PROGRAM PROGRAMME
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RED SEAL OCCUPATIONAL STANDARD

Industrial Mechanic (Millwright)

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INDUSTRIAL MECHANIC (MILLWRIGHT)

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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 Industrial Mechanic (Millwright) 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 analyses of occupations.

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 Regulated Occupations Directorate
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This standard was prepared by Apprenticeship and Regulated Occupations Directorate of ESDC. The coordinating, facilitating and processing of this analysis were undertaken by employees of the standards development team of the Trades and Apprenticeship Division and of Manitoba, the host jurisdiction for this trade.

STRUCTURE OF THE OCCUPATIONAL STANDARD

To facilitate understanding of the occupation, this standard contains the following sections:

Description of the Industrial Mechanic (Millwright) trade: An overview of the trade's duties, work environment, job requirements, similar occupations and career progression

Trends in the Industrial Mechanic (Millwright) 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 9 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: a graph which depicts the national percentages of exam questions assigned to the major work activities

Task Matrix and Examination Weightings: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard and their respective exam weightings

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

Essential Skills: The most relevant essential skills for this sub-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 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: a non-exhaustive list of tools and equipment used in this trade

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

A complete version of the occupational standard, which provides additional detail for the trade activities, skills and knowledge can be found at www.red-seal.ca

DESCRIPTION OF THE INDUSTRIAL MECHANIC (MILLWRIGHT) TRADE

"Industrial Mechanic (Millwright)" is this trade's official Red Seal occupational title approved by the CCDA. This analysis covers tasks performed by industrial mechanics (millwrights) 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
Industrial Mechanic (Millwright)	■	■	■	■	■		■	■		■	■	■	■
Millwright									■				
Industrial Mechanic Millwright						■							

Industrial mechanics (millwrights) work on industrial and mechanical equipment and components. This equipment may include mechanical, pneumatic, hydraulic, fuel, lubrication, cooling and exhaust systems and equipment. Some components worked on include pumps, gear boxes, fans, tanks, conveyors, presses, generators, prime movers, pneumatic and hydraulic systems, robotics and automated equipment.

Industrial mechanics (millwrights) are responsible for assembling, installing, aligning, commissioning, maintaining, repairing, diagnosing, inspecting, dismantling, moving and decommissioning equipment. Servicing may include diagnosing irregularities and malfunctions, making adjustments, and repairing or replacing parts. Cleaning and lubricating equipment are also important maintenance tasks of the trade.

Other tasks that may be performed include welding, cutting, rigging and machining as required. Industrial mechanics (millwrights) may prepare bases for equipment. In certain jurisdictions, industrial mechanics (millwrights) may assist other trades in troubleshooting and repairing other systems.

Industrial mechanics (millwrights) may refer to schematics, engineered drawings and manuals, both hard copy and electronic, to determine work procedures.

Industrial mechanics (millwrights) work with a wide variety of tools. They may use hand and power tools and access equipment in installation and repair work. Larger machine tools such as lathes, milling machines, drill presses and grinders may be used in fabrication of machine parts. Rigging, hoisting/lifting and moving equipment such as cranes, jacks and powered mobile equipment (PME) are commonly used to position large machines or machine parts.

Industrial mechanics (millwrights) are employed in all sectors of industry that involve mechanical moving equipment including mining, petrochemical, power generation, manufacturing, forestry, and processing facilities (food, service) among others. Industrial mechanics (millwrights) are involved with the installation, diagnosis, maintenance and repair of equipment and components.

The work environment for industrial mechanics (millwrights) is varied and may involve working in extreme or adverse conditions. They often work shift work. They may work in confined spaces, underground (in mines), at heights, with heavy equipment and around moving equipment. The work often requires considerable standing, kneeling and lifting of materials.

Key skills for people in this trade are mechanical aptitude, problem-solving, communication, job planning and organizing and the ability to use trade-related calculations. They have the ability to detect malfunctions through sensory tests which are often confirmed by condition-based monitoring. Other important attributes include good coordination, manual dexterity and spatial visualization.

Industrial mechanics (millwrights) often possess overlapping skills with other tradespeople such as steamfitter/pipefitters, industrial instrument mechanics, power engineers, welders, machinists or industrial electricians. Industrial mechanics (millwrights) may work in specialized areas of the trade such as vibration analysis, thermography, tribology (fluid analysis) and laser/optical alignment. With experience, they may advance to other positions such as mentor, supervisor, planner, superintendent, manager, instructor or trainer.

TRENDS IN THE INDUSTRIAL MECHANIC (MILLWRIGHT) TRADE

There is a progression from analog to digital equipment that provides computer generated readouts and can be programmed to give accurate readings in less time. This technology allows for improved self-diagnosis and predictive maintenance and has reduced the length of mechanical outages and manpower required to complete outages. For example, the technology has reduced equipment down time for tasks such as alignment, diagnosis, assembly and repair. Industrial mechanics (millwrights) need to keep pace with changes in technology.

Advances in predictive maintenance have led to more advanced diagnostic equipment such as alignment equipment and vibration monitoring equipment. Acoustic monitoring technology is advancing rapidly. Fibre-optic scopes are increasingly used to view and troubleshoot internal components. Thermal imaging is advancing preventive maintenance based upon equipment heat signature. Ultrasound testing is becoming prevalent in the maintenance of piping systems. There is advanced diagnostic equipment for fluid power inspection such as handheld analyzers and clamp-on flowmeters.

Hydraulic tools are continuously evolving in ease of use and size. They are becoming safer and more efficient to use. Hydraulic technology is being used for broader applications such as bolt tensioning and torquing.

There is a move toward environmentally conscious hydroelectric construction projects such as “run of the river” that also minimize the human footprint. The emphasis is on building smaller units as opposed to one large unit. Windmill technology continues to advance. However in this case, the units are increasing in size to allow more production of energy. Waste management is another growing industry. These are all creating more work for industrial mechanics (millwrights) in the installation, diagnosis, maintenance and repair of these units.

The evolution of technology and the complexity of systems such as hydraulics, robotics and renewable energy systems (solar panels, wind turbines) are expanding the scope of work for industrial mechanics (millwrights).

There is a wider variety of materials available for use in the construction of machinery and components, such as new composite alloys, fibre-based composites and advanced plastics. More types of sealant and epoxy materials are available.

Preventive and predictive maintenance planning is seen as more important and scheduled shutdowns are more prevalent. The knowledge and use of a Computer Maintenance Management System (CMMS) to manage labour and cost is essential. For example, Reliability Centered Maintenance (RCM) and Total Quality Management (TQM) methodology are becoming more common because of its cost effectiveness.

Some hand and power tools are ergonomically designed to prevent repetitive strain injuries. Many power tools are now cordless with improved battery life and light-weight design, making them more ergonomically friendly, resulting in fewer injuries. There is an increased use of powered mobile equipment (PME) such as scissor lifts, aerial work platforms (AWP) and lift trucks in the trade. This equipment is incorporating more safety features. Certification of the equipment and of employees’ competency is becoming mandatory. Jurisdictional regulations are becoming more stringent by requiring documentation for equipment operation and training.

Technological advances and worker education regarding personal protective equipment (PPE) has improved effectiveness and functionality, resulting in improved safety practices and procedures among tradespersons. Improved identification of hazardous materials through increased use of Safety Data Sheets (SDS) contributes to a safer work environment.

Quality assurance, reliability, maintainability and safety are critical elements of the standards for industrial mechanics (millwrights). Continuous changes in technology, environmental regulations and worker safety concerns have led to improved safe work practices.

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.

Tools are available online or for order at: http://www.esdc.gc.ca/eng/jobs/les/tools/index.shtml.

The application of these skills may be described throughout this document within the competency statements which support each subtask 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: www.red-seal.ca.

READING

Industrial mechanics (millwrights) read texts such as short descriptions and directions on labels for products. They read bulletins, manuals, work orders, reports and procedures when installing, operating, diagnosing, maintaining and repairing equipment. They also read emails and memos from supervisors, co-workers and suppliers about ongoing work.

DOCUMENT USE

Industrial mechanics (millwrights) scan and locate data on labels, lists, tables and schedules. They may interpret graphs when monitoring equipment operation. They interpret or review schematics and engineered drawings of systems (pneumatic, mechanical, structural and hydraulic) to identify malfunctions. Industrial mechanics (millwrights) may also retrieve and study data from scale drawings to identify location of equipment to be installed and verify location. They also complete forms such as purchase orders, maintenance forms, logbooks and work orders.

WRITING

Industrial mechanics (millwrights) write brief text entries in logbooks and in forms. They may write maintenance, repair and safe work procedures. Industrial mechanics (millwrights) write emails to supervisors, co-workers about ongoing work, and suppliers about equipment specifications. They may also write incident reports and update drawings.

ORAL COMMUNICATION

Industrial mechanics (millwrights) talk to suppliers, engineers and contractors about equipment specifications and access, orders, delivery and service times. They discuss work orders, equipment malfunctions and job task coordination with co-workers. They inform supervisors about work progress and may seek guidance and approvals from them. Industrial mechanics (millwrights) may discuss work with clients, advise them about maintenance and propose equipment modifications. They also discuss safety, productivity, and procedural and policy changes at meetings with co-workers, supervisors, engineers and clients. Industrial mechanics (millwrights) communicate with other tradespeople and personnel from other departments.

NUMERACY

Industrial mechanics (millwrights) measure various physical properties of equipment. Calculations are required in multiple aspects of the industrial mechanics (millwrights) trade, such as pneumatic, mechanical, structural and hydraulic systems. They calculate distances, totals, maximums, minimums, tolerances, fits and quantities required. They also calculate loads, capacities, speeds, feeds and dimensions for mechanical components and systems. They perform calculations in order to adjust, level and align equipment according to specifications, and for diagnosing process variables. Industrial mechanics (millwrights) estimate weights and distances appropriate for rigging, hoisting, lifting and moving equipment and procedures.

THINKING

Thinking skills are critical to the industrial mechanics (millwrights) trade. They may problem solve by fabricating or adapting parts from other machines when parts needed are not available for maintenance and repairs. They may choose among refurbish, repair and replacement options for worn and defective parts such as hoses, motors, valves and bushings. They take into consideration factors such as maintenance guidelines, performance and test results, safety, efficiency and durability of replacement parts. Industrial mechanics (millwrights) evaluate conditions of parts and equipment, and the safety of their work environment. They may assess feasibility of designs for small modifications to equipment, ensuring that designs meet technical specifications, performance requirements and jurisdictional regulations.

DIGITAL TECHNOLOGY

Industrial mechanics (millwrights) may use databases to perform queries on maintenance history, regulatory items and procedures. They may also enter data from completed work orders in a computerized maintenance management system (CMMS). They may use programs to aid in the adjustment of drawings with computer-assisted design (CAD) software and to control and monitor operation of manufacturing and machining equipment. Industrial mechanics (millwrights) use hand-held computerized alignment, leveling and vibration measurement tools. They may use word processing software to write, edit and format texts such as incident reports and maintenance procedures. They may access work orders, asset information and documents on tablets, phones and other electronic devices.

WORKING WITH OTHERS

Industrial mechanics (millwrights) are required to work independently, with other industrial mechanics (millwrights) other tradespeople and personnel from other departments and jurisdictional organisations depending on the scope of the work.

CONTINUOUS LEARNING

Industrial mechanics (millwrights) read manuals and trade related documents to stay up to date on developments in their trade. They also attend training sessions (online or classroom-based) on new technologies, equipment and safety procedures. In addition, they learn informally by exchanging information with co-workers and suppliers.

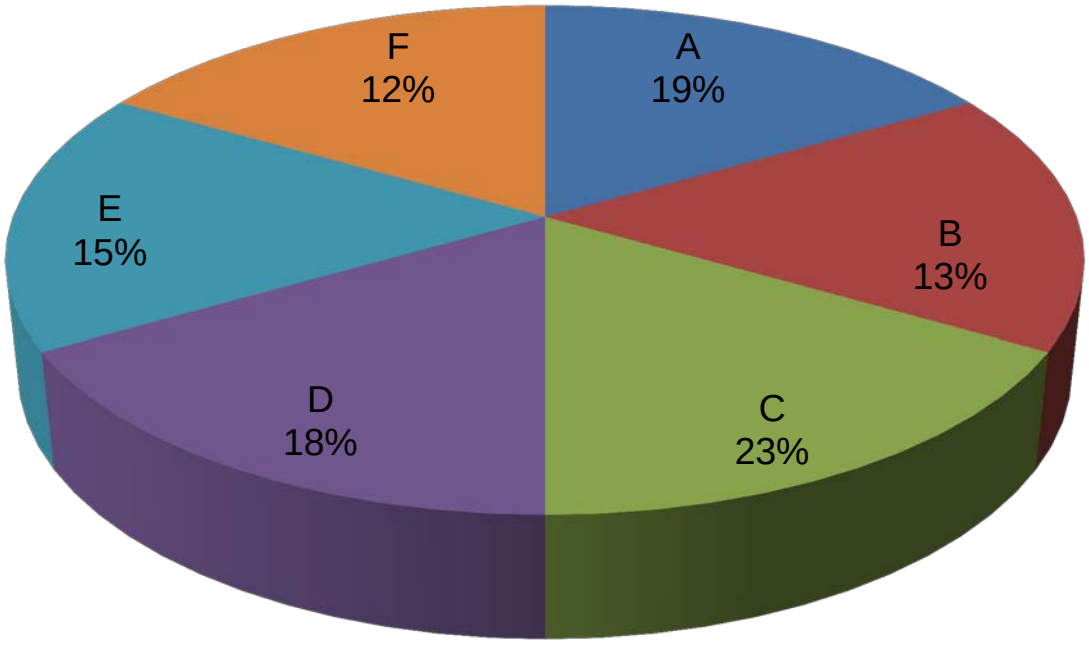
INDUSTRY EXPECTED PERFORMANCE

All tasks must be performed according to the applicable jurisdictional regulations and standards. All health and safety standards must be respected and observed. Work should be performed efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer specifications and client expectations must be met. At a journeyperson level of performance, all tasks must be completed 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 keep 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 language of business as well as language of instruction in apprenticeship programs.

PIE CHART
OF RED SEAL EXAMINATION WEIGHTINGS



MWA A	Performs common occupational skills	19%
MWA B	Performs rigging, hoisting/lifting and moving	13%
MWA C	Services mechanical power transmission components and systems	23%
MWA D	Services material handling/process systems	18%
MWA E	Services fluid power systems	15%
MWA F	Performs preventative and predictive maintenance, commissioning and decommissioning	12%

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. Interprovincial examinations typically have between 100 and 150 questions.

INDUSTRIAL MECHANIC (MILLWRIGHT)

TASK MATRIX

A - PERFORMS COMMON OCCUPATIONAL SKILLS — 19%

Task A-1 **Performs safety-related functions** **17%**	**A-1.01 Uses personal protective equipment (PPE) and safety equipment**	**A-1.02 Maintains safe worksite**	**A-1.03 Protects the environment**
	A-1.04 Performs lock-out/tag-out and zero-energy state procedures		
Task A-2 **Uses tools and equipment** **21%**	**A-2.01 Uses hand and portable power tools**	**A-2.02 Uses shop machines**	**A-2.03 Uses access equipment**
Task A-3 **Performs routine trade tasks** **26%**	**A-3.01 Plans work**	**A-3.02 Fabricates work piece**	**A-3.03 Lubricates systems and components**
	A-3.04 Performs leveling of components and systems	**A-3.05 Uses fastening and retaining devices**	**A-3.06 Performs material identification**
	A-3.07 Performs heat treatment of metal	**A-3.08 Uses mechanical drawings and schematics**	
Task A-4 **Uses communication and mentoring techniques** **10%**	**A-4.01 Uses communication techniques**	**A-4.02 Uses mentoring techniques**	

Task A-5 **Performs measuring and layout** **16%**	**A-5.01 Prepares work area, tools and materials**	**A-5.02 Measures material and components**	**A-5.03 Lays out components**
	A-5.04 Maintains precision measuring and layout tools		
Task A-6 **Performs cutting and welding operations** **10%**	**A-6.01 Cuts material with oxy-fuel and plasma arc equipment**	**A-6.02 Joins material using oxy-fuel welding equipment**	**A-6.03 Welds material using shielded metal arc welding (SMAW) equipment**
	A-6.04 Welds material with gas metal arc welding (GMAW) equipment	**A-6.05 Welds material with gas tungsten arc welding (GTAW) equipment (NOT COMMON CORE)**	**A-6.06 Maintains welding equipment**

B - PERFORMS RIGGING, HOISTING/LIFTING AND MOVING — 13%

Task B-7 **Plans rigging, hoisting/lifting and moving** **48%**	**B-7.01 Determines load**	**B-7.02 Selects rigging equipment**	**B-7.03 Selects hoisting/lifting and moving equipment**
	B-7.04 Secures area		
Task B-8 **Rigs, hoists/lifts and moves load** **52%**	**B-8.01 Sets up rigging, hoisting/lifting and moving equipment**	**B-8.02 Performs hoist/lift and move**	**B-8.03 Maintains rigging, hoisting/lifting and moving equipment**

C - SERVICES MECHANICAL POWER TRANSMISSION COMPONENTS AND SYSTEMS

23%

Task C-9 **Services prime movers** **16%**	**C-9.01 Installs prime movers**	**C-9.02 Diagnoses prime movers**	**C-9.03 Maintains prime movers**
	C-9.04 Repairs prime movers		
Task C-10 **Services shafts, bearings and seals** **20%**	**C-10.01 Installs shafts, bearings and seals**	**C-10.02 Diagnoses shafts, bearings and seals**	**C-10.03 Maintains shafts, bearings and seals**
	C-10.04 Repairs shafts, bearings and seals		
Task C-11 **Services couplings, clutches and brakes** **16%**	**C-11.01 Installs couplings, clutches and brakes**	**C-11.02 Diagnoses couplings, clutches and brakes**	**C-11.03 Maintains couplings, clutches and brakes**
	C-11.04 Repairs couplings, clutches and brakes		
Task C-12 **Services chain and belt drive systems** **15%**	**C-12.01 Installs chain and belt drive systems**	**C-12.02 Diagnoses chain and belt drive systems**	**C-12.03 Maintains chain and belt drive systems**
	C-12.04 Repairs chain and belt drive systems		

Task C-13 **Services gear systems** **16%**	**C-13.01 Installs gear systems**	**C-13.02 Diagnoses gear systems**	**C-13.03 Maintains gear systems**
	C-13.04 Repairs gear systems		
Task C-14 **Performs shaft alignment procedures** **17%**	**C-14.01 Performs rough alignment**	**C-14.02 Performs dial alignment**	**C-14.03 Performs laser alignment**

D - SERVICES MATERIAL HANDLING / PROCESS SYSTEMS — 18%

Task D-15 **Services robotics and automated equipment** **7%**	**D-15.01 Installs robotics and automated equipment**	**D-15.02 Diagnoses robotics and automated equipment**	**D-15.03 Maintains robotics and automated equipment**
	D-15.04 Repairs robotics and automated equipment		
Task D-16 **Services fans and blowers** **17%**	**D-16.01 Installs fans and blowers**	**D-16.02 Diagnoses fans and blowers**	**D-16.03 Maintains fans and blowers**
	D-16.04 Repairs fans and blowers		
Task D-17 **Services pumps** **21%**	**D-17.01 Installs pumps**	**D-17.02 Diagnoses pumps**	**D-17.03 Maintains pumps**

	D-17.04 Repairs pumps		
Task D-18 **Services compressors** **20%**	D-18.01 Installs compressors	D-18.02 Diagnoses compressors	D-18.03 Maintains compressors
	D-18.04 Repairs compressors		
Task D-19 **Services process piping, tanks and containers** **15%**	D-19.01 Installs process tanks and containers	D-19.02 Installs process piping	D-19.03 Diagnoses process tanks and containers
	D-19.04 Diagnoses process piping	D-19.05 Maintains process tanks and containers	D-19.06 Maintains process piping
	D-19.07 Repairs process tanks and containers	D-19.08 Repairs process piping	
Task D-20 **Services conveying systems** **20%**	D-20.01 Installs conveying systems	D-20.02 Diagnoses conveying systems	D-20.03 Maintains conveying systems
	D-20.04 Repairs conveying systems		

E - SERVICES FLUID POWER SYSTEMS

15%

Task E-21 **Services hydraulic systems** **57%**	**E-21.01 Installs hydraulic systems**	**E-21.02 Diagnoses hydraulic systems**	**E-21.03 Maintains hydraulic systems**
	E-21.04 Repairs hydraulic systems		
Task E-22 **Services pneumatic and vacuum systems** **43%**	**E-22.01 Installs pneumatic and vacuum systems**	**E-22.02 Diagnoses pneumatic and vacuum systems**	**E-22.03 Maintains pneumatic and vacuum systems**
	E-22.04 Repairs pneumatic and vacuum systems		

F - PERFORMS PREVENTATIVE AND PREDICTIVE MAINTENANCE, COMMISSIONING AND DECOMMISSIONING

12%

Task F-23 **Performs preventative and predictive maintenance** **66%**	**F-23.01 Performs preventative maintenance activities**	**F-23.02 Performs vibration analysis procedures**	**F-23.03 Performs balancing procedures**
	F-23.04 Performs non-destructive testing (NDT) procedures	**F-23.05 Performs fluid analysis procedures**	**F-23.06 Performs predictive maintenance activities**
Task F-24 **Commissions and decommissions equipment** **34%**	**F-24.01 Commissions systems and components**	**F-24.02 Decommissions systems and components**	

MAJOR WORK ACTIVITY A

Performs common occupational skills

TASK A-1 Performs safety-related functions

TASK DESCRIPTOR

Industrial mechanics (millwrights) use PPE and safety equipment, maintain a safe work environment and perform other procedures for the purpose of preventing personal injury, equipment damage and environmental impact.

