | describe different software programs of a DCS |
| | | describe data flow, scan cycle and databases of a DCS |

| | | |
|---|---|---|
| | | describe security and access privileges for a DCS |
| | | describe redundancy as it applies to DCS |
| | | explain importance of compatibility with other process control systems |
| | | explain licensing and service contract requirements pertaining to DCS |
| | | describe tag descriptors and addressing |
| G-27.02.02L | demonstrate knowledge of ***programming languages*** used to program DCS | identify ***programming languages*** used to program DCS |
| | | describe DCS function block, sequential logic and ST programs |
| | | describe DCS programs that use subroutines |
| | | describe DCS mixed language programs |
| | | describe DCS integration with various Fieldbus devices |
| | | identify ***types of data*** |
| | | describe software and hardware limitations |
| G-27.02.03L | demonstrate knowledge of procedures used to configure and program DCS and their ***components*** | identify tools, equipment and software used to configure and program DCS and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to configure and program DCS and their ***components*** |
| | | describe software and hardware limitations |
| | | describe configuration parameters |
| | | describe programming consistency issues |
| | | describe safety considerations as they apply to a DCS when making changes online, forcing, disabling and bypassing I/O |
| | | describe procedures used to back up DCS and their ***components*** |
| | | describe importance of backing up and documenting program and configuration before and after service |
| | | describe alarm management and history management concepts for a DCS |
| | | explain digital, discrete and analogue signals |
| | | describe trending software used in DCS |

## RANGE OF VARIABLES

***components*** include: cabinets, operator stations, servers (memory, historian, security), cards (I/O, network, processor), power supplies, memory, UPS, annunciators

***programming languages*** include: FBD, ST, IL, SFC, Boolean logic diagrams

***types of data*** include: binary, integer, floating point, analogue

## G-27.03 Performs maintenance, diagnostics and repairs on DCS

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| G-27.03.01P | select and use tools, equipment and software | tools, equipment and software are selected and used according to manufacturers' specifications and engineered designs |
| G-27.03.02P | perform ***maintenance*** | ***maintenance*** is performed according to schedule |
| G-27.03.03P | check power supply for proper voltage level | power supply is checked for proper voltage level |
| G-27.03.04P | use diagnostic menu to identify ***problems*** | diagnostic menu is used to identify ***problems*** |
| G-27.03.05P | identify probable root cause of faults | probable root cause is identified by investigating symptoms and conditions to determine location of faults |
| G-27.03.06P | determine steps required to address ***problems*** | steps required to address ***problems*** are determined based on probable root cause |
| G-27.03.07P | replace ***components*** | ***components*** are replaced according to job procedures and manufacturers' specifications |
| G-27.03.08P | restore DCS program and configuration from backup | DCS program and configuration are restored from backup |
| G-27.03.09P | verify DCS configuration | DCS configuration is verified |
| G-27.03.10P | back up and document DCS program and servers | DCS program and servers are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***maintenance*** includes: replacing backup batteries, checking indicator lights, verifying environmental conditions (temperature, cleanliness), testing UPS

***problems*** include: network, hardware and communication faults

***components*** include: cabinets, operator stations, servers (memory, historian, security), cards (I/O, network, processor), power supplies, memory, UPS, annunciators

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-27.03.01L | demonstrate knowledge of DCS, their ***components***, operation, architecture and capabilities | define terminology associated with DCS and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to DCS |
| | | interpret information pertaining to DCS found on drawings and specifications |
| | | identify DCS ***components***, buses and systems and describe their purpose and operation |
| | | explain digital, discrete and analogue signals |
| | | describe different software programs of a DCS |
| | | describe data flow, scan cycle and databases of a DCS |
| | | describe security and access privileges for a DCS |
| | | describe redundancy as it applies to DCS |
| | | explain importance of compatibility with other process control systems |
| | | explain licensing and service contract requirements pertaining to DCS |
| | | describe tag descriptors and addressing |
| G-27.03.02L | demonstrate knowledge of procedures used to maintain, diagnose, repair and replace DCS and their ***components*** | identify tools, equipment and software used to maintain, diagnose, repair and replace DCS and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to maintain, diagnose, repair and replace DCS and their ***components*** |
| | | describe effects of maintenance actions or errors |
| | | describe cause and effects of forcing, disabling and bypassing I/O |
| | | describe importance of backing up and documenting program and configuration before and after service |

## RANGE OF VARIABLES

***components*** include: cabinets, operator stations, servers (memory, historian, security), cards (I/O, network, processor), power supplies, memory, UPS, annunciators

# TASK G-28 Installs and services human machine interface (HMI)

## TASK DESCRIPTOR

Instrumentation and control technicians install and service HMI. HMI interfaces with the controlling devices such as PLC, DCS and SCADA systems in order to allow monitoring and controlling of the process through graphical displays or text. HMI often has the ability to provide trending, alarm summaries and historical data collection.

## G-28.01 Installs HMI

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-28.01.01P | select and use tools and equipment | tools and equipment are selected and used according to manufacturers' specifications |
| G-28.01.02P | determine HMI | HMI is determined according to codes, engineered designs, application, control strategy and company requirements |
| G-28.01.03P | confirm installation details of HMI | installation details of HMI are confirmed |
| G-28.01.04P | address ***environmental conditions*** | ***environmental conditions*** are addressed |
| G-28.01.05P | mount HMI ***components*** | HMI ***components*** are mounted according to industry practices, engineered designs, manufacturers' specifications and codes |
| G-28.01.06P | connect cabling and network to HMI | cabling and network are connected to HMI according to industry practices, engineered designs, manufacturers' recommendations, site requirements and codes |

## RANGE OF VARIABLES

***environmental conditions*** include: ambient conditions, contamination, ergonomics, hazardous locations

***components*** include: hardware (computer, monitor, keyboard, mouse, printers, scanners, recorder/data loggers, annunciator), software (engineering/design, operation/application)