A-1.01 Uses personal protective equipment (PPE) and safety equipment

Essential Skills	Reading, Document Use, Oral Communication

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-1.01.01P	organize ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are organized according to site specifications and ***jurisdictional regulations***
A-1.01.02P	select ***PPE*** and ***safety equipment*** specific to job task	***PPE*** and ***safety equipment*** is selected according to job task, site specifications and ***jurisdictional regulations***
A-1.01.03P	recognize worn, damaged or defective ***PPE*** and ***safety equipment***	worn, damaged or defective ***PPE*** and ***safety equipment*** is recognized and removed from service according to site and manufacturers' specifications, and ***jurisdictional regulations***
A-1.01.04P	ensure fit of ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** fit according to site and manufacturers' specifications and ***jurisdictional regulations***
A-1.01.05P	clean and store ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** is cleaned and stored according to site and manufacturers' specifications and ***jurisdictional regulations***

RANGE OF VARIABLES

PPE includes: safety glasses (face shield), respirators, hardhats, footwear, gloves, coveralls, acid suits, personal monitors, fall protection, hearing protection, high-visibility clothing

safety equipment includes: lockout devices, fire extinguishers, gas detectors, fall protection equipment and devices

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.01.01L	demonstrate knowledge of ***personal protective equipment (PPE)*** and ***safety equipment***, their applications, maintenance and procedures for use	identify types of ***PPE*** and clothing, and describe their characteristics, applications and procedures for use
		identify types of ***safety equipment*** and describe their characteristics, applications and procedures for use
		describe the procedures used to care for, maintain and store ***PPE***
		describe the procedures used to care for, maintain and store ***safety equipment***

RANGE OF VARIABLES

PPE includes: safety glasses (face shield), respirators, hardhats, footwear, gloves, coveralls, acid suits, personal monitors, fall protection, hearing protection, high-visibility clothing

safety equipment includes: lockout devices, fire extinguishers, gas detectors, fall protection equipment and devices

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

A-1.02 Maintains safe worksite

Essential Skills	Document Use, Oral Communication, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.02.01P	recognize and address ***hazards***	***hazards*** that could cause personal injury, or damage to equipment or the worksite are recognized and addressed according to site specifications and ***jurisdictional regulations***
A-1.02.02P	handle and store hazardous materials according to WHMIS	hazardous materials are handled and stored according to WHMIS
A-1.02.03P	install ***safety protection***	***safety protection*** is installed according to manufacturers' specifications and ***jurisdictional regulations***
A-1.02.04P	identify and implement ventilation in workspace	ventilation is identified and implemented in workspace according to ***jurisdictional regulations***
A-1.02.05P	ensure clear path of access and egress	a clear path is ensured for access and egress according to ***jurisdictional regulations***
A-1.02.06P	test air quality of confined spaces	air quality of confined spaces is tested on a continuous basis using calibrated air monitoring devices according to manufacturers' specifications and ***jurisdictional regulations***
A-1.02.07P	follow confined space procedures and ***jurisdictional regulations***	confined space procedures are followed according to site specifications and ***jurisdictional regulations***
A-1.02.08P	follow safe work practices working around mobile and overhead cranes	safe work practices related to mobile and overhead cranes are followed according to site specifications and ***jurisdictional regulations***
A-1.02.09P	ensure cables and straps for monitoring equipment are secured	cables and straps are secured to ensure they do not get caught in equipment when performing condition-based monitoring
A-1.02.10P	ensure cables and straps for ***PPE*** are secured	cables and straps for ***PPE*** are secured to ensure they do not get caught in equipment

RANGE OF VARIABLES

hazards include: poor housekeeping, improper use of ***PPE***, lack of monitoring devices, improper rigging of material, improper hardware selection, poor air quality, poor ventilation, improper pre-use inspection, improper preparation for hot work

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

safety protection includes: signage, barrier tape and barricades, ***PPE***, monitors, proper training, designated spotter, guarding, warning devices (e.g. horns), rescue plan

PPE includes: safety glasses (face shield), respirators, hardhats, footwear, gloves, coveralls, acid suits, personal monitors, fall protection, hearing protection, high-visibility clothing

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.02.01L	demonstrate knowledge of safe work practices	define terminology associated with safety in the worksite
		identify worksite ***hazards*** and assess risks
		describe the procedures used to maintain a safe worksite
		identify ***hazards*** and describe safe work practices pertaining to rigging, hoisting/lifting and moving
		describe the ***procedures used to ensure the work area is safe for lifting***
		identify ***hazards*** and describe safe work practices pertaining to inert gases, oxy-fuel cutting, heating, welding, brazing and soldering
		identify ***hazards*** and describe safe work practices pertaining to working in confined spaces
		identify ***hazards*** and describe safe work practices pertaining to working at heights
		identify ***hazards*** and describe safe work practices pertaining to working around ***energized equipment***
A-1.02.02L	demonstrate knowledge of regulatory requirements pertaining to safety	interpret ***jurisdictional regulations*** related to workplace health and safety
		interpret ***jurisdictional regulations*** pertaining to rigging, hoisting/lifting and moving
		interpret ***jurisdictional regulations*** pertaining to inert gases, oxy-fuel cutting, heating, welding, brazing and soldering
		interpret ***jurisdictional regulations*** related to working in confined spaces

	interpret ***jurisdictional regulations*** related to working at heights
	interpret ***jurisdictional regulations*** related to working around ***energized equipment***

RANGE OF VARIABLES

hazards include: poor housekeeping, improper use of ***PPE***, lack of monitoring devices, improper rigging of material, improper hardware selection, poor air quality, poor ventilation, improper pre-use inspection, improper preparation for hot work, personal, workplace (electrical, chemical, potential sources of energy, sources of radiation, confined spaces, fire, heights, air quality, rotating equipment)

procedures used to ensure the work area is safe for lifting include: supervision of lift, securing work area, communication, critical lift plan, engineered lift plan, fire watch

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

energized equipment includes: mobile equipment (e.g. loader, crane, fork truck), stationary rotating equipment, conveying systems, bus bars, motor control centre, pressurized equipment

A-1.03 Protects the environment

Essential Skills Document Use, Continuous Learning, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.03.01P	recognize ***environmental hazards*** that could cause personal injury and harm the environment, and report potential ***environmental hazards***	potential ***environmental hazards*** that could cause personal injury and harm the environment are recognized and reported according to site specifications, and ***jurisdictional regulations***
A-1.03.02P	follow due diligence procedures to avoid contamination	due diligence procedures are followed to avoid contamination of water, air and soil according to site specifications, and ***jurisdictional regulations***
A-1.03.03P	follow disposal procedures of hazardous material	disposal procedures of hazardous material are followed according to site specifications, and ***jurisdictional regulations***

RANGE OF VARIABLES

environmental hazards include: contamination (water, air, soil), hazardous materials

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.03.01L	demonstrate knowledge of regulatory requirements pertaining to environmental safety and protection	identify ***environmental hazards***, assess risks and describe the procedures used to protect the environment
		identify how to access current information on site specifications and ***jurisdictional regulations***
		identify reporting requirements and procedures

RANGE OF VARIABLES

environmental hazards include: contamination (water, air, soil), hazardous materials

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

A-1.04 Performs lock-out/tag-out and zero-energy state procedures

Essential Skills Document Use, Thinking, Oral Communication

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-1.04.01P	recognize and de-energize ***energy potential in machines, process systems and components*** and confirm zero-energy state	***energy potential in machines, process systems and components*** is recognized and de-energized according to site and manufacturers' specifications, and ***jurisdictional regulations*** and zero-energy state is confirmed
A-1.04.02P	follow recognized standard operating procedure (SOP) for shutdown, lock-out and tag-out	SOP is followed for shutdown, lock-out and tag-out according to site and manufacturers' specifications, and ***jurisdictional regulations***

RANGE OF VARIABLES

energy potential in machines, process systems and components includes: accumulators, suspended loads, pneumatic and hydraulic equipment, gravity, piping, pipe blockages, rotating equipment, stress, strain and/or tension, material memory (e.g. coiled cable, springs), electrical, thermal

jurisdictional regulations include: federal, provincial/territorial, municipal

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.04.01L	demonstrate knowledge of the procedures used to perform lock-out/tag-out and zero-energy procedures	identify ***energy potential in machines, process systems and components*** and methods to verify zero-energy state
		describe the procedures used to lock-out and tag-out equipment and to return to zero-energy state
A-1.04.02L	demonstrate knowledge of potential hazards associated with lock-out/tag-out and zero-energy procedures	identify and describe potential outcomes of not following procedures used to lock-out and tag-out equipment and to return to zero-energy state

RANGE OF VARIABLES

energy potential in machines, process systems and components includes: accumulators, suspended loads, pneumatic and hydraulic equipment, gravity, piping, pipe blockages, rotating equipment, stress, strain and/or torsion/tension, material memory (e.g. coiled cable, springs), electrical, thermal, counter weights

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

TASK A-2 Uses tools and equipment

TASK DESCRIPTOR

Industrial mechanics (millwrights) use various tools and equipment to perform their work. These subtasks include both the use of the tool as well as maintenance of the tools to ensure optimal efficiency and safe operation.

A-2.01 Uses hand and portable power tools

Essential Skills Thinking, Numeracy, Continuous Learning

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-2.01.01P	recognize worn, damaged or defective ***hand*** and ***portable power tools***	worn, damaged or defective ***hand*** and ***portable power tools*** are identified and removed from service according to site and manufacturers' specifications
A-2.01.02P	operate ***hand*** and ***portable power tools***	***hand*** and ***portable power tools*** are operated according to site and manufacturers' specifications
A-2.01.03P	maintain ***hand*** and ***portable power tools***	***hand*** and ***portable power tools*** are maintained according to site and manufacturers' specifications
A-2.01.04P	store ***hand*** and ***portable power tools***	***hand*** and ***portable power tools*** are stored according to site and manufacturers' specifications

RANGE OF VARIABLES

hand tools include: wrenches, screwdrivers, measuring tools, hammers, pry bars, hand saws, pneumatic tools

portable power tools include: grinders, power metal saws, drilling machines, wrenches (hydraulic, impact), portable hydraulic unit

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.01.01L	demonstrate knowledge of ***hand tools*** and ***portable power tools***, their applications and procedures for use	define terminology associated with ***hand tools*** and ***portable power tools*** and equipment
		interpret ***jurisdictional regulations***, and ***manufacturers' specifications*** pertaining to ***hand tools*** and ***portable power tools***
		identify types of ***hand tools*** and describe their applications and procedures for use
		identify types of ***portable power tools*** and describe their applications and procedures for use
A-2.01.02L	demonstrate knowledge of the procedures used to clean, inspect, maintain and store ***hand tools*** and ***portable power tools***	describe the procedures used to clean, inspect, maintain and store ***hand tools*** and ***portable power tools***
A-2.01.03L	demonstrate knowledge of safety practices related to ***hand tools*** and ***portable power tools*** and equipment	identify hazards and describe safe work practices pertaining to the use of ***hand tools*** and ***portable power tools*** and equipment

RANGE OF VARIABLES

hand tools include: wrenches, screwdrivers, measuring tools, hammers, pry bars, hand saws, pneumatic tools

portable power tools include: grinders, power metal saws, drilling machines, wrenches (hydraulic, impact), portable hydraulic unit

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

manufacturers' specifications include: licensing, training

A-2.02 Uses shop machines

Essential Skills Thinking, Continuous Learning, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.02.01P	set up ***shop machines*** to perform task	***shop machines*** are set up according to job requirements, drawings and manufacturers' specifications
A-2.02.02P	apply coolants and cutting fluids	coolants and cutting fluids are applied according to speed, material and manufacturers' specifications
A-2.02.03P	clean and lubricate ***shop machines***	***shop machines*** are cleaned and lubricated according to manufacturers' specifications
A-2.02.04P	cut, drill, machine and grind work piece	work piece is cut, drilled, machined and ground according to recommended speed, drawings or instructions
A-2.02.05P	bend, cope, notch and roll work piece	work piece is bent, coped, notched and rolled according to recommended drawings or instructions

RANGE OF VARIABLES

shop machines include: drill presses, pedestal grinders, surface and cylindrical grinders, abrasive cutoff saw (chop saw), band saws, lathes, milling machines, ironworkers (slip-roll and brakes), sandblasters, shears

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.02.01L	demonstrate knowledge of ***shop machines***, their applications and procedures for use	identify types of ***shop machines*** and describe their applications and procedures
A-2.02.02L	demonstrate knowledge of safety practices related to the use of ***shop machines***	identify hazards and describe safe work practices pertaining to grinding operations
		identify hazards and describe safe work practices pertaining to power metal saws
		identify hazards and describe safe work practices pertaining to drilling operations
		identify hazards and describe safe work practices pertaining to lathe operations

		identify hazards and describe safe work practices pertaining to milling operations, materials used, and coolants
A-2.02.03L	demonstrate knowledge of ironworkers shop equipment, their applications and procedures for use	identify types of ironworkers shop equipment and describe their applications and procedures
A-2.02.04L	demonstrate knowledge of safety practices related to the use of ironworkers shop equipment	identify hazards and describe safe work practices pertaining to ironworkers equipment to slip-roll applications
		identify hazards and describe safe work practices pertaining to brakes applications
		describe the procedures used to set up ironworkers equipment
		describe the procedures used to align work pieces
		describe the procedures used to bend workpiece with brakes
		describe the procedures used to cope and notch workpiece
A-2.02.05L	demonstrate knowledge of grinders and their applications	define terminology associated with grinders
A-2.02.06L	demonstrate knowledge of the procedures used to perform grinding operations	describe the ***techniques used to sharpen and dress tools*** using grinders
		identify ***types of grinders*** and describe their characteristics and applications
		identify grinder components, accessories and attachments and describe their applications
		identify the ***factors to consider when selecting grinding wheels*** for specific operations
		describe the procedures used to change, ring test, mount and dress grinding wheels
A-2.02.07L	demonstrate knowledge of power metal saws and their applications	define terminology associated with power metal saws
A-2.02.08L	demonstrate knowledge of the procedures to perform cutting operations using power metal saws	describe the procedures used to perform and troubleshoot cutting operations using power metal saws
		identify ***types of power metal saws*** and describe their applications
		identify power metal saw components, accessories and attachments and describe their applications
		identify cutting fluids and coolants used during cutting operations

		identify the factors to consider when selecting power metal saw blades for specific operations
		describe procedures used to change power metal saw blades and tension
		describe procedures used to select power metal saw feed and speed
A-2.02.09L	demonstrate knowledge of drilling machines, their accessories and their applications	define terminology associated with drilling machines and drilling operations
A-2.02.10L	demonstrate knowledge of the procedures used to perform drilling operations, and the associated calculations	identify ***types of drilling machines***, their components and accessories and describe their characteristics and applications
		identify types of drill bits and describe their characteristics and applications
		identify cutting fluids and coolants used during drilling operations and describe their characteristics and applications
		describe the procedures used to set up, operate and troubleshoot drilling machines
		determine and calculate speeds and feeds for drilling operations
A-2.02.11L	demonstrate knowledge of lathes, their accessories, attachments and applications	define terminology associated with lathes
A-2.02.12L	demonstrate knowledge of the procedures used to perform lathe operations, and the associated calculations	describe the procedures used to perform basic lathe operations
		describe the procedures used to align work pieces
		describe the procedures used to prevent and correct problems that occur when performing lathe operations
		identify types of lathes and describe their applications and operation
		identify lathe components, ***accessories and attachments***, and describe their characteristics and applications
		identify types of tool holding and work holding devices, and describe their characteristics and applications
		identify types of lathe tools and describe their characteristics and applications
		describe the procedures used to sharpen lathe cutting tools

		calculate and determine speeds, feeds and depth of cut for lathe operations
		describe the procedures used to set up lathes
		identify cutting fluids and coolants used during lathe operations
A-2.02.13L	demonstrate knowledge of milling machines and their applications	define terminology associated with milling machines
A-2.02.14L	demonstrate knowledge of the procedures used to perform milling operations, and the associated calculations	describe the procedures used to align work pieces
		identify cutting fluids and coolants used during milling operations
		describe the procedures used to perform basic milling operations
		describe the procedures used to prevent and correct problems that occur when performing milling machine operations
		identify types of milling machines and describe their applications
		identify milling machine components, accessories and attachments, and describe their characteristics, applications and maintenance
		identify types of tool holding and work holding devices and describe their characteristics, applications and procedures for use
		identify types of cutting tools and describe their characteristics and applications
		calculate and determine speeds, feeds and depth of cut for milling operations

RANGE OF VARIABLES

shop machines include: drill presses, pedestal grinders, surface and cylindrical grinders, abrasive cutoff saw (chop saw), band saws, lathes, milling machines, ironworkers (slip-roll and brakes), sandblasters, shears

techniques used to sharpen or dress tools include: sharpening chisels, sharpening drills, conditioning grinding wheels

types of grinders include: pedestal, bench, hand, surface, die

factors to consider when selecting grinding wheels include: abrasive type, wet or dry grinding, work piece material, speed and feed requirements

types of power metal saws include: horizontal and vertical band saws, abrasive cut-off saws, reciprocating saws, portable, power hack saws

types of drilling machines include: drill press, radial arm drill press, turret drill, gang drill

accessories and ***attachments*** include: tool holders, knurling tools, live centers, drill chucks, taper attachments, steady rests, follower rests, tool post grinders, three and four jaw chucks

A-2.03 Uses access equipment

Essential Skills	Continuous Learning, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.03.01P	select ***access equipment***	***access equipment*** is selected according to job requirements and taking into consideration ***unstable conditions***
A-2.03.02P	set up and use ***access equipment***	***access equipment*** is set up and used according to site and manufacturers' specifications, and ***jurisdictional regulations***
A-2.03.03P	identify and remove from service unsafe, worn, damaged or defective ***access equipment***	unsafe, worn, damaged or defective ***access equipment*** is identified, and removed from service
A-2.03.04P	clean and lubricate ***access equipment***	***access equipment*** is cleaned and lubricated according to manufacturers' specifications
A-2.03.05P	store ***access equipment***	***access equipment*** is stored according to site and manufacturers' specifications, and ***jurisdictional regulations***

RANGE OF VARIABLES

access equipment includes: powered mobile equipment (PME), ladders, scaffolds

unstable conditions include: soft ground, uneven terrain, slippery (winter conditions, grease), wind

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.03.01L	demonstrate knowledge of ***access equipment*** and fall protection equipment, their applications, limitations and procedures for use	define terminology associated with ***access equipment*** and fall protection equipment
		interpret ***jurisdictional regulations*** pertaining to ***access equipment*** and fall protection equipment
		identify types of ***access equipment*** and describe their characteristics and applications

		identify types of fall protection equipment and describe their applications and procedures for use
		describe the procedures used to erect and dismantle ladders and scaffolding
		describe the procedures used to inspect and maintain ***access equipment*** and fall protection equipment
A-2.03.02L	demonstrate knowledge of safety practices related to ***access equipment*** and fall protection equipment	identify hazards and describe safe work practices pertaining to ***access equipment*** and fall protection equipment

RANGE OF VARIABLES

access equipment includes: powered mobile equipment (PME), ladders, scaffolds

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

TASK A-3 Performs routine trade tasks

TASK DESCRIPTOR

Industrial mechanics (millwrights) perform routine trade tasks to optimize the efficiency and life expectancy of equipment.

A-3.01 Plans work

Essential Skills	Document Use, Working with Others, Reading

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-3.01.01P	determine scope of job	scope of job is determined according to work order
A-3.01.02P	develop safety plan	safety plan is developed according to site, ***jurisdictional regulations*** and manufacturers' specifications
A-3.01.03P	gather ***documents***	***documents*** are gathered according to job requirements
A-3.01.04P	determine tools and equipment	tools and equipment needed are determined according to job requirements

A-3.01.05P	identify required ***materials***	required ***materials*** are identified according to job requirements
A-3.01.06P	coordinate work and consult with other tradespersons and personnel	work with other tradespersons and personnel is coordinated and they are consulted
A-3.01.07P	estimate time to complete job	time to complete job is estimated and job is completed within estimated time

RANGE OF VARIABLES

jurisdictional regulations include: ISO procedures, federal (Workplace Hazardous Materials Information System (WHMIS), Canadian Nuclear Safety Commission), provincial/territorial (worker's rights and responsibilities), municipal

documents include: work orders (written), Safety Data Sheets (SDS), safety documents, manuals, standard operating procedure (SOP), drawings

materials include: consumables, parts, rigging, hoisting/lifting equipment

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.01.01L	demonstrate knowledge of job planning	define terminology associated with job planning
		identify ***sources of information*** relevant to job planning
		identify the ***factors*** to consider for determining job requirements
		explain the concept of job sequencing and describe its application and purpose in the job planning process
A-3.01.02L	demonstrate knowledge of the procedures used to plan and organize jobs	describe the ***procedures used to plan job tasks***
		describe the procedures used to organize and store tools, equipment and materials on-site

RANGE OF VARIABLES

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

factors include: personnel, tools and equipment, materials, permits, environmental, time

procedures used to plan job tasks include: scheduling, estimating

A-3.02 Fabricates work piece

Essential Skills Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.02.01P	select and use tools	tools are selected and used according to job requirements and manufacturers' specifications
A-3.02.02P	identify ***fabrication requirements*** and ***materials***	***fabrication requirements*** and ***materials*** are identified according to job requirements, engineered drawings and manufacturers' specifications
A-3.02.03P	identify fit and assembly requirements	fit and assembly requirements are identified according to job requirements, engineered drawings and manufacturers' specifications
A-3.02.04P	lay out work piece	work piece is laid out according to job requirements, engineered drawings and manufacturers' specifications
A-3.02.05P	***performs fabrication*** of work piece	work piece is fabricated according to job requirements, engineered drawings and manufacturers' specifications
A-3.02.06P	inspect fabricated work piece	fabricated work piece is inspected in accordance with job requirements, engineered drawings and manufacturers' specifications

RANGE OF VARIABLES

fabrication requirements include: size, strength, materials, weight
materials include: ferrous and non-ferrous materials
performs fabrication includes: cutting, drilling, sanding, machining, grinding

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.02.01L	demonstrate knowledge of ***shop machines***, their applications and ***procedures for use***	identify types of ***shop machines*** and describe their applications and ***procedures for use***
A-3.02.02L	demonstrate knowledge of safety practices related to the use of ***shop machines***	identify hazards and describe safe work practices pertaining to grinding operations, materials used and coolants

		identify hazards and describe safe work practices pertaining to power metal saws, materials used and coolants
		identify hazards and describe safe work practices pertaining to drilling operations, materials used and coolants
		identify hazards and describe safe work practices pertaining to lathe operations, materials used and coolants
		identify hazards and describe safe work practices pertaining to milling operations, materials used and coolants
A-3.02.03L	demonstrate knowledge of grinders and their applications	define terminology associated with grinders
A-3.02.04L	demonstrate knowledge of the procedures used to perform grinding operations	describe the ***techniques used to sharpen and dress tools*** using grinders
		identify ***types of grinders*** and describe their characteristics and applications
		identify grinder components, accessories and attachments and describe their applications
		identify the ***factors to consider when selecting grinding wheels*** for specific operations
		describe the procedures used to change, ring test, mount and dress grinding wheels
A-3.02.05L	demonstrate knowledge of power metal saws and their applications	define terminology associated with power metal saws
A-3.02.06L	demonstrate knowledge of the procedures to perform cutting operations using power metal saws	describe the procedures used to perform and troubleshoot cutting operations using power metal saws
		identify ***types of power metal saws*** and describe their applications
		identify power metal saw components, accessories and attachments and describe their applications
		identify cutting fluids and coolants used during cutting operations
		identify the factors to consider when selecting power metal saw blades for specific operations
		describe procedures used to change power metal saw blades and tension
		describe procedures used to select power metal saw feed and speed

A-3.02.07L	demonstrate knowledge of drilling machines, their accessories and their applications	define terminology associated with drilling machines and drilling operations
A-3.02.08L	demonstrate knowledge of the procedures used to perform drilling operations, and the associated calculations	identify ***types of drilling machines***, their components and accessories and describe their characteristics and applications
		identify types of drill bits and describe their characteristics and applications
		identify cutting fluids and coolants used during drilling operations and describe their characteristics and applications
		describe the procedures used to set up, operate and troubleshoot drilling machines
		determine and calculate speeds and feeds for drilling operations
A-3.02.09L	demonstrate knowledge of lathes, their accessories, attachments and applications	define terminology associated with lathes
A-3.02.10L	demonstrate knowledge of the procedures used to perform lathe operations, and the associated calculations	describe the procedures used to perform basic lathe operations
		describe the procedures used to align work pieces
		describe the procedures used to prevent and correct problems that occur when performing lathe operations
		identify types of lathes and describe their applications and operation
		identify lathe components, ***accessories and attachments***, and describe their characteristics and applications
		identify types of tool holding and work holding devices, and describe their characteristics and applications
		identify types of lathe tools and describe their characteristics and applications
		describe the procedures used to sharpen lathe cutting tools
		calculate and determine speeds, feeds and depth of cut for lathe operations
		describe the procedures used to set up lathes
		identify cutting fluids and coolants used during lathe operations
A-3.02.11L	demonstrate knowledge of milling machines and their applications	define terminology associated with milling machines

A-3.02.12L	demonstrate knowledge of the procedures used to perform milling operations, and the associated calculations	describe the procedures used to align work pieces
		identify cutting fluids and coolants used during milling operations
		describe the procedures used to perform basic milling operations
		describe the procedures used to prevent and correct problems that occur when performing milling machine operations
		identify types of milling machines and describe their applications
		identify milling machine components, accessories and attachments, and describe their characteristics, applications and maintenance
		identify types of tool holding and work holding devices and describe their characteristics, applications and procedures for use
		identify types of cutting tools and describe their characteristics and applications
		calculate and determine speeds, feeds and depth of cut for milling operations

RANGE OF VARIABLES

shop machines include: drill presses, pedestal grinders, surface and cylindrical grinders, abrasive cutoff saw (chop saw), band saws, lathes, milling machines, ironworkers, sandblasters, shears

procedures for use include: drilling, boring, reaming, counterboring, countersinking, tapping, spot facing, turning, grooving, facing, knurling, parting off, threading

techniques used to sharpen or dress tools include: sharpening chisels, sharpening drills, conditioning grinding wheels

types of grinders include: pedestal, bench, hand, surface, die

factors to consider when selecting grinding wheels include: abrasive type, wet or dry grinding, work piece material, speed and feed requirements

types of power metal saws include: horizontal and vertical band saws, abrasive cut-off saws, reciprocating saws, portable, power hack saws

types of drilling machines include: drill press, radial arm drill press, turret drill, gang drill

accessories and attachments include: tool holders, knurling tools, live centers, drill chucks, taper attachments, steady rests, follower rests, tool post grinders, three and four jaw chucks

A-3.03 Lubricates systems and components

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications
A-3.03.02P	determine ***lubricants*** requirements	***lubricants*** requirements are determined according to site, manufacturers' specifications, technical manuals and jurisdictional regulations
A-3.03.03P	select ***lubricants***	***lubricants*** are selected according to compatibility with the operational process (chemical plant)
A-3.03.04P	identify points requiring ***lubricants***	points requiring ***lubricants*** are identified according to manufacturers' specifications and engineered drawings
A-3.03.05P	maintain ***lubricant*** levels	levels of ***lubricants*** are maintained according to site and manufacturers' specifications, and engineered drawings
A-3.03.06P	remove and replace ***lubricants***	***lubricants*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
A-3.03.07P	treat, clean and maintain ***systems*** and components	***systems*** and components are treated, cleaned and maintained according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: hand tools, PPE, grease guns, oil cans, portable filtration units
lubricants include: oil, grease, dry solid, water
systems include: once through, oil bath, oil mist, manual, enclosed circulating, pressurized, automated

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.03.01L	demonstrate knowledge of ***lubricants***, lubrication systems and their components, applications and procedures for use	define terminology associated with ***lubricants*** and lubrication systems
		interpret jurisdictional regulations and specifications pertaining to ***lubricants*** and lubrication systems
		identify ***types of lubrication systems*** and describe their characteristics and applications
		identify maintenance and troubleshooting procedures for lubrication systems
A-3.03.02L	demonstrate knowledge of the procedures used to handle, store, recycle and dispose of ***lubricants***	identify tools and equipment used with ***lubricants*** and lubrication systems, and describe their applications and procedures
		explain the principles and types of friction and their effects on surfaces in contact
		identify types of ***lubricants*** and describe their applications
		identify the ***properties and characteristics of lubricants***
		identify the factors to consider when selecting ***lubricants***
		explain the effects of using incorrect lubricant
		identify ***sources of information*** relating to system lubricant and lubrication requirements
		describe the effect of lubricant levels on machine operation
		identify procedures to recycle or dispose of lubricants
A-3.03.03L	demonstrate knowledge of safety practices related to ***lubricants*** and lubricant systems	identify ***hazards*** and describe ***safe work practices*** pertaining to ***lubricants*** and lubrication systems

RANGE OF VARIABLES

lubricants include: oil, grease, dry solid, water

types of lubrication systems include: once through, oil bath, oil mist, manual, enclosed circulating, pressurized, automated

properties and characteristics of lubricants include: adhesion/cohesion, viscosity, additives and inhibitors, penetration, drop point, flash point, classifications and grades

sources of information include: technical manuals, manufacturers' specifications

hazards include: environmental, personal health, fire, contamination, slipping, housekeeping issues

safe work practices include: using PPE, disposing according to jurisdictional requirements, spill response procedures, storing materials

A-3.04 Performs leveling of components and systems

Essential Skills Thinking, Numeracy, Digital Technology

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-3.04.01P	select and use ***leveling tools***	leveling tools are selected and used according to job requirements, engineered drawings, site evaluation and ***conditions***
A-3.04.02P	level machinery and components	machinery and components are levelled according to site and manufacturers' specifications and engineered drawings
A-3.04.03P	record leveling data	leveling data is recorded to demonstrate compliance to site and manufacturers' specifications, and engineered drawings

RANGE OF VARIABLES

leveling tools include: theodolites, levels (optical, laser, spirit), piano wire, plumb bob

conditions include: weather, vibration, ground conditions

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.04.01L	demonstrate knowledge of the ***procedures used to level and align equipment***	define terminology associated with equipment leveling and alignment
		interpret jurisdictional regulations and specifications pertaining to equipment leveling and alignment
		identify ***tools and equipment*** used for equipment leveling and alignment, and describe their application and procedures
		identify types of ***bases*** and describe their applications
		describe the ***procedures used to level and align equipment***
A-3.04.02L	demonstrate knowledge of safety practices related to equipment leveling and alignment	identify hazards and describe safe work practices pertaining to equipment leveling and alignment

RANGE OF VARIABLES

procedures used to level and align equipment include: planning, interpreting drawings, fabricating component supports, installing base, shimming, positioning equipment, relieving stresses/strains, anchoring and grouting, completing documentation

tools and equipment include: theodolites, levels (optical, laser, water, spirit), piano wire, plumb bob

conditions include: weather, vibration, ground conditions

bases include: base plate, sole plate, fabricated, skid mounted, foundations

A-3.05 Uses fastening and retaining devices

Essential Skills Numeracy, Document Use, Thinking

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-3.05.01P	select and use ***tools and equipment*** to install or remove fastening and retaining devices	***tools and equipment*** are selected and used to install or remove fastening and retaining devices
A-3.05.02P	select fastening and retaining devices	fastening and retaining devices are selected according to job requirements, engineered drawings and manufacturers' specifications

A-3.05.03P	select and apply chemical fasteners	chemical fasteners are selected and applied for securing according to job requirements, engineered drawings, manufacturers' specifications and jurisdictional regulations
A-3.05.04P	achieve predetermined torque or tensioning	predetermined torque or tensioning is achieved using ***techniques*** according to engineered drawings, manufacturers' specifications and jurisdictional regulations
A-3.05.05P	select and verify thread pitch (imperial or metric) on fastener	thread pitch (imperial or metric) is selected and verified on fastener using measuring tools and gauges according to engineered drawings and manufacturers' specifications
A-3.05.06P	select ***fluids and compounds*** associated with threaded fasteners	***fluids and compounds*** associated with threaded fasteners are selected according to job requirements, engineered drawings, manufacturers' specifications and jurisdictional regulations
A-3.05.07P	clean, chase, drill and tap threads	threads are cleaned, chased, drilled and tapped to ensure secure fastening
A-3.05.08P	restore threads	threads are restored using ***thread restoration methods***

RANGE OF VARIABLES

tools and equipment include: torque wrenches, impact wrenches, hydraulic tensioning devices, hand tools (snap-ring pliers, riveting tools)

torquing and tensioning techniques include: stretching fasteners using heat, hydraulics, pneumatics, mechanical

fluids and compounds include: lubrication, thread lockers, gap filling compounds, sealants

thread restoration methods include: chasing, plugging, using thread inserts, thread filing

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.05.01L	demonstrate knowledge of ***fastening*** and ***retaining devices***, and their applications	define terminology associated with ***fastening*** and ***retaining devices***
		identify ***tools and equipment*** pertaining to the use of ***fastening*** and ***retaining devices***, and describe their applications and procedures
		identify types of ***fastening devices*** and materials, and describe their characteristics and applications
		identify strength of fasteners by grade and applications

		identify types of ***retaining devices*** and describe their characteristics and applications
A-3.05.02L	demonstrate knowledge of the procedures used to install and remove ***fastening*** and ***retaining devices***	identify thread types and classifications and describe the procedures used for thread identification
		explain the purpose of torquing and tensioning ***fastening devices*** and describe associated procedures
		describe the procedures used to install, remove and repair ***fastening devices***
		describe the procedures used to install and remove ***retaining devices***
		describe the ***procedures used to make internal and external threads*** to specifications
A-3.05.03L	demonstrate knowledge of safety practices related to ***fastening*** and ***retaining devices***	identify hazards and describe safe work practices pertaining to the use of ***fastening*** and ***retaining devices***

RANGE OF VARIABLES

fastening devices include: mechanical, chemical

retaining devices include: snap-rings, pins, keys, set screws, locking tabs

tools and equipment include: torque wrenches, impact wrenches, hydraulic tensioning devices, hand tools (snap-ring pliers, riveting tools)

procedures used to make internal and external threads include: external threading (dies), internal threading (taps), using threading machines

A-3.06 Performs material identification

Essential Skills Document Use, Reading, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.06.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to visual inspection
A-3.06.02P	perform file, chisel and punch test	file, chisel and punch tests are performed to distinguish ***types of materials*** and their ***properties***

A-3.06.03P	perform spark test	spark test is performed to identify the metal by examining the colour, shape, volume and length of the sparks
A-3.06.04P	perform magnet test	magnet test is performed to identify ferrous and non-ferrous metals and materials
A-3.06.05P	perform ***hardness test***	***hardness tests*** are performed using specialized tools

RANGE OF VARIABLES

tools and equipment include: hammers, chisels, grinders, magnets
types of materials include: ferrous and non-ferrous metals, composites, plastics, rubber
material properties include: hardness, colour, malleability, embeddability, ductility, conductivity
hardness test includes: Rockwell, Brinnell, Vickers, Durometer

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.06.01L	demonstrate knowledge of metals and their characteristics	define terminology associated with metallurgy
A-3.06.02L	demonstrate knowledge of non-metallic materials and their characteristics	define terminology associated with non-metallic materials
A-3.06.03L	demonstrate knowledge of metallurgic principles	describe the properties of metals
		describe the identification systems for metals
		identify the methods and processes used in the manufacture of steel and alloys
		describe the ***problems*** that may occur when working metals
		describe the procedures used to prevent and correct ***problems*** that occur when working metals
A-3.06.04L	demonstrate knowledge of material testing procedures	identify common ***material testing techniques*** and describe their associated procedures
		describe safe work practices pertaining to identification and handling of materials
A-3.06.05L	demonstrate knowledge of structural shapes and their applications	identify structural shapes and describe their characteristics and applications

RANGE OF VARIABLES

problems include: stress, contraction, expansion, distortion, work hardening, galvanic action, fire, tensile strength
material testing techniques include: Rockwell, Brinnell, Vickers, spark, chisel, file, magnet, conductivity, visual inspection

A-3.07 Performs heat treatment of metal

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.07.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to the heat treatment process
A-3.07.02P	clean metal	metal is cleaned to remove contaminants for heat treatment
A-3.07.03P	heat metal	metal is heated to reach predetermined temperature according to engineered documentation and manufacturers' specifications
A-3.07.04P	quench metal	metal is quenched to achieve required ***metal properties*** according to engineered documentation and manufacturers' specifications
A-3.07.05P	temper metal	metal is tempered to achieve required metal properties according to engineered documentation and manufacturers' specifications

RANGE OF VARIABLES

tools and equipment include: ovens, forges, oxy-fuel torches, temperature sticks, thermal imaging devices, heat treatment colour charts, magnets, infrared guns, oil bath, hand tools

metal properties include: hardness, malleability, toughness, ductility, elasticity

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.07.01L	demonstrate knowledge of metals and their characteristics	define terminology associated with metallurgy
A-3.07.02L	demonstrate knowledge of metallurgic principles	describe the properties of metals
		describe the identification systems for metals
		identify the methods and processes used in the manufacture of steel and alloys
		describe the ***problems*** that can occur when working metals

		describe the procedures used to prevent and correct problems that occur when working metals
A-3.07.03L	demonstrate knowledge of structural shapes and their applications	identify structural shapes and describe their characteristics and applications
A-3.07.04L	demonstrate knowledge of ***processes used in the heat treatment of metals***	define terminology associated with heat treatment of metal
		interpret jurisdictional regulations pertaining to heat treatment of metal
		identify types of heat treating equipment and accessories and describe their applications
		describe the procedures used in the heating of metal
A-3.07.05L	demonstrate knowledge of safety practices related to heat treatment of metal	identify ***hazards*** and describe safe work practices pertaining to heat treatment of metal

RANGE OF VARIABLES

problems include: stress, contraction, expansion, distortion, work hardening, galvanic action

processes used in the heat treatment of metals include: stress relieving, hardening, annealing, tempering, normalizing, quenching

hazards include: personal, shop/facility, equipment, ventilation, storage

A-3.08 Uses mechanical drawings and schematics

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.08.01P	determine and recognize locations of equipment, components and parts	locations of equipment, components and parts are determined and recognized from ***drawings***
A-3.08.02P	interpret and cross-reference specifications, technical manuals and ***drawings***	specifications, technical manuals and ***drawings*** are interpreted and cross-referenced to visualize the outcome
A-3.08.03P	perform trade-related calculations	trade-related calculations are performed to achieve job requirements
A-3.08.04P	produce field drawings and sketches	field drawings and sketches are produced in order to communicate job requirements

A-3.08.05P	identify ***symbols***	***symbols*** are identified according to standards
A-3.08.06P	request updates to ***drawings***	***drawings*** are updated to reflect the as-built drawings

RANGE OF VARIABLES

drawings include: civil/site, engineered, architectural, mechanical, structural, electrical, shop drawings, field drawings, sketches, as-builts, working, P&ID (piping and instrumentation diagram), installation, ITP (inspection and test plan), drawing assembly

symbols include: hydraulic, welding, pneumatic, electrical, piping

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.08.01L	demonstrate knowledge of ***drawings***, their use and interpretation	define terminology associated with ***drawings***
		identify the ***views*** found on drawings and describe their characteristics
		interpret drawings and instructions on drawings
		interpret material specifications found on drawings
		identify the ***purposes for drawings***
A-3.08.02L	demonstrate knowledge of calculations relevant to drawings	describe the procedures used to perform calculations relevant to drawings
		identify the metric and imperial systems of measurement and describe the procedures used to perform conversions between the systems
		identify ***drawing projections*** and describe their applications
		interpret and extract ***information*** from drawings
		explain the use of scales
		identify the styles of dimensioning on drawings and describe their applications
A-3.08.03L	demonstrate knowledge of basic sketching techniques	demonstrate basic sketching techniques
		demonstrate awareness of computer aided drawing (CAD) systems
		create sketch using a blueprint/drawing as a starting point

RANGE OF VARIABLES

drawings include: civil/site, engineered, architectural, mechanical, structural, electrical, shop drawings, field drawings, sketches, as-builts, working, P&ID (piping and instrumentation diagram), installation, ITP (inspection and test plan), drawing assembly

views include: elevation, plan, section, detail

purposes for drawings include: determine location of components, determine the positioning of components, determine elevation of components

drawing projections include: orthographic, oblique, isometric, section, auxiliary

information includes: dimensions, lines, legend, symbols and abbreviations, title block, notes and specifications, tolerances/allowances, bill of materials

TASK A-4 Uses communication and mentoring techniques

TASK DESCRIPTOR

Learning in the trades is done primarily in the workplace with tradespeople 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

Essential Skills Reading, Writing, Oral Communication

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-4.01.01P	demonstrates ***communication practices*** individually or in a group	instructions and messages are understood by all parties involved in communication
A-4.01.02P	listens using ***active listening*** practices	steps of ***active listening*** are used
A-4.01.03P	receives and responds to feedback on work	response to feedback indicates understanding and corrective measures are taken
A-4.01.04P	explains and provides feedback	explanation and feedback is provided and task is carried out as directed
A-4.01.05P	uses questioning to improve communication	understanding, on-the-job training and goal setting are enhanced by questioning

A-4.01.06P	participates in safety and information meetings	meetings are attended and information is understood and applied
A-4.01.07P	confirms understanding of information	information is confirmed by ***active listening*** and by ***sources of information***

RANGE OF VARIABLES

communication practices include: verbal communication techniques, written communication techniques, electronic communication techniques, hand signal techniques

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

sources of information include: jurisdictional regulations, codes, prints, drawings, specifications, company and client documentation, job procedures, work orders, installation instructions

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 the 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***
		identify ***personal responsibilities and attitudes*** that contribute to on-the-job success
		identify communication that constitutes ***harassment*** and ***discrimination***

RANGE OF VARIABLES

communication practices include: verbal communication techniques, written communication techniques, electronic communication techniques, hand signal techniques

people in the workplace include: other tradespeople, colleagues, apprentices, supervisors, clients, manufacturers, suppliers

sources of information include: jurisdictional regulations, codes, prints, drawings, specifications, company and client documentation, job procedures, work orders, installation instructions

learning styles include: visual, verbal, tactile, individual, group

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 practices, respectful workplace

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, marital status, family status, disability or conviction for which a pardon has been granted

A-4.02 Uses mentoring techniques

Essential Skills	Oral Communication, Working with Others, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.02.01P	demonstrates performance of a skill to a learner	***steps required to demonstrate a skill*** are performed
A-4.02.02P	set up conditions required for a learner to develop proficiency in a skill	***conditions*** are set up so that the skill can be developed safely by the learner
A-4.02.03P	assess and give feedback	best practices are adopted by the learner after receiving feedback
A-4.02.04P	support apprentices in pursuing technical training opportunities	technical training is completed within timeframe prescribed by apprenticeship authority

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

conditions include: guided, limited independence, full independence

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.02.01L	identify, explain and demonstrate strategies for learning skills in the workplace	describe the importance of individual experience
		determine one's own ***learning styles*** and explain how these relate to learning new skills
		describe the importance of different types of skills in the workplace
A-4.02.02L	demonstrate knowledge of ***strategies for mentoring workplace skills***	identify different roles played by a workplace mentor
		describe the ***steps involved in mentoring skills***
		explain the importance of identifying the point of a task
		identify how to choose an appropriate time to explain a task
		identify the components of the skill (the context)

	describe considerations in setting up opportunities for skill practice
	explain the importance of providing feedback
	identify techniques for giving effective feedback
	describe a skills assessment
	identify methods of assessing progress
	explain how to adjust a learning opportunity to different situations

RANGE OF VARIABLES

learning styles include: visual, verbal, tactile, individual, group

strategies for mentoring workplace skills include: understanding the basic principles of instruction, developing coaching skills, being mature and patient, providing feedback

steps for mentoring skills include: identifying the point of the lesson, linking the lesson, demonstrating the skill, providing practice, giving feedback, assessing skills and progress

TASK A-5 Performs measuring and layout

TASK DESCRIPTOR

Industrial mechanics (millwrights) ensure installation of equipment by utilizing precision measuring tools and measuring practices to lay out and assemble components and systems.

A-5.01 Prepares work area, tools and materials

Essential Skills Numeracy, Writing, Document Use

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-5.01.01P	acclimatize optical precision, measuring, layout and leveling tools	optical precision, measuring, layout and leveling tools are acclimatized according to environmental conditions
A-5.01.02P	verify optical precision, measuring, layout and leveling tools	optical precision, measuring, layout and leveling tools are verified for accuracy by calibration

A-5.01.03P	prepare material to be measured	material to be measured is prepared by cleaning or filing
A-5.01.04P	clean and prepare ***work area***	***work area*** is cleaned and prepared by removing obstructions

RANGE OF VARIABLES

work area includes: table, floor, wall, component (both inside and outside)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-5.01.01L	demonstrate knowledge of measuring and layout	define terminology associated with measuring and layout
		identify types of ***precision measuring tools*** and describe their applications and procedures for use
		identify types of ***layout tools*** and describe their applications and procedures for use
A-5.01.02L	demonstrate knowledge of the procedures used to maintain, calibrate and store ***precision measuring*** and ***layout tools***	describe the procedures used to inspect, maintain, calibrate and ***store precision measuring*** and ***layout tools***
A-5.01.03L	demonstrate knowledge of preparing a work area	identify types of tools that are required to prepare the work area and describe their applications and procedures for use
	demonstrate knowledge of safe work practices related to preparing work area, tools and materials	describe safe work practices related to precision measuring and layout tools
		describe safe work practices related to preparing work area, tools and materials

RANGE OF VARIABLES

precision measuring tools include: micrometers, calipers, dial indicators, protractors, vernier height gauges, feeler gauges, plug, ring and snap gauges, gauge blocks, theodolites, transits, total station

layout tools include: straightedges, squares, combination sets, surface plates, scribers, hermaphrodite calipers, dividers, trammels, prick and centre punches, angle plates, parallels, v-blocks, surface gauges, layout dye

A-5.02 Measures material and components

Essential Skills	Numeracy, Writing, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.02.01P	select and use ***measuring tools and equipment***	***measuring tools and equipment*** are selected and used according to precision required
A-5.02.02P	read and interpret measurements	measurements are read and interpreted according engineered drawings and manufacturers' specifications
A-5.02.03P	transfer measurements to ***components***, work area and material	measurements are transferred to ***components***, work area and material, according to engineered drawings and manufacturers' specifications
A-5.02.04P	take ***inside and outside measurements***	***inside and outside measurements*** are taken according to engineered drawings and manufacturers' specifications

RANGE OF VARIABLES

measuring tools and equipment include: tape measures, calipers, micrometers, jig transit, GPS
inside and outside measurements include: diameters, bores, lengths, thicknesses
components include: sole plates, bases

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.02.01L	demonstrate knowledge of measuring and layout and their applications	define terminology associated with measuring and layout
		identify types of ***precision measuring tools*** and describe their applications and procedures
		identify types of ***layout tools*** and describe their applications and procedures
A-5.02.02L	demonstrate knowledge of the procedures used to perform measuring operations	describe the procedures used to transfer and document measurements

		interpret information from ***precision measuring tools***
	demonstrate knowledge of safe work practices related to measuring material and components	describe safe work practices related to ***precision measuring*** and ***layout tools***

RANGE OF VARIABLES

precision measuring tools include: micrometers, calipers, dial indicators, protractors, vernier height gauges, feeler gauges, plug, ring and snap gauges, gauge blocks, theodolites, transits, total station

layout tools include: straightedges, squares, combination sets, surface plates, scribers, hermaphrodite calipers, dividers, trammels, prick and centre punches, angle plates, parallels, v-blocks, surface gauges, layout dye