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-28.01.01L | demonstrate knowledge of HMI and their ***components***, purpose, operation, design and capabilities | define terminology associated with HMI and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to HMI |
| | | interpret information pertaining to HMI found on drawings and specifications |
| | | describe how HMI are incorporated in PLC, DCS and SCADA systems |
| | | identify types of HMI and their ***components***, and describe their purpose, operation, design and capabilities |
| | | identify types of ***HMI operator displays*** and their purpose |
| | | explain digital, discrete and analogue signals |
| | | identify types of HMI programs and associated ***software*** |
| | | describe security and access privileges for HMI |
| | | explain importance of compatibility with other process control systems |
| | | describe communication systems used with HMI |
| | | explain licensing and service contract requirements pertaining to HMI |
| G-28.01.02L | demonstrate knowledge of regulatory requirements pertaining to HMI and their ***components*** | identify ***standards, codes and regulations*** pertaining to HMI and their ***components*** |
| G-28.01.03L | demonstrate knowledge of procedures used to install HMI and their ***components*** | identify tools and equipment used to install HMI and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to select and install HMI and their ***components*** |

| | |
|---|---|
| | describe methods used to install cabling and network to HMI |
| | describe ***environmental conditions*** to address when installing HMI |

## RANGE OF VARIABLES

***components*** include: hardware (computer, monitor, keyboard, mouse, printers, scanners, recorder/data loggers, annunciator), software (engineering/design, operation/application)
***HMI operator displays*** include: overview, group, detail, graphic, alarm summary, annunciator, trend, text
***software*** includes: word processors, spreadsheets, databases, trending
***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC, NERC
***environmental conditions*** include: ambient conditions, contamination, ergonomics, hazardous locations

## G-28.02 Configures HMI

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-28.02.01P | select and use tools, equipment and software for configuration | tools, equipment and software are selected and used for configuration according to manufacturers' specifications and company practices |
| G-28.02.02P | update software and firmware | software and firmware are updated according to manufacturers' specifications |
| G-28.02.03P | validate HMI configuration, including depiction of process control strategy | HMI configuration, including depiction of process control strategy, is validated |
| G-28.02.04P | configure external communication with other systems and devices | external communication is configured with other systems and devices |
| G-28.02.05P | verify that HMI configuration and programming interface with and control process variables | HMI configuration and programming interfaces with and controls process variables according to operational requirements and industry standards |
| G-28.02.06P | back up and document HMI configuration, settings and parameters | HMI configuration, settings and parameters are backed up and documented for future data recovery |

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-28.02.01L | demonstrate knowledge of HMI, their ***components***, purpose, operation, design and capabilities | define terminology associated with HMI and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to HMI |
| | | interpret information pertaining to HMI found on drawings and specifications |
| | | describe how HMI are incorporated in PLC, DCS and SCADA systems |
| | | identify HMI and their ***components***, and describe their purpose, operation, design and capabilities |
| | | identify types of ***HMI operator displays*** and their purpose |
| | | explain digital, discrete and analogue signals |
| | | identify types of HMI programs and associated ***software*** |
| | | describe security and access privileges for HMI |
| | | explain importance of compatibility with other process control systems |
| | | describe communication systems used with HMI |
| | | explain licensing and service contract requirements pertaining to HMI |
| G-28.02.02L | demonstrate knowledge of procedures used to configure and program HMI and their ***components*** | identify tools, equipment and software used to configure and program HMI and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to configure and program HMI and their ***components*** |
| | | describe software and firmware limitations |
| | | describe configuration parameters |
| | | describe alarm management and history management concepts for an HMI |
| | | describe programming consistency issues |
| | | describe importance of backing up and documenting program and configuration before and after service |
| | | describe tag descriptors and addressing |

## RANGE OF VARIABLES

***components*** include: hardware (computer, monitor, keyboard, mouse, printers, scanners, recorder/data loggers, annunciator), software (engineering/design, operation/application)

***HMI operator displays*** include: overview, group, detail, graphic, alarm summary, annunciator, trend, text

***software*** includes: word processors, spreadsheets, databases, trending

## G-28.03 Performs maintenance, diagnostics and repairs on HMI

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-28.03.01P | select and use tools, equipment and software | tools, equipment and software are selected and used according to manufacturers' specifications and company practices |
| G-28.03.02P | perform ***maintenance*** | ***maintenance*** is performed according to schedule |
| G-28.03.03P | review error messages and logs to isolate ***faults*** | error messages and logs are reviewed to isolate ***faults*** |
| G-28.03.04P | perform ***diagnostic procedures*** | ***diagnostic procedures*** are performed |
| G-28.03.05P | check power supply for proper voltage | power supply is checked for proper voltage |
| G-28.03.06P | identify probable root cause of ***faults*** | probable root cause is identified by investigating symptoms and conditions to determine location of ***faults*** |
| G-28.03.07P | determine steps required to address ***faults*** | steps required to address ***faults*** are determined based on probable root cause |
| G-28.03.08P | replace ***components*** | ***components*** are replaced according to job procedures and manufacturers' recommendations |
| G-28.03.09P | restore HMI program and configuration from backup | HMI program and configuration from backup are restored |
| G-28.03.10P | verify and test HMI configuration | HMI configuration is verified and tested |
| G-28.03.11P | back up and document HMI program and configuration | HMI program and configuration are backed up and documented for future data recovery |

## RANGE OF VARIABLES

***maintenance*** includes: replacing backup batteries, addressing environmental conditions

***faults*** include: network, communication

***diagnostic procedures*** include: manipulating process variables, verifying communication status, verifying graphic updates, verifying database integrity

***components*** include: communication modules, power supplies

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-28.03.01L | demonstrate knowledge of HMI, their ***components***, purpose, operation, design and capabilities | define terminology associated with HMI and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to HMI |
| | | interpret information pertaining to HMI found on drawings and specifications |
| | | describe how HMI are incorporated in PLC, DCS and SCADA systems |
| | | identify HMI and their ***components***, and describe their purpose, operation, design and capabilities |
| | | identify types of ***HMI operator displays*** and their purpose |
| | | explain digital, discrete and analogue signals |
| | | identify types of HMI programs and associated ***software*** |
| | | describe security and access privileges for HMI |
| | | explain importance of compatibility with other process control systems |
| | | describe communication systems used with HMI |
| | | explain licensing and service contract requirements pertaining to HMI |
| | | describe tag descriptors and addressing |
| G-28.03.02L | demonstrate knowledge of procedures used to maintain, diagnose, repair and replace HMI and their ***components*** | identify tools, equipment and software used to maintain, diagnose, repair and replace HMI and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to maintain, diagnose, repair and replace HMI and their ***components*** |

| | |
|---|---|
| | describe effects of maintenance actions or errors |
| | describe importance of backing up and documenting program and configuration before and after service |

### RANGE OF VARIABLES

***components*** include: communication modules, power supplies
***HMI operator displays*** include: overview, group, detail, graphic, alarm summary, annunciator, trend, text
***software*** includes: word processors, spreadsheets, databases, trending

## TASK G-29 Installs and services supervisory control and data acquisition (SCADA) systems

### TASK DESCRIPTOR

Instrumentation and control technicians install and service SCADA systems. SCADA systems are data transmission and acquisition systems for remote control and monitoring of equipment and facilities. They can be used for control applications such as remote shut-down and start-up of equipment. They may have the added ability to store, measure, trend and manipulate data for reporting purposes.

### G-29.01 Installs SCADA systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

| | SKILLS | |
|---|---|---|
| | **Performance Criteria** | **Evidence of Attainment** |
| G-29.01.01P | select SCADA equipment | SCADA equipment is selected according to codes, engineered designs, application, control strategy and site specifications |
| G-29.01.02P | select and use tools and equipment | tools and equipment are selected and used according to manufacturers' specifications |
| G-29.01.03P | mount SCADA ***components*** | SCADA ***components*** are mounted according to industry practices, engineered designs, manufacturers' specifications and codes |
| G-29.01.04P | terminate wiring and network to SCADA equipment | wiring and network are terminated to SCADA equipment according to industry practices, engineered designs, manufacturers' specifications and codes |

| | | |
|---|---|---|
| G-29.01.05P | mount and test wireless transmission | wireless transmission is mounted and tested according to industry practices, engineered designs, manufacturers' specifications and codes |
| G-29.01.06P | avoid interference with other systems and processes | interference with other systems and processes are avoided by ***methods*** |

## RANGE OF VARIABLES

***components*** include: hardware (master terminal unit [MTU], remote terminal unit [RTU], PLC, HMI, multiple variable computing devices), software, communication systems, power supplies

***methods*** include: selecting proper channel and wavelength, using proper cable routing, using signal isolators

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-29.01.01L | demonstrate knowledge of SCADA systems, their ***components*** and operation | define terminology associated with SCADA systems and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to SCADA systems |
| | | interpret information pertaining to SCADA systems found on drawings and specifications |
| | | identify SCADA system ***components*** and describe their purpose and operation |
| | | identify types of SCADA protocols and configurations and describe their features and limitations |
| | | describe ***SCADA theory*** |
| | | identify ***connection methods*** for SCADA systems |
| | | identify potential causes of interference |
| | | describe grounding/bonding methods |
| G-29.01.02L | demonstrate knowledge of regulatory requirements pertaining to SCADA systems and their ***components*** | interpret ***standards, codes and regulations*** pertaining to SCADA systems and their ***components*** |
| G-29.01.03L | demonstrate knowledge of procedures used to install SCADA systems and ***components*** | identify tools and equipment used to install SCADA systems and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to select and install SCADA systems and their ***components*** |

## RANGE OF VARIABLES

***components*** include: hardware (MTU, RTU, PLC, HMI, multiple variable computing devices), software, communication systems, power supplies

***SCADA theory*** includes: remote processes, system interactions

***connection methods*** include: hardwired, wireless

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC, NERC

## G-29.02 Configures SCADA systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-29.02.01P | select and use tools, equipment and software | tools, equipment and software to configure SCADA system are selected and used according to manufacturers' specifications |
| G-29.02.02P | configure and validate SCADA system, including comments and tagging | SCADA system, including comments and tagging, is configured according to application and company standards |
| G-29.02.03P | update software and firmware | software and firmware are updated |
| G-29.02.04P | upload and download SCADA system configurations/database | SCADA system configurations/database are uploaded and downloaded |
| G-29.02.05P | configure external communication with other systems and devices | external communication is configured with other systems and devices |
| G-29.02.06P | determine if SCADA system monitors and controls process | SCADA system monitors and controls process according to operational requirements |
| G-29.02.07P | back up and document programming, configuration, settings and parameters | programming, configuration, settings and parameters are backed up and documented for future data recovery |

### KNOWLEDGE

| | Learning Outcomes | Learning Objectives |
|---|---|---|
| G-29.02.01L | demonstrate knowledge of SCADA systems, their ***components*** and operation | define terminology associated with SCADA systems and their ***components*** |
| | | identify hazards and describe safe work practices pertaining to SCADA systems |
| | | interpret information pertaining to SCADA systems found on drawings and specifications |

| | | |
|---|---|---|
| | | identify SCADA system ***components*** and describe their purpose and operation |
| | | identify types of SCADA protocols and configurations and describe their features and limitations |
| | | describe ***SCADA theory*** |
| | | identify ***connection methods*** for SCADA systems |
| | | identify potential causes of interference |
| G-29.02.02L | demonstrate knowledge of regulatory requirements pertaining to SCADA systems and their ***components*** | interpret ***standards, codes and regulations*** pertaining to SCADA systems and their ***components*** |
| G-29.02.03L | demonstrate knowledge of procedures used to configure SCADA systems and ***components*** | identify tools, equipment, and software used to configure SCADA systems and their ***components***, and describe their applications and procedures for use |
| | | describe procedures used to configure SCADA systems and their ***components*** |
| | | describe procedures to program a SCADA system |
| | | describe ***configuration methods*** |
| | | describe ***communication protocols*** |
| | | describe time synchronization and time-stamping |
| | | describe procedures used to configure, upgrade and restore SCADA systems and their ***components*** |
| | | describe importance of backing up and documenting program and configuration before and after service |