A-5.03 Lays out components

Essential Skills Numeracy, Digital Technology, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.03.01P	select and use ***layout tools*** and equipment	***layout tools*** and equipment are selected and used according to job requirements, manufacturers' specifications, and engineered drawings
A-5.03.02P	transfer measurements from benchmark and datum points to work area	measurements are transferred from benchmark and datum points to work area according to manufacturers' specifications and engineered drawings
A-5.03.03P	transfer measurements from drawings to work material	measurements are transferred from drawings to work material according to manufacturers' specifications and engineered drawings

RANGE OF VARIABLES

layout tools include: straightedges, squares, combination sets, surface plates, scribers, hermaphrodite calipers, dividers, trammels, prick and centre punches, angle plates, parallels, v-blocks, surface gauges, layout dye

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-5.03.01L	demonstrate knowledge of the layout of components and their applications	define terminology associated with the layout of components
		identify types of ***layout tools*** and describe their applications and procedures
A-5.03.02L	demonstrate knowledge of the procedures used to perform layout operations	describe the procedures used to lay out equipment and components
		describe precision measurement procedures
	demonstrate knowledge of safe work practices related to laying out components	describe safe work practices related to laying out components

RANGE OF VARIABLES

layout tools include: straightedges, squares, combination sets, surface plates, scribers, hermaphrodite calipers, dividers, trammels, prick and centre punches, angle plates, parallels, v-blocks, surface gauges, layout dye

A-5.04 Maintains precision measuring and layout tools

Essential Skills Document Use, Digital Technology, Numeracy

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-5.04.01P	clean and lubricate ***precision measuring*** and ***layout tools***	***precision measuring*** and ***layout tools*** are cleaned and lubricated according to manufacturers' specifications
A-5.04.02P	verify and set calibration of ***precision measuring tools***	***precision measuring tools*** are verified for accuracy and calibrated if required
A-5.04.03P	recognize worn, damaged or defective ***precision measuring*** and ***layout tools***	worn, damaged or defective ***precision measuring*** and ***layout tools*** are recognized and removed from service for recalibration, repair or disposal
A-5.04.04P	store ***precision measuring*** and ***layout tools***	***precision measuring*** and ***layout tools*** are stored according to manufacturers' specifications

RANGE OF VARIABLES

precision measuring tools include: micrometers, calipers, dial indicators, protractors, vernier height gauges, feeler gauges, plug, ring and snap gauges, gauge blocks, theodolites, transits, total station

layout tools include: straightedges, squares, combination sets, surface plates, scribers, hermaphrodite calipers, dividers, trammels, prick and centre punches, angle plates, parallels, v-blocks, surface gauges, layout dye

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-5.04.01L	demonstrate knowledge of ***precision measuring*** and ***layout tools***, their applications and procedures	identify types of ***precision measuring tools*** and describe their applications and procedures
		identify types of ***layout tools*** and describe their applications and procedures
		describe the procedures used to clean, inspect, maintain, calibrate and store ***precision measuring*** and ***layout tools***
A-5.04.02L	demonstrate knowledge of safety practices related to the maintenance of ***precision measuring*** and ***layout tools***	identify hazards pertaining to the maintenance of ***precision measuring*** and ***layout tools***
		describe safe work practices pertaining to the maintenance of ***precision measuring*** and ***layout tools***

RANGE OF VARIABLES

precision measuring tools include: micrometers, calipers, dial indicators, protractors, vernier height gauges, feeler gauges, plug, ring and snap gauges, gauge blocks, theodolites, transits, total station

layout tools include: straightedges, squares, combination sets, surface plates, scribers, hermaphrodite calipers, dividers, trammels, prick and centre punches, angle plates, parallels, v-blocks, surface gauges, layout dye

TASK A-6 Performs cutting and welding operations

TASK DESCRIPTOR

Industrial mechanics (millwrights) use welding and cutting equipment to heat, repair and fabricate components.

A-6.01 Cuts material using oxy-fuel and plasma arc equipment

Essential Skills Reading, Document Use, Working with Others

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
A-6.01.01P	identify and prepare material to be cut	material to be cut is identified and prepared according to job requirements, manufacturers' specifications, and engineered drawings
A-6.01.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements, manufacturers' specifications and engineered drawings
A-6.01.03P	select gas for cutting	gas for cutting is selected according to job requirements, manufacturers' specifications and engineered drawings
A-6.01.04P	perform oxy-fuel cutting procedures	oxy-fuel cutting procedures are performed according to type of materials to be cut, site conditions and jurisdictional regulations
A-6.01.05P	perform plasma arc cutting procedures	plasma arc cutting procedures are performed according to type of materials to be cut, site conditions and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: oxy-fuel torches, plasma arc

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-6.01.01L	demonstrate knowledge of oxy-fuel equipment and accessories	define terminology associated with oxy-fuel cutting
		identify types of oxy-fuel cutting equipment and accessories and describe their applications
		interpret jurisdictional regulations pertaining to oxy-fuel cutting
A-6.01.02L	demonstrate knowledge of the procedures used to cut with oxy-fuel equipment	describe the procedures used to set up, adjust and shut down oxy-fuel equipment
		describe the procedures used to inspect and maintain oxy-fuel equipment
		describe the procedures used to cut materials using oxy-fuel equipment
		describe the procedures used to prepare materials using oxy-fuel equipment
A-6.01.03L	demonstrate knowledge of safety practices related to oxy-fuel cutting	identify ***hazards*** and describe ***safe work practices*** pertaining to oxy-fuel cutting
A-6.01.04L	demonstrate knowledge of procedures used for plasma arc cutting	define terminology associated with plasma arc cutting
		interpret jurisdictional regulations pertaining to plasma arc cutting
		interpret information pertaining to plasma arc cutting found on drawings and specifications
		describe the plasma arc cutting process and its applications
		describe the procedures used to prepare materials when plasma arc cutting
A-6.01.05L	demonstrate knowledge of plasma arc equipment and accessories	identify plasma arc equipment and accessories and describe their applications
		describe the procedures used to set up, adjust and shut down plasma arc equipment
		describe the procedures used to inspect and maintain plasma arc equipment
A-6.01.06L	demonstrate knowledge of safety practices related to plasma arc cutting	identify ***hazards*** and describe ***safe work practices*** pertaining to plasma arc cutting

RANGE OF VARIABLES

hazards include: personal, shop/facility, equipment, ventilation, storage

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

A-6.02 Joins material using oxy-fuel welding equipment

Essential Skills Reading, Document Use, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-6.02.01P	select and prepare material to be ***oxy-fuel*** welded, brazed or soldered	material to be ***oxy-fuel*** welded, brazed or soldered is selected and prepared according to job requirements and material compatibility
A-6.02.02P	select and use ***tools***	***tools*** are selected and used according to job requirements
A-6.02.03P	match filler rods and flux to materials when ***oxy-fuel*** welding, brazing or soldering	materials to be ***oxy-fuel*** welded, brazed or soldered are matched to filler rods and flux
A-6.02.04P	perform ***oxy-fuel*** welding, brazing or soldering procedures	***oxy-fuel*** welding, brazing or soldering procedures are performed according to materials being welded, brazed or soldered
A-6.02.05P	prepare the work piece	work piece is prepared according to ***procedural requirements***

RANGE OF VARIABLES

oxy-fuel includes: liquid petroleum gas, acetylene, oxygen
tools include: tips, tip cleaners, wrenches, chipping hammer, needle gun, grinder
procedural requirements include: cleaning, pre-heating, post-heating

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-6.02.01L	demonstrate knowledge of ***oxy-fuel*** equipment and accessories	define terminology associated with ***oxy-fuel*** heating and welding
		interpret jurisdictional regulations pertaining to ***oxy-fuel*** heating, welding, brazing and soldering
		identify types of ***oxy-fuel*** heating, welding, brazing and soldering equipment and accessories and describe their applications
A-6.02.02L	demonstrate knowledge of the procedures used to heat, weld, solder and braze with ***oxy-fuel*** equipment	describe the procedures used to ***set up***, adjust and shut down ***oxy-fuel*** equipment

		describe the procedures used to inspect and maintain ***oxy-fuel*** equipment
		describe the procedures used to heat, weld, braze and solder materials using ***oxy-fuel*** equipment
A-6.02.03L	demonstrate knowledge of safety practices related to ***oxy-fuel*** heating, welding, brazing and soldering	identify ***hazards*** and describe ***safe work practices*** pertaining to ***oxy-fuel*** heating, welding, brazing and soldering

RANGE OF VARIABLES

oxy-fuel includes: liquid petroleum gas, acetylene, oxygen

set up includes: adjusting flame characteristics (carburizing, neutral and oxidizing), assembling equipment, adjusting pressures

hazards include: personal, shop/facility, equipment, ventilation, storage

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

A-6.03 Welds material using shielded metal arc welding (SMAW) equipment

Essential Skills Reading, Document Use, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-6.03.01P	select and prepare material to be welded	material to be welded is selected and prepared according to job requirements, material compatibility and engineered drawings
A-6.03.02P	select and use electrodes	electrodes are selected and used according to site and job requirements, material compatibility, manufacturers' specifications and engineered drawings
A-6.03.03P	perform welding procedures	welding procedures are performed according to manufacturers' specifications and engineered drawings for the materials being welded
A-6.03.04P	adjust amperage and polarity	amperage and polarity are adjusted to achieve proper fusion and penetration
A-6.03.05P	inspect welds	welds are inspected to confirm fusion and penetration according to manufacturers' specifications and engineered drawings

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-6.03.01L	demonstrate knowledge of shielded metal arc welding (SMAW) equipment and accessories	define terminology associated with SMAW
		interpret jurisdictional regulations pertaining to SMAW
		interpret information pertaining to SMAW found on drawings and specifications
		identify SMAW equipment, consumables and accessories, and describe their applications
A-6.03.02L	demonstrate knowledge of procedures used to weld using SMAW equipment	describe the SMAW process and its applications
		describe the procedures used to set up and adjust SMAW equipment
		identify the types of welds performed using SMAW equipment
		identify welding positions and describe their applications
		describe the procedures used to weld using SMAW equipment
		describe weld defects, their causes and prevention
A-6.03.03L	demonstrate knowledge of safety practices related to SMAW	identify ***hazards*** and describe ***safe work practices*** pertaining to SMAW

RANGE OF VARIABLES

hazards include: personal, shop/facility, equipment, ventilation sparks, radiation, ultraviolet light, storage
safe work practices include: use of PPE, following confined space procedures, obtaining required permits

A-6.04 Welds material with gas metal arc welding (GMAW) equipment

Essential Skills Reading, Document Use, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-6.04.01P	select and prepare material to be welded	material to be welded is selected and prepared according to job requirements, material compatibility and engineered drawings
A-6.04.02P	select types of gas used for welding	types of gas used for welding are selected according to job requirements, material compatibility, manufacturers' specifications and engineered drawings
A-6.04.03P	select and use wire	wire is selected and used according to job requirements, material compatibility, manufacturers' specifications, and engineered drawings
A-6.04.04P	perform welding procedures	welding procedures are performed according to job requirements, material compatibility and manufacturers' specifications
A-6.04.05P	adjust amperage, shielding gas flow and feed rate to achieve proper fusion and penetration	proper fusion and penetration is achieved by adjusting amperage, shielding gas flow and feed rate
A-6.04.06P	inspect welds	welds are inspected to confirm fusion and penetration according to job requirements, material compatibility, and manufacturers' specifications
A-6.04.07P	prepare the work piece	the work piece is prepared according to ***procedural requirements***

RANGE OF VARIABLES

procedural requirements include: cleaning, pre-heating, post-heating

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-6.04.01L	demonstrate knowledge of gas metal arc welding (GMAW) equipment and accessories	define terminology associated with GMAW
		interpret jurisdictional regulations pertaining to GMAW

		interpret information pertaining to GMAW found on drawings and specifications
		identify GMAW equipment, consumables and accessories, and describe their applications
A-6.04.02L	demonstrate knowledge of the procedures used to weld with GMAW equipment	describe the GMAW process and its applications
		describe the procedures used to set up, adjust and shut down GMAW equipment
		identify welding positions and describe their applications
		describe the procedures used to weld using GMAW equipment
		describe weld defects, their causes and prevention
A-6.04.03L	demonstrate knowledge of safety practices related to GMAW	identify ***hazards*** and describe ***safe work practices*** pertaining to GMAW

RANGE OF VARIABLES

hazards include: personal, shop/facility, equipment, ventilation

safe work practices include: use of PPE, following confined space procedures, obtaining required permits

A-6.05 Welds material with gas tungsten arc welding (GTAW) equipment (NOT COMMON CORE)

Essential Skills Reading, Document Use, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-6.05.01P	select and prepare material to be welded	material to be welded is selected and prepared according to job requirements, material compatibility and manufacturers' specifications
A-6.05.02P	select types of gas used for welding	types of gas used for welding are selected according to job requirements, material compatibility and manufacturers' specifications, and engineered drawings

A-6.05.03P	select and use filler material	filler material is selected and used according to job requirements, material compatibility, manufacturers' specifications, and engineered drawings
A-6.05.04P	perform GTAW procedures	GTAW procedures are performed according to job requirements, material compatibility, manufacturers' specifications, and engineered drawings
A-6.05.05P	adjust amperage, shielding gas flow and feed rate to achieve proper fusion and penetration	proper fusion and penetration is achieved by adjusting amperage, shielding gas flow and feed rate
A-6.05.06P	inspect welds	welds are inspected to confirm fusion and penetration according to job requirements, material compatibility, and manufacturers' specifications

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-6.05.01L	demonstrate knowledge of gas tungsten arc welding (GTAW) equipment and accessories	define terminology associated with the GTAW process
		identify the types of welds performed using GTAW equipment
		interpret jurisdictional regulations pertaining to GTAW
		interpret information pertaining to the GTAW process found on drawings and specifications
		identify GTAW equipment, consumables and accessories, and describe their applications
A-6.05.02L	demonstrate knowledge of the procedures used to weld with GTAW equipment	describe the procedures used to set up, adjust and shut down GTAW equipment
		describe the procedures used to weld using GTAW equipment
		identify welding positions and describe their applications
		describe weld defects, their causes and prevention
A-6.05.03L	demonstrate knowledge of safety practices related to the GTAW process	identify ***hazards*** and describe ***safe work practices*** pertaining to the GTAW process

RANGE OF VARIABLES

hazards include: personal, shop/facility, equipment, ventilation, sparks, radiation, ultraviolet light, storage

safe work practices include: use of PPE, following confined space procedures, obtaining required permits

A-6.06 Maintains welding equipment

Essential Skills Reading, Document Use, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-6.06.01P	perform scheduled ***maintenance on oxy-fuel units***	scheduled ***maintenance on oxy- fuel units*** is performed according to site and manufacturers' specifications, and jurisdictional regulations
A-6.06.02P	perform scheduled ***maintenance on electrically powered units***	scheduled ***maintenance on electrically powered units*** is performed according to site and manufacturers' specifications, and jurisdictional regulations
A-6.06.03P	perform scheduled ***maintenance on mobile welding units***	scheduled ***maintenance on mobile welding units*** is performed according to site and manufacturers' specifications, and jurisdictional regulations
A-6.06.04P	store equipment	equipment is stored according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

maintenance on oxy-fuel units includes: inspecting, replacing and repairing hoses, gauges, regulators, valves, mixing chamber

maintenance on electrically powered units includes: inspecting and replacing cables, clamps, bottles, gauges, hoses

maintenance on mobile welding units includes: inspecting and replacing oil and air filters, spark plugs, cables, clamps, bottles, gauges, hoses, vehicle/trailer

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-6.06.01L	demonstrate knowledge of different types of welding equipment and ***accessories***	identify types of welding equipment and describe their applications and procedures
		identify types of oxy-fuel cutting, heating, welding, brazing and soldering equipment and ***accessories*** and describe their applications
		identify SMAW equipment, consumables and ***accessories***, and describe their applications
		identify GMAW equipment, consumables and ***accessories***, and describe their applications
		identify GTAW equipment, consumables and ***accessories***, and describe their applications
A-6.06.02L	demonstrate knowledge of the procedures used to maintain welding equipment	describe the procedures used to inspect, maintain and repair oxy-fuel equipment
		describe the procedures used to inspect, maintain and repair SMAW equipment
		describe the procedures used to inspect, maintain and repair GMAW equipment
		describe the procedures used to inspect, maintain and repair GTAW equipment
A-6.06.03L	demonstrate knowledge of safety practices related to the maintenance of welding equipment	identify ***hazards*** and describe ***safe work practices*** pertaining to the maintenance of welding equipment

RANGE OF VARIABLES

accessories include: flashback arrestors, fire extinguishers, emergency shut-off switches
hazards include: personal, shop/facility, equipment, ventilation, storage
safe work practices include: use of PPE, safe disposal of fuels, lock-out and tag-out

MAJOR WORK ACTIVITY B

Performs rigging, hoisting/lifting and moving

TASK B-7 Plans rigging, hoisting/lifting and moving

TASK DESCRIPTOR

Industrial mechanics (millwrights) determine load and select appropriate rigging, hoisting/lifting and moving equipment to ensure proper and safe lifts of machinery. For the purpose of this task, lifts include hoisting, lifting and moving of equipment, materials and components.

B-7.01 Determines load

Essential Skills Numeracy, Working with Others, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.01.01P	scale the load using ***measuring devices***	load is scaled using ***measuring devices***
B-7.01.02P	calculate load	load weight is calculated taking into consideration size, material type, wet/dry, centre of gravity, added components and weight of ***rigging hardware***
B-7.01.03P	refer to nameplates, shipping information and manufacturers' manuals	load weight is referenced from nameplates, shipping information and manufacturers' manuals to determine ***procedures used to perform a lift***

RANGE OF VARIABLES

measuring devices include: scales, dynamometers

rigging hardware includes: blocks, shackles, spreader beams, slings

procedures used to perform a lift include: planning, environment analysis, load determination, communication methods, pre-lift checks, placement of load, post-lift inspection, supervision of lift, securing work area

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.01.01L	demonstrate knowledge of rigging, hoisting/lifting and moving equipment, their applications, limitations and procedures for use	define terminology associated with rigging, hoisting/lifting and moving
		interpret jurisdictional regulations pertaining to rigging, hoisting/lifting and moving
		identify types of rigging equipment and accessories, and describe their applications, limitations and procedures
		identify types of hoisting and lifting equipment and accessories, and describe their applications, limitations and procedures
		identify types of moving equipment and accessories, and describe their applications, limitations and procedures
B-7.01.02L	demonstrate knowledge of calculations required when performing hoisting and lifting operations	identify the ***factors*** to consider when selecting rigging, hoisting/lifting and moving equipment
		describe the ***procedures used to determine the weight and weight distribution of loads***

RANGE OF VARIABLES

factors include: weight (dry or wet), material, dimensions, sling angles, centre of gravity, environmental conditions

procedures used to determine the weight and weight distribution of loads include: reference load charts, determine types of loads, engineered lifts

B-7.02 Selects rigging equipment

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-7.02.01P	determine rigging equipment needed	rigging equipment is determined based on the characteristics of the lift, ***process***, the number of items being lifted at one time and determined weight of load
A-7.02.02P	refer to load ratings for ***sling arrangements***	load ratings are referred to for ***sling arrangements***
A-7.02.03P	confirm rigging capacity	rigging capacity is determined to be appropriate for the lift by taking into consideration working load limit (WLL), design factors and actual weight of load being lifted
A-7.02.04P	confirm certification of rigging equipment	certification of rigging equipment is confirmed by referring to the equipment's tag or documentation
A-7.02.05P	assess, inspect and document rigging equipment condition	rigging equipment condition is assessed, inspected and documented to ensure they meet site and manufacturers' specifications, and jurisdictional regulations
A-7.02.06P	remove and tag faulty or damaged rigging equipment from service	faulty or damaged rigging equipment is removed from service and tagged to be repaired or discarded, and is reported to appropriate authority according to site and manufacturers' specifications and jurisdictional regulations

RANGE OF VARIABLES

process includes: lifting, dragging (using rollers), pulling sideways
sling arrangements include: all recommended sling configurations

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-7.02.01L	demonstrate knowledge of rigging equipment, its applications, limitations and procedures	define terminology associated with rigging equipment
		interpret jurisdictional regulations pertaining to rigging equipment
		identify types of rigging equipment and accessories, and describe their applications, limitations and procedures
A-7.02.02L	demonstrate knowledge of the procedures used to rig material or equipment for lifting	identify the factors to consider when selecting rigging equipment
		describe the procedures used to rig material or equipment for lifting
A-7.02.03L	demonstrate knowledge of safety practices related to rigging equipment	identify hazards and describe ***safe work practices*** pertaining to rigging equipment

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations, hazard identification

B-7.03 Selects hoisting/lifting and moving equipment

Essential Skills	Numeracy, Thinking, Document Use

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-7.03.01P	determine hoisting/lifting and moving equipment needed	hoisting/lifting and moving equipment needed is determined based on the ***job scope***, ***process*** and determined weight of load
B-7.03.02P	inspect and document condition of hoisting/lifting and moving equipment	condition of hoisting/lifting and moving equipment is inspected and documented
B-7.03.03P	confirm certification of hoisting/lifting and moving equipment	certification of hoisting/lifting and moving equipment is confirmed by referring to operators' manuals, and the equipment's ***document of certification*** according to site and manufacturers' specifications, and jurisdictional regulations

B-7.03.04P	refer to load charts for boom angles and distance	load charts for boom angles and distance, for mobile equipment, are referred to, to ensure equipment is not overloaded
B-7.03.05P	remove and tag faulty or damaged hoisting/lifting and moving equipment from service	faulty or damaged hoisting/lifting and moving equipment is removed from service and tagged to be repaired or discarded, and reported to appropriate authority according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

job scope includes: headroom, environment (ground conditions, obstructions, weather), distance

process includes: lifting, dragging (using rollers), pulling sideways

document of certification includes: tags, stamps, crane inspection reports, certification reports, load ratings

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.03.01L	demonstrate knowledge of hoisting/lifting and moving equipment, their applications, limitations and procedures	define terminology associated with hoisting/lifting and moving equipment
		interpret jurisdictional regulations pertaining to hoisting/lifting and moving equipment
		identify types of hoisting/lifting equipment and accessories, and describe their applications, limitations and procedures
		describe inspection requirements for hoisting/lifting and moving equipment and accessories
		identify types of moving equipment and accessories, and describe their applications, limitations and procedures
		explain sling angle when preparing for hoisting/lifting operations
		identify the ***factors*** to consider when selecting hoisting/lifting and moving equipment
B-7.03.02L	demonstrate knowledge of safety practices related to hoisting/lifting and moving equipment	identify hazards and describe ***safe work practices*** pertaining to hoisting/lifting and moving equipment
		identify hazards and describe ***safe work practices*** pertaining to mobile and overhead cranes

RANGE OF VARIABLES

factors include: weight (dry or wet), material, dimensions, sling angles, centre of gravity, environmental conditions

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations, hazard identification

B-7.04 Secures area

Essential Skills Oral Communication, Writing, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.04.01P	assess site, ground, environmental conditions and plan route	site, ground and environmental conditions are identified before route is planned
B-7.04.02P	determine and secure lift radius	lift radius is determined and secured using barricades and tape
B-7.04.03P	confirm location of personnel	location of personnel is confirmed

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-7.04.01L	demonstrate knowledge of rigging, hoisting/lifting and moving equipment, their applications, limitations and procedures	define terminology associated with rigging, hoisting/lifting and moving equipment
		interpret jurisdictional regulations pertaining to rigging, hoisting/lifting and moving equipment
		identify types of rigging equipment and accessories, and describe their applications, limitations and procedures
		identify types of hoisting and lifting equipment and accessories, and describe their applications, limitations and procedures
		identify types of moving equipment and accessories, and describe their applications, limitations and procedures
		describe the ***procedures used to ensure the work area is safe for lifting***

B-7.04.02L	demonstrate knowledge of safety practices related to rigging, hoisting/lifting and moving operations	identify hazards and describe ***safe work practices*** pertaining to rigging, hoisting/lifting and moving
		identify hazards and describe ***safe work practices*** pertaining to mobile and overhead cranes

RANGE OF VARIABLES

procedures used to ensure the work area is safe for lifting include: barriers installed and tagged, assessment of ground conditions, non-congestion of the work area, approach limits, obtain required permits

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations, hazard identification

TASK B-8 Rigs, hoists/lifts and moves load

TASK DESCRIPTOR

Rigging, hoisting/lifting and moving loads are hazardous activities and care must be taken to ensure the safety of all personnel and prevent damage to equipment. Industrial mechanics (millwrights) must be skilled in the proper procedures for rigging, hoisting, lifting, drifting, dragging (using rollers) loads.