## RANGE OF VARIABLES

***components*** include: hardware (MTU, RTU, PLC, HMI, multiple variable computing devices), software, communication systems (cellular, satellite, radio), interconnected media

***SCADA theory*** includes: remote processes, system interactions

***connection methods*** include: hardwired, wireless

***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC, NERC

***configuration methods*** include: addressing, networking

***communication protocols*** include: Modbus, TCP/IP, Fieldbus, Devicenet, Master/Slave

## G-29.03 Performs maintenance, diagnostics and repairs on SCADA systems

| NL | NS | PE | NB | QC | ON | MB | SK | AB | BC | NT | YT | NU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| yes | yes | NV | yes | ND | yes | yes | yes | yes | yes | NV | NV | NV |

### SKILLS

| | Performance Criteria | Evidence of Attainment |
|---|---|---|
| G-29.03.01P | select and use tools, equipment and software | tools, equipment and software are selected and used according to manufacturers' specifications |
| G-29.03.02P | monitor network scan times | network scan times are monitored |
| G-29.03.03P | follow manufacturers' ***maintenance*** schedule | manufacturers' ***maintenance*** schedule is followed |
| G-29.03.04P | review error messages, logs and status lights | error messages, logs and status lights are reviewed to isolate problems |
| G-29.03.05P | perform ***diagnostic procedures*** | ***diagnostic procedures*** are performed |
| G-29.03.06P | check power source for proper voltage | power source is checked for proper voltage |
| G-29.03.07P | interpret self-diagnostic and alarm indicators | self-diagnostic and alarm indicators are interpreted |
| G-29.03.08P | test wireless signal strength | wireless signal strength is tested to ensure that it is operational |
| G-29.03.09P | verify maintenance documentation and historical data | maintenance documentation and historical data are verified to assist in determining probable root cause |
| G-29.03.10P | determine steps required to address faults | steps required to address faults are determined based on probable root cause |
| G-29.03.11P | replace ***components*** | ***components*** are replaced according to job procedures and manufacturers' recommendations |
| G-29.03.12P | restore and verify SCADA configuration from backup | SCADA configuration is restored from backup and verified |
| G-29.03.13P | back up and document SCADA configuration for future data recovery | SCADA configuration is backed up and documented for future data recovery |

### RANGE OF VARIABLES

***maintenance*** includes: replacing backup batteries, cleaning solar panels, checking indicator lights, verifying environmental conditions (ambient conditions, cleanliness)

***diagnostic procedures*** include: forcing I/O, setting traps (first outs) and counters

***components*** include: servers, power supplies, cards (I/O, network, processor), operator stations

| | KNOWLEDGE | |
|---|---|---|
| | **Learning Outcomes** | **Learning Objectives** |
| G-29.03.01L | demonstrate knowledge of SCADA systems, their ***components*** and operation | define terminology associated with SCADA systems |
| | | identify hazards and describe safe work practices pertaining to SCADA systems |
| | | interpret information pertaining to SCADA systems found on drawings and specifications |
| | | identify SCADA system ***components*** and describe their purpose and operation |
| | | identify types of SCADA protocols and configurations and describe their features and limitations |
| | | describe ***SCADA theory*** |
| | | identify ***connection methods*** for SCADA systems |
| | | identify potential causes of interference |
| G-29.03.02L | demonstrate knowledge of regulatory requirements pertaining to SCADA systems and their ***components*** | interpret ***standards, codes and regulations*** pertaining to SCADA systems and their ***components*** |
| G-29.03.03L | demonstrate knowledge of procedures used to maintain, diagnose, repair and replace SCADA systems and ***components*** | identify tools, equipment, and software used to maintain, diagnose, repair and replace SCADA systems, and describe their applications and procedures for use |
| | | describe procedures used to maintain, diagnose, repair and replace SCADA systems and their ***components*** |
| | | describe procedures used to manipulate process to allow for servicing |
| | | describe procedures and importance of backing up and documenting SCADA configuration before and after service |

## RANGE OF VARIABLES

***components*** include: servers, power supplies, cards (I/O, network, processor), operator stations
***SCADA theory*** includes: remote processes, system interactions
***connection methods*** include: hardwired, wireless
***standards, codes and regulations*** include: CEC, IEEE, ISA, CSA, CRTC, NERC

# APPENDIX A
# ACRONYMS

| | |
|---|---|
| AC/DC | alternating current/direct current |
| A/D | analogue-to-digital |
| AHJ | authorities having jurisdiction |
| API | American Petroleum Institute |
| BCD | binary coded decimal |
| BMS | burner management system |
| BNC | Bayonet Neill Concelman |
| CAD | computer-assisted design |
| CCTV | closed-circuit television |
| CEC | Canadian Electrical Code |
| CEMS | continuous emissions monitoring system |
| CRTC | Canadian Radio and Telecommunications Council |
| CSA | Canadian Standards Association |
| D/A | digital-to-analogue |
| DCS | distributed control system |
| DP | differential pressure |
| EMC | electromagnetic compatibility |
| EMI | electromagnetic interference |
| FBD | function block diagram |
| FLRA | field level risk assessment |
| $H_2S$ | hydrogen sulfide |
| HART | Highway Addressable Remote Transducer |
| HMI | Human Machine Interface |
| IEEE | Institute of Electrical and Electronic Engineering |
| IL | instruction list |
| I/O | input/output |
| I/P | current-to-pneumatic |
| IR | infrared |
| ISA | International Society of Automation |
| JSHA | job safety hazard assessment |
| LD | ladder diagram |
| LOPA | layers of protection analysis |
| LVDT | linear variable displacement transformer |
| MCC | motor control centre |
| MIMO | multiple input multiple output |
| MISO | multiple input single output |

| | |
|---|---|
| MOC | Management of Change |
| MTU | master terminal unit |
| NERC | North American Electric Reliability Corporation |
| OH&S | Occupational Health and Safety |
| ORP | oxidation reduction potential |
| OSI | open systems interconnection |
| PI | proportional-integral |
| PID | proportional-integral-derivative |
| P&ID | process and instrumentation diagram |
| PD | positive displacement |
| P&C | process and control |
| PLC | programmable logic controller |
| PPE | personal protective equipment |
| psi | pounds per square inch |
| PTFE | polytetrafluoroethylene |
| PVC | polyvinyl chloride |
| RC | resistance/capacitance |
| RFID | radio frequency identification |
| RL | resistance/inductance |
| RLC | resistance/inductance/capacitance |
| RTD | resistive thermal device |
| RTU | remote terminal unit |
| SAC | stand-alone controller |
| SAMA | Scientific Apparatus Makers Association |
| SCADA | supervisory control and data acquisition |
| SCBA | self-contained breathing apparatus |
| SFC | sequential function chart |
| SIL | safety integrity level |
| SIF | safety instrumented functions |
| SIS | safety instrumented system |
| ST | structured text |
| STP | shielded twisted pair |
| SWP | safe work practices |
| TAPPI | Technical Association for the Pulp and Paper Industry |
| TCP/IP | transport control protocol/internet protocol |
| TDG | transportation of dangerous goods |
| UPS | uninterruptible power supply |
| USB | Universal Serial Bus |
| UTP | unshielded twisted pair |
| UV | ultraviolet |
| UV/IR | ultraviolet/infrared |

| | |
|---|---|
| VFD | variable frequency drive |
| VSD | variable speed drive |
| WHMIS | Workplace Hazardous Materials Information System |
| WLL | working load limit |

# APPENDIX B

# TOOLS AND EQUIPMENT / OUTILS ET ÉQUIPEMENT

## Hand Tools / Outils à mains

| | |
|---|---|
| calipers (assorted) | pieds à coulisse (divers) |
| desoldering tool | outil à dessouder |
| diagonal cutters | pinces à coupe transversale |
| drill bits | mèches |
| easy-outs (extractors) | extracteurs de vis |
| feeler gauges | jauges d'épaisseur |
| flaring tools | évaseur |
| flashlight | lampe de poche |
| fuse puller | extracteur de fusible |
| gasket cutter | coupe-joints |
| gauge pointer puller | extracteur d'aiguille d'indicateur |
| grease gun | pistolet-graisseur |
| hammers (assorted) | marteaux (divers) |
| hand files (assorted) | jeu de limes à main |
| hexalobular wrench (Torx) | clé à empreinte à six lobes (Torx) |
| hex keys (Imperial/Metric) | clés hexagonales (impériales et métriques) |
| I/C integrated-circuit extractor | extracteur de circuit intégré |
| knives | couteaux |
| knock-out punches | poinçons emporte-pièce |
| level | niveau |
| magnet | aimant |
| measuring tape | ruban à mesurer |
| micrometers (assorted) | jeu de micromètres |
| mirrors | miroirs |
| nut drivers (assorted) | jeu de tournevis à douille |
| o-ring picks | pics à joints toriques |
| packing puller | extracteur de garniture |
| pipe threader | filière à tuyaux |
| pliers (assorted) | pinces de diverses grosseurs |
| pry bar | levier |
| punches (assorted) | jeu de poinçons |
| ratchets | rochets |
| reamers | alésoirs |
| rubber mallet | maillet en caoutchouc |
| saws (assorted) | scies |
| screwdrivers (assorted) | tournevis |
| screw starters | pose-vis |
| scribers | pointe à tracer |
| sockets (Imperial/Metric) | douilles (impériales et métriques) |
| square | équerre |
| steel rule | règle en acier |
| strap wrenches | clés à courroie |
| tap and die set | ensemble à fileter |
| torch | chalumeau |
| torque wrenches | clés dynamométrique |

| | |
|---|---|
| tube benders | cintreuses de conduites |
| tube cutters | coupe-tubes |
| tweezers | brucelles |
| wire brushes | brosses métalliques |
| wire crimpers | outils de sertissage pour fils métalliques |
| wire cutters | coupe-fils |
| wire strippers | dénudeurs de fils |
| wrenches (assorted) | clés |

## Power Tools / Outils mécaniques

| | |
|---|---|
| air compressor | compresseur d'air |
| band saw | scie à ruban |
| cut-off saw | scie à tronçonner |
| drill press | perceuse à colonne |
| grinders | meuleuses |
| hammer drill | marteau perforateur |
| heat gun | pistolet thermique |
| high pressure grease gun | pistolet-graisseur à haute pression |
| hydraulic press | presse hydraulique |
| hydraulic knock-out punch | poinçon emporte-pièce hydraulique |
| impact wrench | clé à chocs |
| jig saw | scie sauteuse |
| pipe threader | filière à tuyaux |
| pneumatic tools | outils pneumatiques |
| portable electric drill | perceuse électrique portative |
| portable generator | génératrice portative |
| powder actuated tools | outils à charge explosive |
| pressure and vacuum pumps | pompes à pression et à vide |
| reciprocating saw | scie alternative |
| sandblaster | décapeuse au jet de sable |
| soldering iron | fer à souder |
| wire labeler | étiqueteuse pour fils et câbles |