B-8.01 Sets up rigging, hoisting/lifting and moving equipment

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.01.01P	prepare for lift	lift is prepared for by using floats under outriggers, cribbing (dunnage)
B-8.01.02P	install and set up all rigging, hoisting/lifting and moving components	all rigging, hoisting/lifting and moving components are installed and set up in preparation for moving loads
B-8.01.03P	perform pre-use inspection of equipment	pre-use inspection of equipment is performed to verify ***conditions*** and documented
B-8.01.04P	read and interpret load charts	load charts are read and interpreted
B-8.01.05P	adjust schedule of the lift to address ***environmental conditions***	schedule of the lift is adjusted to address ***environmental conditions***

RANGE OF VARIABLES

conditions include: fuel levels, tire pressure, absence of leaks
environmental conditions include: wind, shifting ground, lightning, fog, rain, snow, temperature

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-8.01.01L	demonstrate knowledge of rigging, hoisting/lifting and moving equipment, their applications, limitations and procedures	define terminology associated with rigging, hoisting/lifting and moving equipment
		interpret jurisdictional regulations pertaining to rigging, hoisting/lifting and moving
		identify types of rigging equipment and accessories, and describe their applications, limitations and procedures
		identify types of hoisting and lifting equipment and accessories, and describe their applications, limitations and procedures
		identify types of moving equipment and accessories, and describe their applications, limitations and procedures
B-8.01.02L	demonstrate knowledge of the procedures used to perform rigging, hoisting/lifting and moving operations	identify types of knots, hitches and bends, and describe their applications
		describe the procedures used to rig material or equipment for hoisting/lifting and moving operations
		explain sling angle when preparing for rigging, hoisting/lifting and moving operations
B-8.01.03L	demonstrate knowledge of safety practices related to rigging, hoisting/lifting and moving operations	identify hazards and describe ***safe work practices*** pertaining to rigging, hoisting/lifting and moving equipment
		identify hazards and describe ***safe work practices*** pertaining to mobile and overhead cranes

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations, hazard identification

B-8.02 Performs hoist/lift and move

Essential Skills	Oral Communication, Working with Others, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.02.01P	ensure direct line of sight between the operator and signal person	direct line of sight between the operator and signal person is ensured
B-8.02.02P	use hand signals and verbal communication according to jurisdictional regulations	hand signals and verbal communication are used according to jurisdictional regulations
B-8.02.03P	use ***alternate communication methods*** when there is no direct line of sight	when there is no direct line of sight, ***alternate communication methods*** are used
B-8.02.04P	assess and make adjustments to stabilize load as required	load is stabilized by assessing and making adjustments as required
B-8.02.05P	adjust schedule of lift to address ***environmental conditions***	schedule of lift is adjusted to address ***environmental conditions***
B-8.02.06P	perform post-lift inspection of rigging, hoisting/lifting and moving equipment	post-lift inspection is performed of rigging, hoisting/lifting and moving equipment

RANGE OF VARIABLES

alternate communication methods include: two-way radio, bell signals, horns, lights

environmental conditions include: wind, changing ground conditions, lightning, fog, rain, snow, temperature

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-8.02.01L	demonstrate knowledge of hoisting/lifting and moving equipment, their applications, limitations and procedures	define terminology associated with hoisting/lifting and moving
		interpret jurisdictional regulations pertaining to hoisting/lifting and moving
		identify types of hoisting and lifting equipment and accessories, and describe their applications, limitations and procedures
		identify types of moving equipment and accessories, and describe their applications, limitations and procedures

B-8.02.02L	demonstrate knowledge of the procedures used to perform hoisting/lifting and moving operations	describe the ***procedures used to perform a lift***
B-8.02.03L	demonstrate knowledge of the use of standard hand signals	describe ***procedures used to communicate*** during hoisting/lifting and moving operations
		perform standard hand signals
B-8.02.04L	demonstrate knowledge of calculations required when performing hoisting/lifting and moving operations	describe the ***procedures used to determine the weight and weight distribution of loads***
B-8.02.05L	demonstrate knowledge of safety practices related to hoisting/lifting and moving operations	identify hazards and describe ***safe work practices*** pertaining to hoisting/lifting and moving operations
		identify hazards and describe ***safe work practices*** pertaining to mobile and overhead cranes

RANGE OF VARIABLES

procedures used to perform a lift include: planning, environment analysis, load determination, communication methods, pre-lift checks, placement of load, post-lift inspection, supervision of lift, securing work area

procedures used to communicate include: verbal, radio, visual (hand signals)

procedures used to determine the weight and weight distribution of loads include: reference load charts, determine types of loads, engineered lifts, engineered drawings, nameplates, calculations, scales

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations, hazard identification

B-8.03 Maintains rigging, hoisting/lifting and moving equipment

Essential Skills Thinking, Document Use, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.03.01P	perform scheduled ***maintenance*** on equipment	scheduled ***maintenance*** is performed on equipment according to site and manufacturers' specifications, and jurisdictional regulations
B-8.03.02P	perform visual inspection of rigging, hoisting/lifting and moving equipment	visual inspection of rigging, hoisting/lifting and moving equipment is performed

B-8.03.03P	identify rejection criteria for hardware	rejection criteria for hardware are identified according to site and manufacturers' specifications, and jurisdictional regulations
B-8.03.04P	identify and replace damaged ***hardware*** and remove from service	damaged ***hardware*** is identified, replaced and removed from service
B-8.03.05P	identify non-destructive testing (NDT) techniques used on rigging, hoisting/lifting and moving equipment	NDT techniques used on rigging, hoisting/lifting and moving equipment are identified to detect ***defects*** according to site and manufacturers' specifications, and jurisdictional regulations
B-8.03.06P	store rigging, hoisting/lifting and moving equipment	rigging, hoisting/lifting and moving equipment is stored according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

maintenance includes: lubricating, cleaning, inspecting, repairing

hardware includes: eye-bolts, slings, shackles, hooks, safety latches, spreader beam, tag lines

defects include: damaged (cracked, stretched or twisted) chains, broken links, broken wires, frayed slings, chemical damage, damaged tags, heat damage

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-8.03.01L	demonstrate knowledge of rigging, hoisting/lifting and moving equipment, their applications, limitations and procedures	define terminology associated with rigging, hoisting/lifting and moving equipment
		interpret jurisdictional regulations pertaining to rigging, hoisting/lifting and moving equipment
		identify types of rigging equipment and accessories, and describe their applications, limitations and procedures
		identify types of hoisting and lifting equipment and accessories, and describe their applications, limitations and procedures
		identify types of moving equipment and accessories, and describe their applications, limitations and procedures
B-8.03.02L	demonstrate knowledge of the procedures used to maintain rigging, hoisting/lifting and moving equipment	describe the procedures used to inspect, maintain and store rigging, hoisting/lifting and moving equipment

B-8.03.03L	demonstrate knowledge of safety practices related to rigging, hoisting/lifting and moving equipment	identify hazards and describe ***safe work practices*** pertaining to rigging, hoisting/lifting and moving
		identify hazards and describe ***safe work practices*** pertaining to mobile and overhead cranes

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations, hazard identification

MAJOR WORK ACTIVITY C

Services mechanical power transmission components and systems

TASK C-9 Services prime movers

TASK DESCRIPTOR

Prime movers are the driver of the mechanical system and include equipment such as electric motors, turbines (for example wind, water, gas or steam) and internal combustion engines. They must be installed correctly and maintained properly to provide optimum power and torque to the driven systems and to ensure reliability of the prime mover. Servicing includes installing, diagnosing, maintaining and repairing.

C-9.01 Installs prime movers

Essential Skills Numeracy, Document Use, Working with Others

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-9.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and manufacturers' specifications
C-9.01.02P	determine location and elevation for installation	location and elevation for installation is determined according to engineered drawings
C-9.01.03P	prepare foundation	foundation is prepared according to manufacturers' specifications and engineered drawings
C-9.01.04P	prepare base, base plates, sole plates and structure	base, base plates, sole plates and structure are prepared using ***methods*** according to manufacturers' specifications and engineered drawings
C-9.01.05P	prepare and inspect ***prime movers***	***prime movers*** are prepared and inspected for installation according to manufacturers' specifications

C-9.01.06P	position ***prime movers***	***prime movers*** are positioned manually or with rigging, hoisting/lifting and moving equipment according to manufacturers' specifications
C-9.01.07P	secure, level and align ***prime mover***	***prime mover*** is secured, leveled and aligned with driven equipment according to site and manufacturers' specifications, and engineered drawings
C-9.01.08P	install ***auxiliary systems***	***auxiliary systems*** are installed according to manufacturers' specifications and engineered drawings
C-9.01.09P	verify rotation	rotation is checked prior to coupling by performing bump test
C-9.01.10P	connect ***prime mover*** to driven equipment	***prime mover*** is connected to driven equipment using ***components*** according to engineered specifications and drawings
C-9.01.11P	install safety guards and ***safety devices***	safety guards and ***safety devices*** are installed according to manufacturers' specifications and jurisdictional regulations
C-9.01.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

tools and equipment include: torque wrenches, dial indicators, precision levels, optical or laser alignment equipment, piano wire, sound mic, hand tools

methods include: cleaning, deburring, degreasing, removing scale and debris

prime movers include: electric motors, turbines (for example wind, water, gas or steam), internal combustion engines, hydraulic drives

auxiliary systems include: lube pumps, filtration systems, cooling systems, equipment protection devices

components include: couplings, sheaves, sprockets, gear boxes, drive shafts, drive belts

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-9.01.01L	demonstrate knowledge of ***prime movers***, their components and operation	define terminology associated with ***prime movers***
		identify types of ***prime movers*** and their components and accessories, and describe their purpose, applications and operation
C-9.01.02L	demonstrate knowledge of safety practices related to ***prime movers***	identify hazards and describe ***safe work practices*** associated with ***prime movers***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***prime movers***

C-9.01.03L	demonstrate knowledge of the procedures used to install ***prime movers***	identify tools and equipment used to install ***prime movers*** and describe their applications and procedures
		describe the procedures used to install ***prime movers*** and their components

RANGE OF VARIABLES

prime movers include: electric motors, turbines (for example wind, water, gas or steam), internal combustion engines

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

C-9.02 Diagnoses prime movers

Essential Skills Thinking, Oral Communication, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
C-9.02.02P	perform ***sensory inspection*** of ***prime movers***	***sensory inspection*** is performed
C-9.02.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and manufacturers' specifications
C-9.02.04P	test and evaluate ***prime movers***	***prime movers*** are tested and evaluated by using specialized equipment and referring to manufacturers' recommendations
C-9.02.05P	perform ***condition-based monitoring methods*** and analysis	***condition-based monitoring methods*** and analysis are performed to detect defects not identified through ***sensory inspection***
C-9.02.06P	inspect prime mover ***components***	prime mover ***components*** are inspected for ***defects*** and to determine ***next steps***
C-9.02.07P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
C-9.02.08P	assess and detect faulty or damaged equipment	faulty or damaged equipment is assessed and detected to determine ***next steps***

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, visually inspecting

prime movers include: electric motors, turbines (for example wind, water, gas or steam), internal combustion engines

tools and equipment include: torque wrenches, dial indicators, precision levels and measuring tools, optical or laser alignment equipment, piano wire, sound mic, hand tools

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

components include: couplings, sheaves, sprockets, gear boxes, drive shafts, drive belts

defects include: excessive wear, corrosion, looseness

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

next steps include: repair, replace, overhaul, adjust, continue operation

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-9.02.01L	demonstrate knowledge of ***prime movers***, their components and operation	define terminology associated with ***prime movers***
		identify types of ***prime movers*** and their ***components*** and accessories, and describe their purpose, applications and operation
C-9.02.02L	demonstrate knowledge of safety practices related to ***prime movers***	identify hazards and describe ***safe work practices*** associated with ***prime movers***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***prime movers***
C-9.02.03L	demonstrate knowledge of the procedures used to diagnose ***prime movers***	identify tools and equipment used to diagnose ***prime movers*** and describe their applications and procedures
		describe the procedures used to inspect ***prime movers*** and their ***components***
		describe the procedures used to diagnose ***prime movers*** and their ***components***
		identify the factors to consider when determining if ***prime movers*** need to be repaired or replaced

RANGE OF VARIABLES

prime movers include: electric motors, turbines (for example wind, water, gas or steam), internal combustion engines

components include: couplings, sheaves, sprockets, gear boxes, drive shafts, drive belts, chain drives, fluid drives, bearings

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

C-9.03 Maintains prime movers

Essential Skills Thinking, Working with Others, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.03.01P	inspect, modify and adjust ***prime movers***	***prime movers*** are inspected, modified and adjusted according to maintenance schedule using ***condition-based monitoring methods***
C-9.03.02P	use ***tools and equipment***	***tools and equipment*** are used according to job and manufacturers' specifications
C-9.03.03P	align components	components are aligned according to manufacturers' specifications
C-9.03.04P	check coolant and lubricant levels, packing, seals and ***equipment protection devices***	coolant and lubricant levels, packing, seals and ***equipment protection devices*** are checked according to manufacturers' specifications and maintenance schedule
C-9.03.05P	monitor temperature, vibration and pressure	temperature, vibration and pressure are monitored
C-9.03.06P	check automatic bearing and seal lubrication systems	automatic bearing and seal lubrication systems are checked
C-9.03.07P	adjust flow and pressure controls	flow and pressure controls for cooling and lubrication of ***prime movers*** are adjusted according to manufacturers' specifications
C-9.03.08P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
C-9.03.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
C-9.03.10P	identify faulty or damaged equipment	faulty or damaged equipment is identified to determine repair or replacement

RANGE OF VARIABLES

prime movers include: electric motors, turbines (for example wind, water, gas or steam), internal combustion engines

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

tools and equipment include: torque wrenches, dial indicators, precision levels, optical or laser alignment equipment, piano wire, sound mic, hand tools

equipment protection devices include: over speed governors, under speed governors, governors, emergency shutdown devices

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-9.03.01L	demonstrate knowledge of ***prime movers***, their components and operation	define terminology associated with ***prime movers***
		identify types of ***prime movers*** and their components and accessories, and describe their purpose, applications and operation
C-9.03.02L	demonstrate knowledge of safety practices related to ***prime movers***	identify hazards and describe ***safe work practices*** associated with ***prime movers***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***prime movers***
C-9.03.03L	demonstrate knowledge of the procedures used to maintain ***prime movers***	identify tools and equipment used to maintain ***prime movers*** and describe their applications and procedures
		identify the factors to consider when determining if ***prime movers*** or their components need to be repaired or replaced
		describe the procedures used to maintain ***prime movers*** and their components

RANGE OF VARIABLES

prime movers include: electric motors, turbines (for example wind, water, gas or steam), internal combustion engines

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

C-9.04 Repairs prime movers

Essential Skills Thinking, Working with Others, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.04.01P	access ***prime movers***	***prime movers*** are accessed by removing ***components***
C-9.04.02P	dismantle and remove ***prime movers*** and ***components***	***prime movers*** and ***components*** are dismantled and removed according to manufacturers' specifications and engineered drawings using tools and procedures and match (witness) marks
C-9.04.03P	use ***tools and equipment***	***tools and equipment*** are used according to job and manufacturers' specifications
C-9.04.04P	prepare ***prime movers*** for repair	***prime movers*** are prepared for repair using various methods
C-9.04.05P	size and replace seals, bearings and power transmission devices	seals, bearings and power transmission devices are sized and replaced according to manufacturers' specifications and engineered drawings
C-9.04.06P	machine keys, keyways and keyseats	keys, keyways and keyseats are machined according to manufacturers' specifications and engineered drawings
C-9.04.07P	pour and scrape new friction bearings	new friction bearings are poured and scraped according to manufacturers' specifications and engineered drawings
C-9.04.08P	replace faulty ***components*** and auxiliary equipment	faulty ***components*** and auxiliary equipment are replaced according to manufacturers' specifications
C-9.04.09P	verify rotation	rotation is checked prior to coupling by performing bump test
C-9.04.10P	align ***components***	***components*** are aligned according to manufacturers' specifications
C-9.04.11P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to manufacturers' specifications, and jurisdictional regulations
C-9.04.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

prime movers include: electric motors, turbines (for example wind, water, gas or steam), internal combustion engines

components include: housings, machine guarding, collars, covers, safety controls

tools and equipment include: torque wrenches, dial indicators, precision levels, optical or laser alignment equipment, piano wire, sound mic, hand tools

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-9.04.01L	demonstrate knowledge of ***prime movers***, their ***components*** and operation	define terminology associated with ***prime movers***
		identify types of ***prime movers*** and their ***components*** and accessories, and describe their purpose, applications and operation
C-9.04.02L	demonstrate knowledge of safety practices related to ***prime movers***	identify hazards and describe ***safe work practices*** associated with ***prime movers***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***prime movers***
C-9.04.03L	demonstrate knowledge of the procedures used to repair ***prime movers***	identify ***tools and equipment*** used to repair ***prime movers*** and describe their applications and procedures
		identify the factors to consider when determining if ***prime movers*** or their ***components*** need to be repaired or replaced
		describe the procedures used to repair ***prime movers*** and their ***components***

RANGE OF VARIABLES

prime movers include: electric motors, turbines (for example wind, water, gas or steam), internal combustion engines

components include: housings, machine guarding, collars, covers, safety controls

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: torque wrenches, dial indicators, precision levels, optical or laser alignment equipment, piano wire, sound mic, hand tools

TASK C-10 Services shafts, bearings and seals

TASK DESCRIPTOR

Shafts transmit power and torque from the prime mover to the driven equipment. Bearings maintain the shaft centerline and allow rotary or linear shaft movement with minimal friction. Seals prevent contamination of other components and ensure lubrication and coolant containment. Servicing includes installing, diagnosing, maintaining and repairing these components.

C-10.01 Installs shafts, bearings and seals

Essential Skills Document Use, Numeracy, Thinking

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-10.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and manufacturers' specifications
C-10.01.02P	select ***shafts, bearings*** and ***seals***	***shafts, bearings*** and ***seals*** are selected according to ***specifications*** and engineered drawings
C-10.01.03P	measure fits and tolerances	fits and tolerances of ***shafts, bearings*** and ***seals*** and housings are measured within manufacturers' specifications
C-10.01.04P	position ***shafts, bearings*** and ***seals***	***shafts, bearings*** and ***seals*** are positioned manually or with rigging, hoisting/lifting and moving equipment
C-10.01.05P	mount ***seals***	***seals*** are mounted according to job and manufacturers' specifications, and engineered drawings, using ***tools and equipment***
C-10.01.06P	mount ***plain (friction) bearings***	***plain (friction) bearings*** are mounted using ***equipment*** to fit according to manufacturers' specifications
C-10.01.07P	mount ***anti-friction (rolling element-type) bearings***	***anti-friction (rolling element-type) bearings*** are mounted using ***equipment*** to fit according to manufacturers' specifications
C-10.01.08P	check, adjust and record clearances of ***bearings*** and ***seals***	clearances of ***bearings*** and ***seals*** are checked, adjusted and recorded according to site and manufacturers' specifications, and engineered drawings

C-10.01.09P	secure, level and align ***shafts, bearings*** and ***seals***	***shafts***, ***bearings*** and ***seals*** are secured, leveled and aligned according to site and manufacturers' specifications, and engineered drawings
C-10.01.10P	apply lubricants	lubricants are applied according to site and manufacturers' specifications, and engineered drawings
C-10.01.11P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: hand tools, torque wrenches, dial indicators, feeler gauges, micrometers, calipers, induction heaters, oil baths, arbour presses, bearing ovens, seal drivers, hydraulic adaptors

shafts include: drive, counter, jack, hollow, shaft accessories (keys, pins, taper bushings, retaining rings, sleeves)

bearings include: plain (friction), anti-friction (rolling element)

seals include: static, dynamic, mechanical, non-contacting (labyrinth/annulus)

specifications include: product, operating environment, loads, temperatures, pressures, rpm

plain (friction) bearings fitting equipment includes: plasti-gauges, lead wires, mechanics' blue, scrapers

anti-friction (rolling element-type) bearings equipment includes: induction heaters, oil baths, arbour presses, bearing ovens

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-10.01.01L	demonstrate knowledge of ***shafts, bearings*** and ***seals***, their components and operation	define terminology associated with ***shafts, bearings*** and ***seals***
		identify types of ***shafts, bearings*** and ***seals*** and their components and accessories***,*** and describe their purpose, applications and operation
C-10.01.02L	demonstrate knowledge of safety practices related to ***shafts, bearings*** and ***seals***	identify hazards and describe ***safe work practices*** associated with ***shafts, bearings*** and ***seals***
C-10.01.03L	demonstrate knowledge of the procedures used to install ***shafts, bearings*** and ***seals***	identify tools and equipment used with ***shafts, bearings*** and ***seals*** and describe their applications and procedures
		describe the procedures used to install ***shafts, bearings*** and ***seals*** and their components

RANGE OF VARIABLES

shafts include: drive, counter, jack, hollow, shaft accessories (keys, pins, taper bushings, retaining rings, adapter and withdrawal sleeves)

bearings include: plain (friction), anti-friction (rolling element)

seals include: static, dynamic, mechanical, non-contacting (labyrinth/annulus)