## Electronic Tools and Test Equipment / Outils électroniques et équipement d'essai

| | |
|---|---|
| amp probe | pince ampèremétrique |
| analogue multimeter | multimètre analogique |
| analyzers | analyseur |
| barometer | baromètre |
| breakout box | contrôleur d'interface |
| bridges | ponts |
| calibrated oven | four étalonné |
| capacitance simulators | simulateurs de capacitance |
| computer | ordinateur |
| current tracer | détecteur de courant |
| dead weight tester | appareil d'essai à contre-poids |
| decade resistance box | boîte de résistance à décades |
| dew point testers (assorted) | analyseur du point de rosée |
| digital logic probe | sonde logique numérique |
| digital multimeter | multimètre numérique |
| dry block calibrator | four d'étalonnage |
| frequency counter | compteur de fréquence |
| frequency generator | générateur de fréquence |
| grounding mats | tapis de mise à la terre |
| handheld programmer (configurators) | programmateur manuel |
| hydrometer | hydromètre |

| | |
|---|---|
| infrared cameras | caméras infrarouges |
| infrared thermometers | thermomètres infrarouges |
| lab scales | balances de laboratoire |
| laser strength meter | appareil de mesure de force laser |
| light microscopes | microscopes optiques |
| logic clip | vérificateur d’états logiques |
| loop calibrator/simulator | étalonneur de boucle, simulateur de boucle |
| manometer and standards | manomètre et étalon |
| microwave leakage meter | appareil de mesure de fuites de micro-ondes |
| millivoltmeter calibrator | étalonneur de millivoltmètre |
| mobile phones/two-way radio | téléphones portatifs et radios bidirectionnels |
| null balance strain indicator | indicateur de tension à équilibrage |
| oscilloscope | oscilloscope |
| pH simulator/buffers | simulateur et tampon de pH |
| pneumatic test stand | banc d’essai pneumatique |
| portable sound level meter | sonomètre portatif |
| pressure pump | pompe à pression |
| proximeter | proximètre |
| power supply | bloc d’alimentation |
| pressure calibrator | calibrateur de pression |
| protocol analyzers | analyseurs de protocoles |
| radiation meters | radiamètres |
| regulators | régulateurs |
| RPM tester/tachometer | tachymètre |
| signal generators | générateurs de signaux |
| signature analyzer | analyseur de signature |
| sling psychrometer | psychromètre fronde |
| stroboscope | stroboscope |
| temperature bath | bain thermostatique |
| temperature calibrator | étalonneur de température |
| test gases | gaz d’étalonnage |
| test gauges | manomètres d’essai |
| thermometer | thermomètre |
| transistor checker | transistormètre |
| voltage tester | testeur de tension |

## Access, Work Holding Equipment and Lifting and Hoisting Equipment / Équipement d’accès, organes de serrage et équipement de levage et de hissage

| | |
|---|---|
| elevated/aerial work platforms | plateformes de travail élévatrices / nacelles élévatrices |
| C-clamps | serre-joint en C |
| chain fall | palan à chaîne |
| come-along | palan à levier |
| crane (overhead, portable) | pont roulant |
| forklift | chariot élévateur à fourche |
| hoist basket | panier de treuil |
| ladders | échelles |
| personal lifting winch | treuil de levage personnel |
| portable cart | chariot portatif |
| prefabricated scaffold | échafaudage préfabriqué |
| slings | élingues |
| vises (assorted) | étaux (divers) |

## Personal Protective Equipment (PPE) and Safety Equipment / Équipement de protection individuelle (EPI) et de sécurité

| | |
|---|---|
| apron | tablier |
| cap lamps | lampes de chapeau |
| chemical shower | douche de sécurité |
| coveralls (regular, disposable and fireproof) | combinaison de travail (normale, jetable et ignifuge) |
| ear protection (muffs and plugs) | protecteurs d’oreilles (cache-oreilles et bouchons) |
| eye wash bottle | pulvérisateur pour les yeux |
| face shield | écran facial |
| fall arrest/restraint harness | harnais antichute |
| fire extinguishers | extincteurs |
| first aid kit | trousse de premiers soins |
| flame retardant clothing | vêtements ignifuges |
| gloves | gants |
| goggles | lunettes de protection |
| hard hat | casque de sécurité |
| low-voltage gloves | gants de protection basse tension |
| masks (assorted) | masques (divers) |
| personal dosimeter | dosimètre individuel |
| personal monitor (gas) | moniteur individuel (gaz) |
| radiation survey meter | radiamètre |
| radiometer | radiomètre |
| respirators | respirateurs |
| rubber boots | bottes en caoutchouc |
| rubber suits | combinaisons en caoutchouc |
| safety boots | bottes de sécurité |
| safety glasses | lunettes de sécurité |
| safety lanyards | cordons de sécurité |
| safety lines | lignes de sécurité |
| self-contained breathing apparatus | appareil respiratoire autonome |
| supplied air hood | cagoule à adduction d'air |
| winter gear | vêtements d’hiver adaptés |

# APPENDIX C
# GLOSSARY / GLOSSAIRE

| | | | |
|---|---|---|---|
| **actuator** | controlled hardware device used to implement change in a process | **actionneur** | dispositif commandé utilisé pour effectuer un changement dans un processus |
| **adapter** | device used to make electrical or mechanical connections between items not originally intended for use together | **adaptateur** | dispositif utilisé pour réaliser des connexions électriques ou mécaniques avec des éléments qui ne sont pas initialement conçus pour être utilisés ensemble |
| **amplifier** | 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 | **amplificateur** | dispositif permettant à un signal d'entrée de commander la puissance venant d'une source indépendante de ce signal et ainsi de produire un signal de sortie qui présente quelque rapport avec le signal d'entrée et est généralement supérieur à ce dernier |
| **analogue signal** | any variable signal continuous in both time and amplitude rather than of a pulsed or discrete nature | **signal analogique** | signal variable continu, tant au niveau du temps que de l'amplitude, par opposition à un signal impulsionnel ou discret |
| **bellows** | elastic element that is a convoluted unit that expands and contracts axially with changes in pressure | **soufflet** | élément élastique qui est une unité enroulée qui s'élargit et se contracte de façon longitudinale en fonction des changements de pression |
| **benchset** | preload or the amount of pressure forcing valves closed with no process affecting it | **mise au banc d'essai** | charge d'étalonnage ou quantité de pression sous laquelle les soupapes se ferment sans incidence du processus |
| **calibrate** | to determine and adjust, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device | **étalonner** | déterminer ou ajuster, par mesure ou par comparaison avec un étalon, l'exactitude de chaque valeur d'échelle d'un compteur ou d'un autre dispositif |
| **cascade control** | type of controller set-up in which the output of one controller acts as the set point or controlling signal of another controller | **régulation en cascade** | type de régulation dans laquelle la sortie d'un des contrôleurs sert de valeur de consigne ou de signal de réglage d'un autre contrôleur |