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

C-10.02 Diagnoses shafts, bearings and seals

Essential Skills Oral Communication, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-10.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
C-10.02.02P	perform ***sensory inspection*** of ***shafts, bearings*** and ***seals*** for defects	***sensory inspection*** of ***shafts, bearings*** and ***seals*** is performed to determine ***next steps***
C-10.02.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and manufacturers' specifications
C-10.02.04P	test and evaluate ***shafts, bearings*** and ***seals***	***shafts, bearings*** and ***seals*** are tested and evaluated using specialized equipment and referring to manufacturers' specifications
C-10.02.05P	perform ***condition-based monitoring methods*** and analysis	***condition-based monitoring methods*** and analysis are performed to detect defects not identified through ***sensory inspection***
C-10.02.06P	inspect ***shafts, bearings*** and ***seals***	***shafts, bearings*** and ***seals*** are inspected for defects and to determine ***next steps***
C-10.02.07P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for leaks, missing and loose parts, worn and damaged components

shafts include: drive, counter, jack, hollow, shaft accessories (keys, pins, taper bushings, retaining rings, adapter and withdrawal sleeves)

bearings include: plain (friction), anti-friction (rolling element)

seals include: static, dynamic, mechanical, non-contacting (labyrinth/annulus)

next steps include: repair, replace, overhaul, adjust, continue operation

tools and equipment include: hand tools, torque wrenches, dial indicators, feeler gauges, micrometers, calipers, induction heaters, oil baths, arbour presses, bearing ovens, seal drivers, hydraulic adaptors

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-10.02.01L	demonstrate knowledge of ***shafts, bearings*** and ***seals***, their components and operation	define terminology associated with ***shafts, bearings*** and ***seals***
		identify types of ***shafts, bearings*** and ***seals*** and their components and accessories, and describe their purpose, applications and operation
C-10.02.02L	demonstrate knowledge of safety practices related to ***shafts, bearings*** and ***seals***	identify hazards and describe ***safe work practices*** associated with ***shafts, bearings*** and ***seals***
C-10.02.03L	demonstrate knowledge of the procedures used to diagnose ***shafts, bearings*** and ***seals***	identify tools and equipment used with ***shafts, bearings*** and ***seals*** and describe their applications and procedures
		describe the procedures used to inspect ***shafts, bearings*** and ***seals*** and their components
		describe the procedures used to diagnose ***shafts, bearings*** and ***seals*** and their components
		identify the factors to consider when determining if ***shafts, bearings*** and ***seals*** need to be repaired or replaced

RANGE OF VARIABLES

shafts include: drive, counter, jack, hollow, shaft accessories (keys, pins, taper bushings, retaining rings, adapter and withdrawal sleeves)

bearings include: plain (friction), anti-friction (rolling element)

seals include: static, dynamic, mechanical, non-contacting (labyrinth/annulus)

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

C-10.03 Maintains shafts, bearings and seals

Essential Skills	Oral Communication, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-10.03.01P	inspect, modify and adjust ***shafts, bearings*** and ***seals***	***shafts, bearings*** and ***seals*** are inspected, modified and adjusted according to maintenance schedule using ***condition-based monitoring methods***
C-10.03.02P	use ***tools and equipment***	***tools and equipment*** are used according to site and manufacturers' specifications
C-10.03.03P	align ***components***	***components*** are aligned according to site and manufacturers' specifications, and engineered drawings
C-10.03.04P	check coolant and lubricants levels, packing, seals and ***equipment protection devices***	coolant and lubricants levels, packing, seals and ***equipment protection devices*** are checked according to manufacturers' specifications and maintenance schedule
C-10.03.05P	monitor temperature, vibration and pressure	temperature, vibration and pressure are monitored using condition-based monitoring methods according to site and manufacturers' specifications and engineered drawings
C-10.03.06P	check automatic bearing and seal lubrication systems	automatic bearing and seal lubrication systems are checked according to site and manufacturers' specifications and engineered drawings
C-10.03.07P	adjust flow and pressure controls	flow and pressure controls for cooling and lubrication of shafts, bearings and seals are adjusted according to manufacturers' specifications
C-10.03.08P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
C-10.03.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
C-10.03.10P	identify faulty or damaged equipment	faulty or damaged equipment is identified to determine repair or replacement

RANGE OF VARIABLES

shafts include: drive, counter, jack, hollow, shaft accessories (keys, pins, taper bushings, retaining rings, adapter and withdrawal sleeves)

bearings include: plain (friction), anti-friction (rolling element)

seals include: static, dynamic, mechanical, non-contacting (labyrinth/annulus)

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

tools and equipment include: hand tools, torque wrenches, dial indicators, feeler gauges, micrometers, calipers, induction heaters, oil baths, arbour presses, bearing ovens, seal drivers, hydraulic adaptors

components include: couplings, keys, gears, pulleys

equipment protection devices include: emergency shutdown devices (temperature, vibration, speed, load)

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-10.03.01L	demonstrate knowledge of ***shafts, bearings*** and ***seals***, their components and operation	define terminology associated with ***shafts, bearings*** and ***seals***
		identify types of ***shafts, bearings*** and ***seals*** and their components and accessories, and describe their purpose, applications and operation
C-10.03.02L	demonstrate knowledge of safety practices related to ***shafts, bearings*** and ***seals***	identify hazards and describe ***safe work practices*** associated with ***shafts, bearings*** and ***seals***
C-10.03.03L	demonstrate knowledge of the procedures used to maintain ***shafts, bearings*** and ***seals***	identify tools and equipment used to maintain ***shafts, bearings*** and ***seals*** and describe their applications and procedures
		identify the factors to consider when determining if ***shafts, bearings*** and ***seals*** or their components need to be repaired or replaced
		describe the procedures used to maintain ***shafts, bearings*** and ***seals*** and their components

RANGE OF VARIABLES

shafts include: drive, counter, jack, hollow shaft accessories (keys, pins, taper bushings, retaining rings, adapter and withdrawal sleeves)

bearings include: plain (friction), anti-friction (rolling element)

seals include: static, dynamic, mechanical, non-contacting (labyrinth/annulus)

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

C-10.04 Repairs shafts, bearings and seals

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-10.04.01P	rebuild and replace faulty ***shafts, bearings*** and ***seals***	faulty ***shafts, bearings*** and ***seals*** are rebuilt and replaced according to manufacturers' specifications
C-10.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to site and manufacturers' specifications
C-10.04.03P	dismantle, remove and reassemble ***shafts, bearings*** and ***seals***	***shafts, bearings*** and ***seals*** are dismantled, removed and reassembled to specifications using tools and procedures, and match (witness) marks
C-10.04.04P	prepare shaft	shaft is prepared for repair using various ***methods***
C-10.04.05P	align ***components***	***components*** are aligned according to manufacturers' specifications
C-10.04.06P	access ***shafts, bearings*** and ***seals***	***shafts, bearings*** and ***seals*** are accessed by removing ***components***
C-10.04.07P	size and replace ***shafts, bearings*** and ***seals***	***shafts, bearings*** and ***seals*** are sized and replaced according to manufacturers' specifications
C-10.04.08P	pour and scrape new plain (friction) bearings	new plain (friction) bearings are poured and scraped according to manufacturers' specifications and engineered drawings
C-10.04.09P	machine keys, keyway and keyseats	keys, keyway and keyseats are machined according to manufacturers' specifications
C-10.04.10P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
C-10.04.11P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

shafts include: drive, counter, jack, hollow

shaft accessories include: keys, pins, taper bushings, retaining rings, sleeves

bearings include: plain (friction), anti-friction (rolling element)

seals include: static, dynamic, mechanical, non-contacting (labyrinth/annulus)

tools and equipment include: hand tools, torque wrenches, dial indicators, feeler gauges, micrometers, calipers, induction heaters, oil baths, arbour presses, bearing ovens, seal drivers, hydraulic adaptors

methods include: sleeving, welding, filing, polishing, machining

components include: couplings, keys, gears, pulleys, housings, sleeves, snap rings, collars and covers

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-10.04.01L	demonstrate knowledge of ***shafts, bearings*** and ***seals***, their components and operation	define terminology associated with ***shafts, bearings*** and ***seals***
		identify types of ***shafts, bearings*** and ***seals*** and their components and accessories, and describe their purpose, applications and operation
C-10.04.02L	demonstrate knowledge of safety practices related to ***shafts, bearings*** and ***seals***	identify hazards and describe ***safe work practices*** associated with ***shafts, bearings*** and ***seals***
C-10.04.03L	demonstrate knowledge of the procedures used to repair ***shafts, bearings*** and ***seals***	identify tools and equipment used to repair ***shafts, bearings*** and ***seals*** and describe their applications and procedures
		identify the factors to consider when determining if ***shafts, bearings*** and ***seals*** or their components need to be repaired or replaced
		describe the procedures used to repair ***shafts, bearings*** and ***seals*** and their components

RANGE OF VARIABLES

shafts include: drive, counter, jack, hollow

shaft accessories include: keys, pins, taper bushings, retaining rings, sleeves

bearings include: plain (friction), anti-friction (rolling element)

seals include: static, dynamic, mechanical, non-contacting (labyrinth/annulus)

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

TASK C-11 Services couplings, clutches and brakes

TASK DESCRIPTOR

Couplings transfer torque, power, and rotary and linear motion from one shaft to another. Clutches allow engagement and disengagement of power and torque. Brakes slow or stop the motion. They must be installed correctly and maintained properly to provide optimum power and torque to the driven systems and to ensure reliability. Servicing includes installing, diagnosing, maintaining and repairing.

C-11.01 Installs couplings, clutches and brakes

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-11.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
C-11.01.02P	select ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are selected according to ***specifications***
C-11.01.03P	place ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are placed manually or by using rigging, hoisting/lifting and moving equipment
C-11.01.04P	mount ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are mounted using ***tools and equipment***, and by heating or cooling the components
C-11.01.05P	assemble ***couplings***, ***clutches*** and ***brakes*** with mating equipment	***couplings***, ***clutches*** and ***brakes*** are assembled with mating equipment according to site and manufacturers' specifications, and engineered drawings
C-11.01.06P	check, adjust and record clearances of ***couplings***, ***clutches*** and ***brakes***	clearances of ***couplings***, ***clutches*** and ***brakes*** are checked, adjusted and recorded according to manufacturers' specifications
C-11.01.07P	align ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are aligned according to manufacturers' specifications
C-11.01.08P	lubricate ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are lubricated according to manufacturers' specifications

C-11.01.09P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
C-11.01.10P	energize equipment, start it up and return to operation	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation

RANGE OF VARIABLES

tools and equipment include: torque wrenches, feeler gauges, straight edges, micrometers, calipers, presses, pullers, laser alignment equipment, hand tools, dial indicators

couplings include: rigid, elastomeric, grid, mechanical, fluid

clutches include: overrunning, friction, positive contact, fluid, electromagnetic

brakes include: friction, fluid/wet disc, electromagnetic

specifications include: torque, horsepower, loads, temperatures, rpm, environment, manufacturers' specifications

safety devices include: thermal protection, light curtains, pressure sensitive matting, keyed switches, shear pins, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-11.01.01L	demonstrate knowledge of ***couplings***, ***clutches*** and ***brakes***, their components and operation	define terminology associated with ***couplings***, ***clutches*** and ***brakes***
		identify types of ***couplings***, ***clutches*** and ***brakes***, their components and accessories, and describe their purpose, applications and operation
C-11.01.02L	demonstrate knowledge of safety practices related to ***couplings***, ***clutches*** and ***brakes***	identify hazards and describe ***safe work practices*** associated with ***couplings***, ***clutches*** and ***brakes***
C-11.01.03L	demonstrate knowledge of the procedures used to remove and install ***couplings***, ***clutches*** and ***brakes***	interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***couplings***, ***clutches*** and ***brakes***
		identify ***tools and equipment*** used to install ***couplings***, ***clutches*** and ***brakes*** and describe their applications and procedures
		describe the procedures used to remove and install ***couplings***, ***clutches*** and ***brakes*** and their components

RANGE OF VARIABLES

couplings include: rigid, elastomeric, grid, mechanical, fluid

clutches include: overrunning, friction, positive contact, fluid, electromagnetic

brakes include: friction, fluid/wet disc, electromagnetic

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: torque wrenches, feeler gauges, straight edges, micrometers, calipers, presses, pullers, laser alignment equipment, hand tools, dial indicators

C-11.02 Diagnoses couplings, clutches and brakes

Essential Skills Thinking, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-11.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained by ***sensory inspection*** or verbal communication
C-11.02.02P	perform ***sensory inspection*** of ***couplings***, ***clutches*** and ***brakes*** for defects	***sensory inspection*** of ***couplings***, ***clutches*** and ***brakes*** is performed to determine ***next steps***
C-11.02.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to results of ***sensory inspection***
C-11.02.04P	use ***test/evaluation procedures***	***test/evaluation procedures*** are used according to results of ***sensory inspection***
C-11.02.05P	perform ***condition-based monitoring methods***	***condition-based monitoring methods*** are performed to detect defects not identified through ***sensory inspection***
C-11.02.06P	verify lubrication levels and condition	lubrication levels and condition are verified by ***physical inspection***
C-11.02.07P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
C-11.02.08P	measure clearances of ***couplings***, ***clutches*** and ***brakes***	clearances of ***couplings***, ***clutches*** and ***brakes*** are measured according to manufacturers' specifications

C-11.02.09P	assess and detect faulty or damaged components	faulty or damaged components are assessed and detected to determine repair or replacement
C-11.02.10P	identify conditions that led to failure or breakdown of ***couplings***, ***clutches*** and ***brakes***	conditions that led to failure or breakdown of ***couplings***, ***clutches*** and ***brakes*** are identified

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for missing and loose parts, worn and damaged components

couplings include: rigid, elastomeric, grid, mechanical, fluid

clutches include: overrunning, friction, positive contact, fluid, electromagnetic

brakes include: friction, fluid/wet disc, electromagnetic

next steps include: repair, replace, overhaul, adjust, continue operation

tools and equipment include: vernier calipers, feeler gauges, taper gauges, thermal imaging equipment, laser alignment equipment, strobe light, dial indicators

test/evaluation procedures include: monitoring temperature and vibration levels with specialized equipment

condition-based monitoring methods include: thermal imaging, tribology, strobe light, vibration analysis

physical inspection includes: visually inspect lubrication levels of couplings, clutches or brakes

safety devices include: thermal protection, light curtains, pressure sensitive matting, keyed switches, shear pins, lock-outs, physical guards

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-11.02.01L	demonstrate knowledge of ***couplings***, ***clutches*** and ***brakes***, their components and operation	define terminology associated with ***couplings***, ***clutches*** and ***brakes***
		identify types of ***couplings***, ***clutches*** and ***brakes***, their components and accessories, and describe their purpose, applications and operation
C-11.02.02L	demonstrate knowledge of safety practices related to ***couplings***, ***clutches*** and ***brakes***	identify hazards and describe safe work practices associated with ***couplings***, ***clutches*** and ***brakes***
C-11.02.03L	demonstrate knowledge of the procedures used to diagnose ***couplings***, ***clutches*** and ***brakes***	interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***couplings***, ***clutches*** and ***brakes***
		identify ***tools and equipment*** used to diagnose ***couplings***, ***clutches*** and ***brakes*** and describe their applications and procedures

	describe the procedures used to inspect ***couplings***, ***clutches*** and ***brakes*** and their components
	identify the factors to consider when determining if ***couplings***, ***clutches*** and ***brakes*** need to be repaired or replaced

RANGE OF VARIABLES

couplings include: rigid, elastomeric, grid, mechanical, fluid

clutches include: overrunning, friction, positive contact, fluid, electromagnetic

brakes include: friction, fluid/wet disc, electromagnetic

tools and equipment include: vernier calipers, feeler gauges, taper gauges, thermal imaging equipment, laser alignment equipment, strobe light, dial indicators

C-11.03 Maintains couplings, clutches and brakes

Essential Skills Thinking, Document Use, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-11.03.01P	access ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are accessed by removing guards and ***safety devices***, and ***coupling, clutch and brake components***
C-11.03.02P	dismantle and remove ***couplings***, ***clutches*** and ***brakes*** and their ***components***	***couplings***, ***clutches*** and ***brakes*** and their ***components*** are dismantled and removed according to manufacturers' specifications using tools and procedures and match (witness) marks
C-11.03.03P	use ***tools and equipment***	***tools and equipment*** are used according to site and manufacturers' specifications
C-11.03.04P	assess machine keys, keyways and keyseats	keys, keyways and keyseats are assessed according to manufacturers' specifications and engineered drawings
C-11.03.05P	assess ***couplings***, ***clutches*** or ***brakes*** and their components' condition	***couplings***, ***clutches*** or ***brakes*** and their components' ***condition*** is assessed
C-11.03.06P	document and/or replace faulty components	faulty components are documented or replaced according to site and manufacturers' specifications and engineered drawings

C-11.03.07P	reinstall machine guarding and ***safety devices***	machine guarding and ***safety devices*** are reinstalled according to site and manufacturers' specifications and jurisdictional regulations
C-11.03.08P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

couplings include: rigid, elastomeric, grid, mechanical, fluid

clutches include: overrunning, friction, positive contact, fluid, electromagnetic

brakes include: friction, fluid/wet disc, electromagnetic

safety devices include: thermal protection, light curtains, pressure sensitive matting, keyed switches, shear pins, lock-outs, physical guards

coupling, clutch and brake components include: springs, grids, elastomeric elements, friction pads, diaphragms

tools and equipment include: micrometers, hydraulic rams, pullers, torque wrenches, dial indicators, vernier calipers, laser alignment equipment, hand tools

condition includes: fluid levels, wear, alignment, heat, vibration, noise

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-11.03.01L	demonstrate knowledge of ***couplings***, ***clutches*** and ***brakes***, their ***components*** and operation	define terminology associated with ***couplings***, ***clutches*** and ***brakes***
		identify types of ***couplings***, ***clutches*** and ***brakes***, their ***components*** and accessories, and describe their purpose, applications and operation
C-11.03.02L	demonstrate knowledge of ***safe work practices*** related to ***couplings***, ***clutches*** and ***brakes***	identify hazards and describe ***safe work practices*** associated with ***couplings***, ***clutches*** and ***brakes***
C-11.03.03L	demonstrate knowledge of the procedures used to maintain ***couplings***, ***clutches*** and ***brakes***	interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***couplings***, ***clutches*** and ***brakes***
		identify ***tools and equipment*** used to maintain ***couplings***, ***clutches*** and ***brakes*** and describe their applications and procedures
		identify the factors to consider when determining if ***couplings***, ***clutches*** and ***brakes*** their components need to be repaired or replaced
		describe the procedures used to maintain ***couplings***, ***clutches*** and ***brakes*** and their components

RANGE OF VARIABLES

couplings include: rigid, elastomeric, grid, mechanical, fluid

clutches include: overrunning, friction, positive contact, fluid, electromagnetic

brakes include: friction, fluid/wet disc, electromagnetic

coupling, clutch and brake components include: springs, grids, elastomeric elements, friction pads, diaphragms

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: micrometers, hydraulic rams, pullers, torque wrenches, dial indicators, vernier calipers, laser alignment equipment, hand tools

C-11.04 Repairs couplings, clutches and brakes

Essential Skills	Thinking, Document Use, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-11.04.01P	access ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are accessed by removing safety guards and ***safety devices***
C-11.04.02P	rebuild or replace faulty ***couplings***, ***clutches*** and ***brakes***	faulty ***couplings***, ***clutches*** and ***brakes*** are rebuilt or replaced according to site and manufacturers' specifications, and engineered drawings
C-11.04.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to site and manufacturers' specifications
C-11.04.04P	dismantle, remove and reassemble ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are dismantled, removed and reassembled using match (witness) marks, and according to site and manufacturers' specifications, engineered drawings and jurisdictional regulations
C-11.04.05P	recondition ***couplings***, ***clutches*** and ***brakes*** and their ***components***	***couplings***, ***clutches*** and ***brakes*** and their ***components*** are reconditioned according to manufacturers' specifications, engineered drawings and jurisdictional regulations
C-11.04.06P	replace ***coupling, clutch and brake components***	***coupling, clutch and brake components*** are replaced according to manufacturers' specifications, engineered drawings and jurisdictional regulations

C-11.04.07P	adjust ***couplings***, ***clutches*** and ***brakes***	***couplings***, ***clutches*** and ***brakes*** are adjusted according to manufacturers' specifications and engineered drawings
C-11.04.08P	align ***coupling, clutch and brake components***	***coupling, clutch and brake components*** are aligned according to manufacturers' specifications and engineered drawings
C-11.04.09P	reinstall guards and ***safety devices***	guards and ***safety devices*** are reinstalled according to site and manufacturers' specifications and jurisdictional regulations
C-11.04.10P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

couplings include: rigid, elastomeric, grid, mechanical, fluid

clutches include: overrunning, friction, positive contact, fluid, electromagnetic

brakes include: friction, fluid/wet disc, electromagnetic

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

tools and equipment include: micrometers, hydraulic rams, pullers, torque wrenches, dial indicators, vernier calipers, laser alignment equipment, hand tools

coupling, clutch and brake components include: springs, grids, elastomeric elements, friction pads, diaphragms

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-11.04.01L	demonstrate knowledge of ***couplings***, ***clutches*** and ***brakes***, their ***components*** and operation	define terminology associated with ***couplings***, ***clutches*** and ***brakes***
		identify types of ***couplings***, ***clutches*** and ***brakes,*** their ***components*** and accessories, and describe their purpose, applications and operation
C-11.04.02L	demonstrate knowledge of ***safe work practices*** related to ***couplings***, ***clutches*** and ***brakes***	identify hazards and describe ***safe work practices*** associated with ***couplings***, ***clutches*** and ***brakes***
C-11.04.03L	demonstrate knowledge of the procedures used to repair ***couplings***, ***clutches*** and ***brakes***	interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***couplings***, ***clutches*** and ***brakes***
		identify ***tools and equipment*** used to repair ***couplings***, ***clutches*** and ***brakes*** and describe their applications and procedures

	identify the factors to consider when determining if ***couplings***, ***clutches*** and ***brakes*** or their ***components*** need to be repaired or replaced
	describe the procedures used to repair ***couplings***, ***clutches*** and ***brakes*** and their ***components***

RANGE OF VARIABLES

couplings include: rigid, elastomeric, grid, mechanical, fluid

clutches include: overrunning, friction, positive contact, fluid, electromagnetic

brakes include: friction, fluid/wet disc, electromagnetic

safe work practices include: company policies and procedures, jurisdictional regulations

coupling, clutch and brake components include: springs, grids, elastomeric elements, friction pads, diaphragms

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: micrometers, hydraulic rams, pullers, torque wrenches, dial indicators, vernier calipers, laser alignment equipment, hand tools

TASK C-12 Services chain and belt drive systems

TASK DESCRIPTOR

Chain and belt drive systems may be a component of a larger power transmission system. They transmit power and motion from one shaft to another and may be used to increase or reduce speed. Proper installation, alignment and maintenance are key to increasing the reliability of the system. Servicing includes installing, diagnosing, maintaining and repairing.

C-12.01 Installs chain and belt drive systems

Essential Skills	Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-12.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to site and manufacturers' specifications
C-12.01.02P	select ***chain*** and ***belt drive systems***	***chain*** and ***belt drive systems*** are selected according to engineered drawings and equipment application

C-12.01.03P	position ***chain*** and ***belt drive systems***	***chain*** and ***belt drive systems*** are positioned manually or with rigging, hoisting/lifting and moving equipment according to engineered drawings
C-12.01.04P	assemble ***chain*** and ***belt drive systems***	***chain*** and ***belt drive systems*** are assembled using ***tools and equipment*** according to manufacturers' specifications and engineered drawings
C-12.01.05P	align ***chain*** and ***belt drive systems***	***chain*** and ***belt drive systems*** are aligned with driven equipment according to site and manufacturers' specifications, and engineered drawings
C-12.01.06P	check and adjust slack/tension of ***chain*** and ***belt drive systems***	slack/tension of ***chain*** and ***belt drive systems*** are checked and adjusted according to manufacturers' specifications and engineered drawings
C-12.01.07P	lubricate chains	chains are lubricated according to site and manufacturers' specifications, and engineered drawings
C-12.01.08P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and ***jurisdictional regulations***
C-12.01.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

tools and equipment include: presses, tensioners, chain breakers, ropes, pullers, torque wrenches, straight edges, parallel shaft alignment tools, hand tools, belt tensioning tools

chain drive systems include: roller, silent, composite, lube free

belt drive systems include: v-belt, cog belt, timing, flat belt

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards, shear pins

formulae include: belt/chain lengths, speed and torque ratios, belt tension

components include: sprockets and sheaves, taper bushing, link (half link, off-set)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-12.01.01L	demonstrate knowledge of ***chain*** and ***belt drive systems***, their ***components*** and operation	define terminology associated with ***chain*** and ***belt drive systems***
		identify types of ***chain*** and ***belt drive systems*** and their ***components*** and accessories, and describe their purpose, applications and operation

C-12.01.02L	demonstrate knowledge of safety practices related to ***chain*** and ***belt drive systems***	identify hazards and describe safe work practices associated with ***chain*** and ***belt drive systems***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***chain*** and ***belt drive systems***
C-12.01.03L	demonstrate knowledge of the procedures used to install and align ***chain*** and ***belt drive systems***	identify ***tools and equipment*** used to install and align ***chain*** and ***belt drive systems*** and describe their applications and procedures
		describe the procedures used to install ***chain*** and ***belt drive systems*** and their ***components***
C-12.01.04L	demonstrate knowledge of ***formulae*** and calculations pertaining to ***chain*** and ***belt drive systems***	identify the factors to consider and required calculations to determine ***chain*** and ***belt drive systems*** requirements
		identify ***formulae*** and perform calculations

RANGE OF VARIABLES

chain drive systems include: roller, silent, composite, lube free

belt drive systems include: v-belt, cog belt, timing, flat belt

specifications include: torque, horsepower, loads, temperatures, rpm, shaft angles (incline or flat)

tools and equipment include: presses, tensioners, chain breakers, ropes, pullers, torque wrenches, straight edges, parallel shaft alignment tools, hand tools, belt tensioning tools

formulae include: belt/chain lengths, speed and torque ratios, belt tension

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards, shear pins

components include: sprockets and sheaves, taper bushing, link (half link, off-set)

C-12.02 Diagnoses chain and belt drive systems

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-12.02.01P	obtain a description of the problem and symptoms	a description of the problem and symptoms is obtained by ***sensory inspection*** or verbal communication
C-12.02.02P	perform ***sensory inspection*** of ***chain*** and ***belt drive systems***	***sensory inspection*** of ***chain*** and ***belt drive systems*** is performed to determine ***next steps***

C-12.02.03P	***test and evaluate chain*** and ***belt drive systems*** and alignment	***chain*** and ***belt drive systems*** and alignment are tested and evaluated according to site and manufacturers' specifications, and engineered drawings
C-12.02.04P	perform ***condition-based monitoring methods*** and analysis	***condition-based monitoring methods*** and analysis are performed to detect defects not identified through ***sensory inspection***
C-12.02.05P	verify chain lubrication level and condition	chain lubrication level and condition is verified according to site and manufacturers' specifications, and engineered drawings
C-12.02.06P	measure slack/tension of ***chain*** and ***belt drive systems***	slack/tension of ***chain*** and ***belt drive systems*** is measured according to site and manufacturers' specifications, and engineered drawings
C-12.02.07P	assess and detect faulty or damaged ***components***	faulty or damaged ***components*** are assessed and detected to determine ***next steps***

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for missing and loose parts, worn and damaged components

chain drive systems include: roller, silent, composite, lube free

belt drive systems include: v-belt, cog belt, timing, flat belt

next steps include: repair, replace, overhaul, adjust, continue operation

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-12.02.01L	demonstrate knowledge of ***chain*** and ***belt drive systems***, their ***components*** and operation	define terminology associated with ***chain*** and ***belt drive systems***
		identify types of ***chain*** and ***belt drive systems*** and their ***components*** and accessories, and describe their purpose, applications and operation
C-12.02.02L	demonstrate knowledge of safety practices related to ***chain*** and ***belt drive systems***	identify hazards and describe safe work practices associated with ***chain*** and ***belt drive systems***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***chain*** and ***belt drive systems***
C-12.02.03L	demonstrate knowledge of the procedures used to diagnose ***chain and belt drive systems***	identify ***tools and equipment*** used to diagnose ***chain*** and ***belt drive systems*** and describe their applications and procedures

		describe the procedures used to inspect and diagnose ***chain*** and ***belt drive systems*** and their components
		identify the factors to consider when determining if ***chain*** and ***belt drive systems*** need to be repaired or replaced
C-12.02.04L	demonstrate knowledge of formulae and calculations pertaining to ***chain*** and ***belt drive systems***	identify the factors to consider and required calculations to determine ***chain*** and ***belt drive systems*** requirements
		identify ***formulae*** and perform calculations

RANGE OF VARIABLES

chain drive systems include: roller, silent, composite, lube free, sprockets
belt drive systems include: v-belt, cog belt, timing, flat belt, sheaves
components include: sprockets and sheaves, taper bushing, link (half link, off-set)
tools and equipment include: straight edges, parallel shaft alignment tools, condition-based monitoring tools, hand tools, belt tensioning tools
formulae include: belt/chain lengths, speed and torque ratios, belt tension

C-12.03 Maintains chain and belt drive systems

Essential Skills	Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-12.03.01P	access ***chain*** and ***belt drive systems***	***chain*** and ***belt drive systems*** are accessed by removing guards and ***safety devices***, and ***components***
C-12.03.02P	clean, inspect, modify and adjust ***chain*** and ***belt drive systems***	***chain*** and ***belt drive systems*** are cleaned, inspected, modified and adjusted according to maintenance schedule using ***condition-based monitoring methods***, tension gauges and alignment tools according to site and manufacturers' specifications, and engineered drawings
C-12.03.03P	check lubricants	lubricants are checked and replaced according to site and manufacturers' specifications, engineered drawings and maintenance schedule

C-12.03.04P	check ***lubricant systems***	***lubricant systems*** are checked according to site and manufacturers' specifications, engineered drawings and maintenance schedule
C-12.03.05P	check condition of sprockets, sheaves, belts and chains	condition of sprockets, sheaves, belts and chains are checked according to site and manufacturers' specifications, engineered drawings and maintenance schedule
C-12.03.06P	check alignment of sprockets and sheaves	alignment of sprockets and sheaves are checked according to site and manufacturers' specifications, engineered drawings and maintenance schedule
C-12.03.07P	adjust ***chain*** and ***belt drive systems***	***chain*** and ***belt drive system*** slack/tension is adjusted according to site and manufacturers' specifications, engineered drawings and maintenance schedule
C-12.03.08P	reinstall machine guarding and ***safety devices***	machine guarding and ***safety devices*** are reinstalled according to site and manufacturers' specifications and jurisdictional regulations
C-12.03.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

chain drive systems include: roller, silent, composite, lube free

belt drive systems include: v-belt, cog belt, timing, flat belt

safety devices include: thermal protection, light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards, shear pins

components include: sprockets and sheaves, taper bushing, link (half link, off-set)

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

lubricant systems include: oil bath, drip, closed loop system, pressurized system, auto lube

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-12.03.01L	demonstrate knowledge of ***chain*** and ***belt drive systems***, their ***components*** and operation	define terminology associated with ***chain*** and ***belt drive systems***
		identify types of ***chain*** and ***belt drive systems***, their ***components***, accessories, and describe their purpose, applications and operation
C-12.03.02L	demonstrate knowledge of safety practices related to ***chain*** and ***belt drive systems***	identify hazards and describe safe work practices associated with ***chain*** and ***belt drive systems***

		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***chain*** and ***belt drive systems***
C-12.03.03L	demonstrate knowledge of the procedures used to maintain ***chain*** and ***belt drive systems***	identify tools and equipment used to maintain ***chain*** and ***belt drive systems*** and describe their applications and procedures
		identify the factors to consider when determining if ***chain*** and ***belt drive systems*** or their components need to be repaired, replaced or re-aligned
		describe the procedures used to maintain ***chain*** and ***belt drive systems*** and their components
		identify ***formulae*** and perform calculations
C-12.03.04L	demonstrate knowledge of formulae and calculations pertaining to ***chain*** and ***belt drive systems***	identify the factors to consider and required calculations to determine ***chain*** and ***belt drive systems*** requirements
		identify ***formulae*** and perform calculations

RANGE OF VARIABLES

chain drive systems include: roller, silent, composite, lube free
belt drive systems include: v-belt, cog belt, timing, flat belt
components include: sprockets and sheaves, taper bushing, link (half link, off-set)
formulae include: belt/chain lengths, speed and torque ratios, belt tension

C-12.04 Repairs chain and belt drive systems

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-12.04.01P	rebuild and replace faulty ***chain*** and ***belt drive systems***	faulty ***chain*** and ***belt drive systems*** are rebuilt and replaced according to site and manufacturers' specifications, and engineered drawings
C-12.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to site and manufacturers' specifications, and engineered drawings

C-12.04.03P	dismantle, remove and reassemble ***chain*** and ***belt drive systems***	***chain*** and ***belt drive systems*** are dismantled, removed and reassembled according to site and manufacturers' specifications, and engineered drawings
C-12.04.04P	access ***chain*** and ***belt drive systems***	***chain*** and ***belt drive systems*** are accessed by removing safety guards, ***safety devices***
C-12.04.05P	align ***components***	***components*** are aligned according to site and manufacturers' specifications, and engineered drawings
C-12.04.06P	lubricate chain	chain is lubricated according to site and manufacturers' specifications, and engineered drawings
C-12.04.07P	reinstall guards and ***safety devices***	guards and ***safety devices*** are reinstalled according to site and manufacturers' specifications, engineered drawings and jurisdictional regulations
C-12.04.08P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

chain drive systems include: roller, silent, composite, lube free

belt drive systems include: v-belt, cog belt, timing, flat belt, high torque drive (HTD)

tools and equipment include: hydraulic presses, pullers, torque wrenches and alignment tools, chain breakers, hand tools, belt tensioning tools

safety devices include: thermal protection, light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards, shear pins

components include: sprockets and sheaves, taper bushing, link (half link, off-set)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-12.04.01L	demonstrate knowledge of ***chain*** and ***belt drive systems***, their ***components*** and operation	define terminology associated with ***chain*** and ***belt drive systems***
		identify types of ***chain*** and ***belt drive systems*** and their ***components*** and accessories, and describe their purpose, applications and operation
C-12.04.02L	demonstrate knowledge of safety practices related to ***chain*** and ***belt drive systems***	identify hazards and describe safe work practices associated with ***chain*** and ***belt drive systems***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***chain*** and ***belt drive systems***

C-12.04.03L	demonstrate knowledge of the procedures used to repair ***chain*** and ***belt drive systems***	identify tools and equipment used to repair ***chain*** and ***belt drive systems*** and describe their applications and procedures
		identify the factors to consider when determining if ***chain*** and ***belt drive systems*** or their ***components*** need to be repaired or replaced
		describe the procedures used to repair ***chain*** and ***belt drive systems*** and their ***components***
		identify ***formulae*** and perform calculations
C-12.04.04L	demonstrate knowledge of formulas and calculations pertaining to ***chain*** and ***belt drive systems***	identify the factors to consider and required calculations to determine ***chain*** and ***belt drive systems*** requirements
		identify ***formulae*** and perform calculations

RANGE OF VARIABLES

chain drive systems include: roller, silent, composite, lube free
belt drive systems include: v-belt, cog belt, timing, flat belt, high torque drive (HTD)
components include: sprockets and sheaves, taper bushing, link (half link, off-set)
formulae include: belt/chain lengths, speed and torque ratios, belt tension

TASK C-13 Services gear systems

TASK DESCRIPTOR

Gear systems transmit torque, power, and rotary and linear movement from one component to another and may be used to increase or reduce speed and change rotational direction. Gear systems are used when there is a need for greater versatility such as speed control, shaft orientation and timing requirements. Servicing includes installing, diagnosing, maintaining and repairing.

C-13.01 Installs gear systems

Essential Skills	Numeracy, Working with Others, Thinking

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-13.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to site and manufacturers' specifications
C-13.01.02P	select gear systems	gear systems are selected according to site and manufacturers' specifications, engineered drawings and equipment application
C-13.01.03P	position gear systems	gear systems are positioned manually or with rigging, hoisting/lifting and moving equipment according to site and manufacturers' specifications, and engineered drawings
C-13.01.04P	assemble gear systems	gear systems are assembled using ***tools and equipment*** and by mechanical means according to site and manufacturers' specifications, and engineered drawings
C-13.01.05P	align gear systems with driven and driver equipment	gear systems are aligned with driven and driver equipment according to site and manufacturers' specifications, and engineered drawings
C-13.01.06P	check and adjust backlash and tooth contact	backlash and tooth contact is checked and adjusted according to manufacturers' specifications and engineered drawings
C-13.01.07P	lubricate gear systems	gear systems are lubricated according to site and manufacturers' specifications and engineered drawings

C-13.01.08P	install safety guards and ***safety devices***	safety guards and ***safety devices*** are installed according to site and manufacturers' specifications, engineered drawings and jurisdictional regulations
C-13.01.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

tools and equipment include: presses, hydraulic jacks, torque wrenches, jacks, alignment tools, mechanics' blue, plasti-gauge, dial indicators, calipers, micrometers, hand tools, strobe lights

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards, shear pins

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-13.01.01L	demonstrate knowledge of ***gears*** and ***gear drives***, their components and operation	define terminology associated with ***gears*** and ***gear drives***
		identify types of ***gears*** and ***gear drives*** and their components and accessories, and describe their purpose, applications and operation
C-13.01.02L	demonstrate knowledge of safety practices related to ***gears*** and ***gear drives***	identify hazards and describe safe work practices associated with ***gears*** and ***gear drives***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***gears*** and ***gear drives***
C-13.01.03L	demonstrate knowledge of the procedures used to install and align ***gears*** and ***gear drives***	identify ***tools and equipment*** used to install ***gears*** and ***gear drives*** and describe their applications and procedures
		describe the procedures used to install and align ***gears*** and ***gear drives*** and their components
C-13.01.04L	demonstrate knowledge of gear engagement procedures	identify tools and equipment used to set backlash and tooth contact
		describe the procedures used to set backlash and tooth contact
C-13.01.05L	demonstrate knowledge of formulae and calculations pertaining to ***gears*** and ***gear drives***	identify the factors to consider and required calculations to determine ***gears*** and ***gear drives*** requirements
		identify ***formulae*** and perform calculations

RANGE OF VARIABLES

gears include: spur, bevel, spiral, herringbone, helical, worm
gear drives include: planetary, worm, parallel shaft, crown and pinion, rack and pinion
tools and equipment include: presses, hydraulic jacks, torque wrenches, jacks, alignment tools, mechanics' blue, plasti-gauge, dial indicators, calipers, micrometers, hand tools, strobe lights
formulae include: diametrical pitch, pitch diameter, gear ratios

C-13.02 Diagnoses gear systems

Essential Skills Thinking, Numeracy, Document Use

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-13.02.01P	obtain a description of the problem and symptoms	a description of the problem and symptoms is obtained
C-13.02.02P	perform ***sensory inspection*** of gear systems	***sensory inspection*** of gear systems is performed to determine ***next steps***
C-13.02.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to site and manufacturers' specifications and engineered drawings
C-13.02.04P	test and evaluate gear systems	gear systems are tested and evaluated according to site and manufacturers' specifications and engineered drawings
C-13.02.05P	perform ***condition-based monitoring methods*** and analysis	***condition-based monitoring methods*** and analysis are performed to detect ***defects*** not identified through ***sensory inspection***
C-13.02.06P	verify lubrication level and condition	lubrication level and condition are verified according to site and manufacturers' specifications and engineered drawings
C-13.02.07P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, engineered drawings, and jurisdictional regulations

C-13.02.08P	measure clearance, backlash and tooth contact of gear systems	clearance, backlash and tooth contact of gear systems are measured according to manufacturers' specifications and engineered drawings
C-13.02.09P	assess and detect faulty or damaged components	faulty or damaged components are assessed and detected to determine ***next steps*** according to site and manufacturers' specifications and engineered drawings

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for missing and loose parts, worn and damaged components

next steps include: repair, replace, overhaul, adjust, continue operation

tools and equipment include: dial indicators, feeler gauges, laser alignment tool, micrometer, plasti-gauge, mechanics' blue, lead wire

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards, shear pins

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-13.02.01L	demonstrate knowledge of ***gears*** and ***gear drives***, their components and operation	define terminology associated with ***gears*** and ***gear drives***
		identify types of ***gears*** and ***gear drives*** and their components and accessories, and describe their purpose, applications and operation
C-13.02.02L	demonstrate knowledge of safety practices related to ***gears*** and ***gear drives***	identify hazards and describe safe work practices associated with ***gears*** and ***gear drives***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***gears*** and ***gear drives***
C-13.02.03L	demonstrate knowledge of the procedures used to diagnose ***gears*** and ***gear drives***	identify tools and equipment used to diagnose ***gears*** and ***gear drives*** and describe their applications and procedures
		describe the procedures used to inspect ***gears*** and ***gear drives*** and their components
		describe the procedures used to diagnose ***gears*** and ***gear drives*** and their components

		identify the ***factors*** to consider when determining if ***gears, gear drives*** or their ***components*** need to be repaired or replaced
C-13.02.04L	demonstrate knowledge of formulae and calculations pertaining to ***gears*** and ***gear drives***	identify the factors to consider and required calculations to determine ***gears*** and ***gear drives*** requirements
		identify ***formulae*** and perform calculations

RANGE OF VARIABLES

gears include: spur, bevel, spiral, herringbone, helical, worm
gear drives include: planetary, worm, parallel shaft, crown and pinion
factors include: condition-based monitoring reports (worn bearings, gear pass frequency, tribology)
formulae include: diametrical pitch, pitch diameter, gear ratios

C-13.03 Maintains gear systems

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-13.03.01P	access gear systems	gear systems are accessed by removing guards, inspection ports, covers and ***safety devices***
C-13.03.02P	clean, inspect, modify and adjust gear systems	gear systems are cleaned, inspected, modified and adjusted according to maintenance schedule, site and manufacturers' specifications using ***condition-based monitoring methods*** and alignment tools
C-13.03.03P	check vents, lubricants and seals	vents, lubricants and seals are checked according to site and manufacturers' specifications, engineered drawings, and maintenance schedule
C-13.03.04P	check condition of gear systems	condition of gear systems and components are checked according to site and manufacturers' specifications, engineered drawings, and maintenance schedule

C-13.03.05P	check alignment, backlash, clearance and tooth contact of gear systems	alignment, backlash, clearance and tooth contact of gear systems are checked according to manufacturers' specifications, engineered drawings, and maintenance schedule
C-13.03.06P	reinstall machine guarding and ***safety devices***, ports and covers	machine guarding, ***safety devices***, ports and covers are reinstalled according to site and manufacturers' specifications and jurisdictional regulations
C-13.03.07P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards, shear pins

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-13.03.01L	demonstrate knowledge of ***gears*** and ***gear drives***, their components and operation	define terminology associated with ***gears*** and ***gear drives***
		identify types of ***gears*** and ***gear drives*** and their components and accessories, and describe their purpose, applications and operation
C-13.03.02L	demonstrate knowledge of safety practices related to ***gears*** and ***gear drives***	identify hazards and describe safe work practices associated with ***gears*** and ***gear drives***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***gears*** and ***gear drives***
C-13.03.03L	demonstrate knowledge of the procedures used to maintain ***gears*** and ***gear drives***	identify ***tools and equipment*** used to maintain ***gears*** and ***gear drives*** and describe their applications and procedures
		identify the ***factors*** to consider when determining if ***gears*** and ***gear drives*** or their components need to be repaired or replaced
		describe the procedures used to maintain ***gears*** and ***gear drives*** and their components

C-13.03.04L	demonstrate knowledge of formulae and calculations pertaining to ***gears*** and ***gear drives***	identify the factors to consider and required calculations to determine ***gears*** and ***gear drives*** requirements
		identify ***formulae*** and perform calculations

RANGE OF VARIABLES

gears include: spur, bevel, spiral, herringbone, helical, worm

gear drives include: planetary, worm, parallel shaft, crown and pinion, rack and pinion

tools and equipment include: dial indicators, feeler gauges, laser alignment tool, micrometer, plasti-gauge, mechanics' blue, lead wire, hand tools

factors include: condition-based monitoring reports (worn bearings, tribology, gear pass frequency)

formulae include: diametrical pitch, pitch diameter, gear ratios

C-13.04 Repairs gear systems

Essential Skills Working with Others, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-13.04.01P	rebuild and replace faulty gear systems	faulty gear systems are rebuilt and replaced according to site and manufacturers' specifications and engineered drawings
C-13.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to manufacturers' specifications and engineered drawings
C-13.04.03P	access gear systems	gear systems are accessed by removing safety guards, ***safety devices***, ports and covers, and lubricant according to site and manufacturers' specifications, and engineered drawings
C-13.04.04P	dismantle, remove and reassemble gear systems	gear systems are dismantled, removed and reassembled according to site and manufacturers' specifications, and engineered drawings
C-13.04.05P	replace and align ***gears*** and gear systems	***gears*** and gear systems are replaced and aligned according to site and manufacturers' specifications, and engineered drawings

C-13.04.06P	adjust ***gears***, backlash, clearance and tooth contact	***gears***, backlash, clearance and tooth contact are adjusted according to site and manufacturers' specifications, and engineered drawings
C-13.04.07P	lubricate ***gears***	***gears*** are lubricated according to site and manufacturers' specifications, and engineered drawings and maintenance schedule
C-13.04.08P	reinstall guards, ***safety devices***, ports and covers	guards, ***safety devices***, ports and covers are reinstalled according to site and manufacturers' specifications, engineered drawings and jurisdictional regulations
C-13.04.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

tools and equipment include: torque wrenches, jacks, alignment tools, feeler gauges, mechanics' blue, plasti-gauge, hand tools

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards, shear pins

gears include: spur, bevel, spiral, herringbone, helical, worm

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-13.04.01L	demonstrate knowledge of ***gears*** and ***gear drives***, their components and operation	define terminology associated with ***gears*** and ***gear drives***
		identify types of ***gears*** and ***gear drives*** and their components and accessories, and describe their purpose, applications and operation
C-13.04.02L	demonstrate knowledge of safety practices related to ***gears*** and ***gear drives***	identify hazards and describe safe work practices associated with ***gears*** and ***gear drives***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***gears*** and ***gear drives***
C-13.04.03L	demonstrate knowledge of the procedures used to repair ***gears*** and ***gear drives***	identify ***tools and equipment*** used to repair ***gears*** and ***gear drives*** and describe their applications and procedures
		identify the ***factors*** to consider when determining if ***gears*** and ***gear drives*** or their components need to be repaired or replaced

		describe the procedures used to repair ***gears*** and ***gear drives*** and their components
C-13.04.04L	demonstrate knowledge of formulae and calculations pertaining to ***gears*** and ***gear drives***	identify the factors to consider and required calculations to determine ***gears*** and ***gear drives*** requirements
		identify ***formulae*** and perform calculations

RANGE OF VARIABLES

gears include: spur, bevel, spiral, herringbone, helical, worm

gear drives include: planetary, worm, parallel shaft, crown and pinion, rack and pinion

tools and equipment include: torque wrenches, jacks, alignment tools, feeler gauges, mechanics' blue, plasti-gauge, hand tools

factors include: condition-based monitoring reports (worn bearings, tribology, gear pass frequency)

TASK C-14 Performs shaft alignment procedures

TASK DESCRIPTOR

Alignment procedures are performed to ensure the three dimensional geometry and increase the operating lifespan of rotating equipment. For the purpose of this standard, this task only addresses shaft collinear alignment as the rotational alignment of equipment is performed throughout their respective installation and maintenance tasks.