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| **commission** | process of testing and ensuring that installed equipment is operating as per engineered design | **mise en service** | activités de mise à l'essai pour s'assurer que le matériel installé fonctionne conformément aux dessins techniques |
| **configure** | to set up a program or computer system for a particular application | **configurer** | régler un programme ou un système informatique en vue d'une application particulière |
| **control variable** | measured variables that can be controlled by the control system, such as flow, level, pressure and temperature | **variable de contrôle** | variables mesurées qui peuvent être commandées par le système de commande, comme le débit, le niveau, la pression et la température |
| **diagnose** | activities to determine the cause and source of faults and defects | **diagnostiquer** | activités visant à déterminer la cause et la source des pannes et des défaillances |
| **distributed control system (DCS)** | system of dividing plant or process control into several areas of responsibility, each managed by its own controller (processor), with the whole system interconnected to form a single entity usually by communication buses of various kinds | **système numérique de contrôle-commande (SNCC)** | système de division de la régulation industrielle ou de processus en plusieurs domaines de responsabilité, chacun étant géré par son propre régulateur (processeur), tout le système étant interconnecté de façon à former une seule entité, habituellement au moyen de divers types de bus de communication |
| **fibre optic** | transmission system utilizing very thin glass fibres through which light is transmitted; information is transferred by modulating the transmitted light | **fibre optique** | moyen de transmission faisant appel à des fibres de verre très minces par lesquelles la lumière est transmise; l'information est transmise en modulant la lumière |
| **Fieldbus** | digital, two-way, multi-drop communication link among intelligent measurement and control devices; it serves as a Local Area Network (LAN) for advanced process control and remote input/output for factory automation applications | **Fieldbus** | lien de communication numérique à deux voies à branchements multiples entre des dispositifs de commande et de mesure intelligents; ils jouent le rôle de réseau local pour les systèmes de commande de processus évolués et les entrées et sorties à distance pour les applications d'automatisation des usines |
| **firmware** | software or data that has been written onto read-only memory chips; firmware is a combination of software and hardware | **micrologiciel** | logiciels ou données transcrits sur les puces de mémoire morte seulement; le micrologiciel est une combinaison de logiciel et de matériel |
| **fluid** | any substance that flows, such as liquid, gas or magma | **fluide** | toute substance qui coule, dont les liquides, les gaz ou le magma |

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| **flume** | open channel device used to measure flow | **canal jaugeur** | dispositif qui mesure le débit dans les canalisations à écoulement libre |
| **frequency** | number of cycles completed by a periodic quantity in a unit of time | **fréquence** | nombre de cycles identiques d'une grandeur périodique dans une unité de temps |
| **Highway Addressable Remote Transducer (HART)** | provides digital communication to microprocessor-based (smart) analogue process control instruments | **protocole de communication HART (Highway Addressable Remote Transducer)** | protocole qui transmet les communications numériques aux instruments de commande de processus analogiques, pilotés par un microprocesseur (intelligents) |
| **Human Machine Interface (HMI)** | graphical display and control interface between a process and a human operator | **interface homme-machine (IHM)** | affichage graphique et une interface de commande entre un processus et un opérateur |
| **input/output (I/O)** | all equipment and activity that transfers information into or out of a computer or device | **entrée-sortie** | tout le matériel et les activités qui transfèrent l'information à l'intérieur ou à l'extérieur d'un ordinateur ou d'un dispositif |
| **install** | activities performed which include mounting and connecting | **installer** | activités qui comprennent le montage et le raccordement |
| **instrumentation** | collection of instruments or their application for the purpose of monitoring, measuring and/or controlling of processes | **instrumentation** | ensemble d'appareils ou leur application aux fins de contrôle, de mesure ou de commande des processus |
| **interface** | place at which mediums meet and interact with each other | **interface** | endroit où les supports se rencontrent et interagissent ensemble |
| **International Society of Automation (ISA)** | governing body that develops and maintains defined standards for both scientific and technical areas of process control and automation | **International Society of Automation (ISA)** | organe directeur qui développe et tient à jour des normes définies à la fois pour les domaines scientifiques et techniques de commande de processus et d'automatisation |
| **maintain** | routine preventative activities performed to ensure reliability and to detect potential faults | **faire l'entretien** | activité préventive effectuée régulièrement pour assurer la fiabilité et pour détecter les pannes éventuelles |
| **Modbus** | serial communications protocol originally published by Modicon; allows for communication between many devices connected to the same network | **Modbus** | protocole de communication en série publié initialement par Modicon; ce protocole permet à plusieurs dispositifs connectés au même réseau de communiquer ensemble |
| **module** | assembly of interconnected components that constitutes an identifiable device, instrument or piece of equipment | **module** | ensemble d'éléments interconnectés qui constitue un dispositif, un appareil de mesure ou un équipement distinct |

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| **network** | interconnection of devices sharing communications protocols | **réseau** | interconnexion de dispositifs qui partagent des protocoles de communication |
| **optimize** | series of activities performed to make the process and its control function closer to or better than specifications | **optimiser** | série d'activités effectuées pour que le processus et ses fonctions de commande soient égaux ou supérieurs aux spécifications |
| **port** | signal input (access) or output (egress) point | **port** | point d'entrée ou de sortie de signaux |
| **power supply** | device that produces one or more voltages for the operation of electronic and logic devices | **bloc d'alimentation** | dispositif qui produit une ou plusieurs tensions continues en vue du fonctionnement des dispositifs électroniques et logiques |
| **probable root cause** | non-mathematical, logical process to determine the cause of the potential fault/failure | **cause fondamentale probable** | processus logique non mathématique qui vise à déterminer la cause d'une défaillance ou d'un défaut potentiel |
| **process** | physical or chemical change of matter or conversion of energy | **processus** | changement physique ou chimique d'une matière ou conversion d'énergie |
| **Profibus** | communication protocol | **Profibus** | protocole de communication |
| **program** | list of instructions that a computer will execute to perform a certain task | **programme** | liste d'instructions que doit exécuter un ordinateur pour effectuer une tâche donnée |
| **Programmable Logic Controller (PLC)** | control device, normally used in industrial control applications that employs the hardware architecture of a computer and programming language | **automate programmable industriel (API)** | dispositif de commande utilisé normalement dans les applications de régulation industrielle et faisant appel à l'architecture matérielle d'un ordinateur et à un langage de programmation |
| **Proportional Integral Derivative (PID)** | proportional gain, integral action time and derivative action time; adjustable parameters that are used in tuning a modulating controller to provide stable control for a process loop; these can be used individually or in conjunction with each other | **proportionnel, intégral et dérivé (PID)** | gain proportionnel, temps de dosage d'intégration et temps de dosage de dérivation; paramètres ajustables qui sont utilisés pour ajuster un régulateur modulant pour offrir un contrôle stable d'une boucle de processus; ils peuvent être utilisés seuls ou ensemble |
| **range** | region between the limits within which a quantity is measured, received or transmitted; expressed by stating the lower and upper range values | **plage** | plage entre deux limites dans lesquelles une grandeur est mesurée, reçue ou émise; s'exprime par l'étendue entre la limite inférieure et supérieure |

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|---|---|---|---|
| **ratio** | quotient of one quantity divided by another | **rapport** | quotient d'une quantité divisée par une autre |
| **remote** | device allowing the set point to be altered by a signal from a physical location away from the controller | **commande à distance** | dispositif permettant de changer la valeur de consigne au moyen d'un signal produit en un point éloigné du contrôleur |
| **repair** | activities performed to correct faults; include cleaning, replacing, rebuilding | **réparer** | activités effectuées pour corriger les défaillances; comprennent le nettoyage, le remplacement et la remise en état |
| **Safety Instrumented Function (SIF)** | built in operation of a machine (a safety loop) that takes the unit to a safe outcome if predetermined conditions are not complied with | **fonctions instrumentées de sécurité** | opération intégrée d'une machine (une boucle de sécurité) qui permet à l'unité d'obtenir un résultat sûr si les conditions prédéterminées ne sont pas respectées |
| **Safety Instrumented System (SIS)** | equipment and networks dedicated to safety monitoring and protection of processes and equipment | **système instrumentés de sécurité (SIS)** | matériel et réseaux conçus pour le contrôle de sécurité et la protection des processus et du matériel |
| **Safety Integrity Level (SIL)** | relative level of risk reduction provided by a safety function, or to specify a target level (1-4) of risk reduction | **niveau d'intégrité de sûreté** | réduction relative du niveau de risque grâce à une fonction de sûreté, ou pour préciser un niveau cible (1-4) de réduction du risque |
| **signal** | form of energy that quantitatively represents a variable | **signal** | forme d'énergie qui représente de façon quantitative une variable |
| **strain gauge** | device that uses the change of electrical resistance of a wire under strain to measure applied force | **jauge de déformation** | dispositif qui détermine la variation de résistance électrique d'un fil subissant une contrainte, pour mesurer la force appliquée |
| **Supervisory Control and Data Acquistion (SCADA)** | data transmission and acquisition system for remote control and monitoring of equipment and facilities | **système de télésurveillance et d'acquisition de données (SCADA)** | système d'acquisition et de diffusion de données pour la commande et le contrôle à distance de l'équipement et des installations |
| **temperature bath** | volume of a substance held at constant temperature, so that an object placed in thermal contact with it is maintained at the same temperature | **bain thermostatique** | volume d'une substance maintenue à une température constante, de sorte qu'un objet mis en contact thermique avec cette substance soit maintenu à la même température |
| **terminal** | peripheral device used by the operator to communicate with the computer or a wire connection | **borne** | périphérique utilisé par l'opérateur pour communiquer avec l'ordinateur ou une liaison par fil |

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| **thermocouple** | element that consists of two contacting dissimilar metals converting thermal energy into electrical energy | **thermocouple** | élément qui comporte deux métaux dissemblables en contact transformant l'énergie thermique en énergie électrique |
| **transducer** | device that receives energy in one form and converts to same or another form | **transducteur** | dispositif qui reçoit de l'énergie sous une forme et la transforme en la même forme ou en une autre |
| **transmitter** | device equipped with 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 | **transmetteur** | dispositif équipé d'un transducteur qui réagit à une variable mesurée au moyen d'un capteur et qui la convertit en un signal de transmission normalisé proportionnel à la variable mesurée |
| **tuning** | adjustment of parameters to optimize a particular process | **ajustement** | réglage des paramètres pour optimiser un processus particulier |
| **Uninterruptible Power Supply (UPS)** | electrical system intended to maintain power to critical equipment in the event of a power failure | **alimentation sans interruption (ASI)** | système électrique conçu pour assurer l'alimentation de l'équipement d'importance vitale en cas de panne de courant |
| **Variable Frequency Drive (VFD) and Variable Speed Drive (VSD)** | electronic equipment that allows an electric motor to be run at varying speeds | **entraînement à fréquence variable et entraînement à vitesse variable** | équipement électronique qui permet à un moteur électrique de fonctionner à des vitesses variables |
| **weir** | engineered obstruction placed in an open channel used to provide flow measurement | **déversoir** | obstacle placé dans une canalisation à écoulement libre utilisé pour obtenir une mesure du débit |
| **wireless** | means to transmit and receive data using electromagnetic waves | **sans fil** | moyen de transmettre et de recevoir des données par le truchement d'ondes électromagnétiques |
| **Workplace Hazardous Materials Information System (WHMIS)** | comprehensive plan for providing information on the safe use of hazardous materials used in workplaces; also known as WHMIS 2015, which aligns with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) | **Système d'information sur les matières dangereuses utilisées au travail (SIMDUT)** | plan global pour fournir de l'information sur l'utilisation sécuritaire de matières dangereuses en milieu de travail; aussi connu comme le SIMDUT 2015, qui s'harmonise au Système général harmonisé de classification et d'étiquetage des produits chimiques (SGH) |