C-14.01 Performs rough alignment

Essential Skills	Thinking, Document Use, Oral Communication

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
C-14.01.01P	inspect equipment	equipment is inspected for ***defects***
C-14.01.02P	select and use ***rough alignment tools***	***rough alignment tools*** are selected and used to determine degree of misalignment
C-14.01.03P	identify cause of misalignment in equipment	cause of misalignment in equipment is identified to determine ***corrective action***

C-14.01.04P	correct vertical, horizontal and angular misalignment	vertical, horizontal and angular misalignment is corrected by shimming and by adjusting the position of the driver/driven equipment
C-14.01.05P	record alignment data	alignment data is recorded to demonstrate compliance according to job requirements

RANGE OF VARIABLES

defects include: loose fasteners, cracked foundations, pipe strain, damaged housings, soft foot, shaft run-out, end float, defective bearings

rough shaft alignment tools include: straight edge, feeler gauge, taper gauge, level

corrective action include: replacement, repair, adjustment

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-14.01.01L	demonstrate knowledge of ***shaft alignment***	define terminology associated with ***shaft alignment methods***
		identify tools and equipment used for ***shaft alignment methods***, and describe their applications and procedures
		describe the procedures used to determine shaft misalignment
C-14.01.02L	demonstrate knowledge of the ***procedures*** used to align shafts	identify the types of rough alignment methods and describe their applications and limitations
		describe the procedures used to calculate shims for hot or cold alignment
		describe the ***procedures*** used to align shafts using the straight edge and feeler gauge method
C-14.01.03L	demonstrate knowledge of safety practices related to shaft alignment	identify hazards and describe safe work practices pertaining to shaft alignment

RANGE OF VARIABLES

shaft alignment is ***only*** collinear alignment

shaft alignment methods include: rough, dial, laser

procedures include: pre-alignment checks, selecting tools and equipment, making adjustments

C-14.02 Performs dial alignment

Essential Skills	Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-14.02.01P	inspect equipment	equipment is inspected for ***defects***
C-14.02.02P	select and use ***dial alignment tools***	***dial alignment tools*** are selected and used to determine degree of misalignment
C-14.02.03P	identify cause of misalignment in equipment	cause of misalignment in equipment is identified to determine ***corrective action***
C-14.02.04P	correct vertical, horizontal and angular misalignment	vertical, horizontal and angular misalignment is corrected by shimming and by adjusting the position of the driver/driven equipment
C-14.02.05P	record alignment data	alignment data is recorded to demonstrate compliance according to site and manufacturers' specifications

RANGE OF VARIABLES

defects include: loose fasteners, cracked foundations, pipe strain, damaged housings, soft foot, shaft run-out, end float, defective bearings

dial alignment tools include: mag bases, dial indicators, contact points, feeler gauges, straightedges, tape measure

corrective action include: replacement, repair, adjustment

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-14.02.01L	demonstrate knowledge of shaft alignment	define terminology associated with ***shaft alignment methods***
		identify tools and equipment used for ***dial alignment methods***, and describe their applications and procedures
		describe the procedures used to determine shaft misalignment
C-14.02.02L	demonstrate knowledge of the ***procedures*** used to align shafts by ***methods***	identify the types of ***dial alignment methods*** and describe their applications and limitations
		describe the procedures used to calculate shims for hot or cold alignment

		describe the ***procedures*** used to align shafts using the ***dial alignment methods***
C-14.02.03L	demonstrate knowledge of safety practices related to shaft alignment	identify hazards and describe safe work practices pertaining to shaft alignment

RANGE OF VARIABLES

shaft alignment methods include: rough, dial, laser, optical alignment

dial alignment tools include: mag bases, dial indicators, contact points, feeler gauges, straightedges, tape measure

procedures include: doing pre-alignment checks, selecting tools and equipment, performing calculations, making adjustments

dial alignment methods include: rim and face, reverse dial, cross dial

C-14.03 Performs laser alignment

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-14.03.01P	inspect equipment	equipment is inspected for ***defects***
C-14.03.02P	select and use ***laser alignment tools***	***laser alignment tools*** are selected and used to determine degree of misalignment
C-14.03.03P	identify cause of misalignment in equipment	cause of misalignment in equipment is identified to determine ***corrective action***
C-14.03.04P	correct vertical, horizontal and angular misalignment	vertical, horizontal and angular misalignment is corrected by shimming and by adjusting the position of the driver/driven equipment
C-14.03.05P	record alignment data	alignment data is recorded to demonstrate compliance according to site and manufacturers' specifications

RANGE OF VARIABLES

defects include: loose fasteners, cracked foundations, pipe strain, damaged housings, soft foot, shaft run-out, end float

laser alignment tools include: laser alignment devices

corrective action include: replacement, repair, adjustment

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-14.03.01L	demonstrate knowledge of shaft alignment	define terminology associated with ***shaft alignment methods***
		identify tools and equipment used for ***shaft alignment methods***, and describe their applications and procedures
		describe the procedures used to determine shaft misalignment
C-14.03.02L	demonstrate knowledge of the ***procedures*** used to align shafts	identify the types of laser alignment methods and describe their applications and limitations
		describe the procedures used to calculate shims for hot or cold alignment
		describe the ***procedures*** used to align shafts using the laser methods
C-14.03.03L	demonstrate knowledge of safety practices related to shaft alignment	identify hazards and describe safe work practices pertaining to shaft alignment

RANGE OF VARIABLES

shaft alignment methods include: rough, dial, laser

procedures include: doing pre-alignment checks, selecting tools and equipment, performing calculations, making adjustments

MAJOR WORK ACTIVITY D

Services material handling / process systems

TASK D-15 Services robotics and automated equipment

TASK DESCRIPTOR

Robotics and automated equipment are machines that can be used in dangerous environments, under heavy loads, high repetition in manufacturing processes. They include a wide range of components and sub-components designated by type of movement (degrees of freedom after application), application (manufacturing process), architecture (serial or parallel), and brand. They must be installed correctly and maintained properly to provide specialized automated services. Servicing includes installing, diagnosing, maintaining and repairing.

D-15.01 Installs robotics and automated equipment

Essential Skills Thinking, Numeracy, Document Use

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-15.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to site and manufacturers' specifications, and jurisdictional regulations
D-15.01.02P	determine location and elevation for installation	location and elevation for installation is determined according to site and manufacturers' specifications and engineered drawings
D-15.01.03P	prepare foundation	foundation is prepared according to engineered drawings and manufacturers' specifications
D-15.01.04P	prepare base, base plates and structure	base, base plates and structure are prepared using ***methods*** according to site and manufacturers' specifications and engineered drawings

D-15.01.05P	prepare and inspect ***robotics*** and ***automated equipment***	***robotics*** and ***automated equipment*** are prepared and inspected for installation according to site and manufacturers' specifications and engineered drawings
D-15.01.06P	position ***robotics*** and ***automated equipment***	***robotics*** and ***automated equipment*** are positioned manually or with rigging, hoisting/lifting and moving equipment according to manufacturers' specifications, engineered drawings and jurisdictional regulations
D-15.01.07P	secure, level and align ***robotics*** and ***automated equipment***	***robotics*** and ***automated equipment*** are secured, leveled and aligned according to site and manufacturers' specifications, and engineered drawings and jurisdictional regulations
D-15.01.08P	install ***auxiliary systems***	***auxiliary systems*** are installed according to site and manufacturers' specifications and engineered drawings, jurisdictional regulations, and procedures
D-15.01.09P	verify complete range of movement	range of movement is checked by performing ***tests***
D-15.01.10P	connect ***robotics*** and ***automated equipment*** with ***controller***	***robotics*** and ***automated equipment*** are connected with ***controller*** using ***components*** according to site and manufacturers' specifications, and engineered drawings
D-15.01.11P	install ***safety guards*** and ***safety devices***	***safety guards*** and ***safety devices*** are installed according to site and manufacturers' specifications, engineered drawings and jurisdictional regulations
D-15.01.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
D-15.01.13P	verify functionality of ***safety devices***	***safety device*** functionality is verified according to site and manufacturers' specifications, engineered drawings and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: rigging and hoisting equipment, hand tools, alignment tools

methods include: installation techniques, alignment

robotics include: 3-axis, 6-axis, 7-axis, end of arm tooling (EOAT), grippers and effectors, Selective Compliance Assembly Robot Arm (SCARA), side entry

automated equipment includes: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)

auxiliary systems include: wire feeders, articulating fingers, filtering systems, tip cleaners, tip changers

tests include: bump (either energized or manual), energized, manual (range of motion, interference)

controllers include: host, network, PLC (programmable logic controller), mainframe

components include: servo motors, fluid power hoses and pistons, sensors, encoders

safety guards include: covers, screens, inspection doors, portals

safety devices include: light curtain, overtravel, overload, heat detectors, emergency stop, laser grids, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-15.01.01L	demonstrate knowledge of ***robotics*** and ***automated equipment***, their ***components*** and operation	define terminology associated with ***robotics*** and ***automated equipment***
		identify ***classifications for robotics and automated equipment*** and their ***components***, and ***auxiliary equipment***, and describe their purpose, applications and operation
D-15.01.02L	demonstrate knowledge of safety practices related to ***robotics*** and ***automated equipment***	identify hazards and describe ***safe work practices*** associated with ***robotics*** and ***automated equipment***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***robotics*** and ***automated equipment***
D-15.01.03L	demonstrate knowledge of the procedures used to install ***robotics*** and ***automated equipment***	identify ***tools and equipment*** used to install ***robotics*** and ***automated equipment*** and describe their applications and procedures
		describe the procedures used to install ***robotics*** and ***automated equipment*** and their ***components***

RANGE OF VARIABLES

robotics include: 3-axis, 6-axis, 7-axis, end of arm tooling (EOAT), grippers and effectors, SCARA, side entry

automated equipment includes: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)

components include: servo motors, fluid power hoses and pistons, sensors, encoders

classifications for robotics and automated equipment include: type of movement (degrees of freedom after application), application (manufacturing process), architecture (serial or parallel), brand

auxiliary equipment includes: wire feeders, articulating fingers, filtering systems

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: rigging and hoisting equipment, hand tools, alignment tools

D-15.02 Diagnoses robotics and automated equipment

Essential Skills Digital Technology, Thinking, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-15.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
D-15.02.02P	perform ***sensory inspection*** of ***robotics*** and ***automated equipment*** for ***defects***	***sensory inspection*** is performed to determine ***next steps***
D-15.02.03P	perform ***condition-based monitoring methods*** and analysis	***condition-based monitoring methods*** and analysis are performed to detect defects not identified through ***sensory inspection***
D-15.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications
D-15.02.05P	test and evaluate ***robotics*** and ***automated equipment***	***robotics*** and ***automated equipment*** are tested and evaluated by using specialized equipment and referring to site and manufacturers' specifications
D-15.02.06P	inspect robotics and automated equipment ***components***	robotics and automated equipment ***components*** are inspected for ***defects*** and to determine ***next steps***

D-15.02.07P	remove and replace ***safety guards*** and ***safety devices***	***safety guards*** and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
D-15.02.08P	detect and assess faulty or damaged equipment	faulty or damaged equipment is assessed and detected to determine repair or replacement

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, temperature, looking for excessive wear, stress indications, corrosion and looseness

robotics include: 3-axis, 6-axis, 7-axis, end of arm tooling (EOAT), grippers and effectors, SCARA, side entry

automated equipment includes: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)

defects include: excessive wear, corrosion, looseness

next steps include: repair, replace, overhaul, adjust, continue operation

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

tools and equipment include: (varies based on the size and type of robotic equipment) rigging and hoisting equipment, hand tools, alignment tools

components include: servo motors, fluid power hoses and pistons, sensors, encoders

safety guards include: covers, screens, inspection doors and portals

safety devices include: light curtain, overtravel, overload, heat detectors, e-stop, vibration sensors, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-15.02.01L	demonstrate knowledge of ***robotics*** and ***automated equipment***, their ***components*** and operation	define terminology associated with ***robotics*** and ***automated equipment***
		identify ***classifications for robotics*** and ***automated equipment*** and their ***components*** and describe their purpose, applications and operation
D-15.02.02L	demonstrate knowledge of safety practices related to ***robotics*** and ***automated equipment***	identify hazards and describe ***safe work practices*** associated with ***robotics*** and ***automated equipment***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***robotics and automated equipment***
D-15.02.03L	demonstrate knowledge of the procedures used to diagnose ***robotics*** and ***automated equipment***	identify ***tools and equipment*** used to maintain ***robotics*** and ***automated equipment*** and describe their applications and procedures

	describe the procedures used to inspect ***robotics*** and ***automated equipment*** and their components
	describe the procedures used to diagnose ***robotics*** and ***automated equipment*** and their components
	identify the factors to consider when determining if ***robotics*** and ***automated equipment*** need to be repaired or replaced

RANGE OF VARIABLES

robotics include: 3-axis, 6-axis, 7-axis, end of arm tooling (EOAT), grippers and effectors, SCARA, side entry

automated equipment includes: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)

components include: servo motors, fluid power hoses and cylinders, sensors, encoders, transducers

classifications for robotics and automated equipment include: type of movement (degrees of freedom after application), application (manufacturing process), architecture (serial or parallel), brand

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: (varies based on the size and type of robotic equipment) rigging and hoisting equipment, hand tools, alignment tools

D-15.03 Maintains robotics and automated equipment

Essential Skills	Digital Technology, Numeracy, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-15.03.01P	inspect, modify and adjust ***robotics*** and ***automated equipment***	***robotics*** and ***automated equipment*** are inspected, modified and adjusted according to site and manufacturers' specifications, and to the maintenance schedule using ***condition-based monitoring methods***
D-15.03.02P	use ***tools and equipment***	***tools and equipment*** are used according to job requirements and manufacturers' specifications
D-15.03.03P	align ***components***	***components*** are aligned according to manufacturers' specifications

D-15.03.04P	check coolant and lubricant levels, packing, seals and ***safety devices***	coolant and lubricant levels, packing, seals and ***safety devices*** are checked according to manufacturers' specifications and maintenance schedule
D-15.03.05P	monitor temperature, vibration, range of movement and pressure	temperature, vibration, range of movement and pressure are monitored according to manufacturers' specifications and maintenance schedule
D-15.03.06P	check automatic bearing and seal lubrication systems	automatic bearing and seal lubrication systems are checked according to site and manufacturers' specifications and maintenance schedule
D-15.03.07P	adjust flow and pressure controls	flow and pressure controls for robotics and automated equipment are adjusted according to manufacturers' specifications and maintenance schedules
D-15.03.08P	remove and replace ***safety guards*** and ***safety devices***	***safety guards*** and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
D-15.03.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
D-15.03.10P	identify faulty or damaged equipment	faulty or damaged equipment is identified to determine repair or replacement according to site specifications
D-15.03.11P	tag and report faulty or damaged equipment	faulty or damaged equipment is tagged and reported according to site specifications and jurisdictional regulations

RANGE OF VARIABLES

robotics include: 3-axis, 6-axis, 7-axis, end of arm tooling (EOAT), grippers and effectors, SCARA, side entry

automated equipment includes: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

tools and equipment include: (varies based on the size and type of robotic equipment) rigging and hoisting equipment, hand tools, alignment tools

components include: servo motors, fluid power hoses and pistons, sensors, encoders

safety devices include: light curtain, overtravel, overload, heat detectors, e-stop, pressure mats, lock-outs, physical guards

safety guards include: covers, screens, inspection doors and portals

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-15.03.01L	demonstrate knowledge of ***robotics*** and ***automated equipment***, their ***components*** and operation	define terminology associated with ***robotics*** and ***automated equipment***
		identify ***classifications for robotics and automated equipment*** and their ***components***, and describe their purpose, applications and operation
D-15.03.02L	demonstrate knowledge of safety practices related to ***robotics*** and ***automated equipment***	identify hazards and describe ***safe work practices*** associated with ***robotics*** and ***automated equipment***
		interpret jurisdictional regulations, site and manufacturers' specifications pertaining to the use of ***robotics*** and ***automated equipment***
D-15.03.03L	demonstrate knowledge of the procedures used to maintain and diagnose ***robotics*** and ***automated equipment***	identify tools and equipment used to maintain ***robotics*** and ***automated equipment*** and describe their applications and procedures
		identify the factors to consider when determining if ***robotics*** and ***automated equipment*** or their ***components*** need to be repaired or replaced
		describe the procedures used to maintain ***robotics*** and ***automated equipment*** and their ***components***
		describe the procedures used to diagnose ***robotics*** and ***automated equipment*** and their ***components***

RANGE OF VARIABLES

robotics include: 3-axis, 6-axis, 7-axis, end of arm tooling (EOAT), grippers and effectors, SCARA, side entry

automated equipment includes: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)

classifications for robotics and automated equipment include: type of movement (degrees of freedom after application), application (manufacturing process), architecture (serial or parallel), brand

components include: servo motors, fluid power hoses and pistons, sensors, encoders

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

auxiliary equipment includes: wire feeders, articulating fingers, filtering systems

D-15.04 Repairs robotics and automated equipment

Essential Skills	Numeracy, Thinking, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-15.04.01P	access ***robotics*** and ***automated equipment***	***robotics*** and ***automated equipment*** are accessed by removing ***components***
D-15.04.02P	dismantle and remove ***robotics*** and ***automated equipment*** and ***components***	***robotics*** and ***automated equipment*** and ***components*** are dismantled and removed according to manufacturers' specifications using tools and procedures and match (witness) marks
D-15.04.03P	use ***tools and equipment***	***tools and equipment*** are used according to job requirements and manufacturers' specifications
D-15.04.04P	prepare ***robotics*** and ***automated equipment*** for repair	***robotics*** and ***automated equipment*** are prepared for repair using various ***methods***
D-15.04.05P	size and replace seals, bearings and power transmission devices	seals, bearings and power transmission devices are sized and replaced according to manufacturers' specifications
D-15.04.06P	inspect and repair zero backlash devices	zero backlash devices are inspected and repaired according to engineering and manufacturers' specifications
D-15.04.07P	replace faulty ***components*** and ***auxiliary equipment***	faulty ***components*** and ***auxiliary equipment*** are replaced according to site and manufacturers' specifications and match (witness) marks
D-15.04.08P	verify complete range of movement	range of movement is checked by performing various ***tests***
D-15.04.09P	align ***components***	***components*** are aligned according to manufacturers' specifications
D-15.04.10P	reinstall machine guarding and ***safety devices***	machine guarding and ***safety devices*** are reinstalled according to site and manufacturers' specifications, and jurisdictional regulations

D-15.04.11P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
D-15.04.12P	tag and report faulty or damaged equipment	faulty or damaged equipment is tagged and reported according to site specifications and jurisdictional regulations

RANGE OF VARIABLES

robotics include: 3-axis, 6-axis, 7-axis, end of arm tooling (EOAT), grippers and effectors, SCARA, side entry

automated equipment includes: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)

components include: servo motors, fluid power hoses and pistons, sensors, encoders

tools and equipment include: (varies based on the size and type of robotic equipment) rigging and hoisting equipment, hand tools, alignment tools

methods include: manufacturers' or engineer's recommendations and procedures

auxiliary equipment includes: wire feeders, articulating fingers, filtering systems

tests include: bump (either energized or manual), energized, manual (range of motion, interference)

safety devices include: light curtain, overtravel, overload, heat detectors, e-stop, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-15.04.01L	demonstrate knowledge of ***robotics*** and ***automated equipment***, their ***components*** and operation	define terminology associated with ***robotics*** and ***automated equipment***
		identify ***classifications for robotics and automated equipment*** and their ***components***, and describe their purpose, applications and operation
D-15.04.02L	demonstrate knowledge of safety practices related to ***robotics*** and ***automated equipment***	identify hazards and describe ***safe work practices*** associated with ***robotics*** and ***automated equipment***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***robotics and automated equipment***
D-15.04.03L	demonstrate knowledge of the procedures used to repair ***robotics*** and ***automated equipment***	identify ***tools and equipment*** used to repair ***robotics*** and ***automated equipment*** and describe their applications and procedures

	identify the ***factors*** to consider when determining if ***robotics*** and ***automated equipment*** or their ***components*** need to be repaired or replaced
	describe the procedures used to repair ***robotics*** and ***automated equipment*** and their ***components***

RANGE OF VARIABLES

robotics include: 3-axis, 6-axis, 7-axis, end of arm tooling (EOAT), grippers and effectors, SCARA, side entry

automated equipment includes: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)

classifications for robotics and automated equipment include: type of movement (degrees of freedom after application), application (manufacturing process), architecture (serial or parallel), brand

components include: servo motors, fluid power hoses and pistons, sensors, encoders

safe work practices include: zero-energy state, immobilization and isolation procedures

tools and equipment include: (varies based on the size and type of robotic equipment) rigging and hoisting equipment, hand tools, alignment tools

factors include: component lifecycle, time, fatigue, maintenance history

TASK D-16 Services fans and blowers

TASK DESCRIPTOR

Fans move air and material from various sources such as fresh air, and heating and cooling applications. Blowers supply pressurized air to transfer product such as woodchips, waste, exhaust gases and dust. The failure of fans and blowers can result in safety issues and lost productivity when not installed, maintained and repaired properly. Servicing includes installing, diagnosing, maintaining and repairing.

D-16.01 Installs fans and blowers

Essential Skills	Document Use, Thinking, Numeracy

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-16.01.01P	use ***safe work practices*** related to installation of fans and blowers	***safe work practices*** related to installation of fans and blowers are used
D-16.01.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements

D-16.01.03P	determine location and elevation for installation	location and elevation for installation is determined according to site specifications and engineered drawings
D-16.01.04P	clean and rough up base for fan or blower using various ***methods***	base for fan or blower is cleaned and roughed up using ***methods*** according to manufacturers' specifications
D-16.01.05P	prepare foundation	foundation is prepared according to site specifications and engineered drawings
D-16.01.06P	position fan or blower in place using rigging, hoisting/lifting and moving equipment	fan or blower is positioned in place using rigging, hoisting/lifting and moving equipment
D-16.01.07P	level, align and secure fans and blowers	fans and blowers are leveled, aligned and secured according to site and manufacturers' specifications, and engineered drawings
D-16.01.08P	grout to distribute load and minimize vibration	load is distributed and vibration is minimized by grouting
D-16.01.09P	check rotation, static and dynamic balance, and vibration	rotation, static and dynamic balance, and vibration is checked and compared to manufacturers' specifications and plant requirements
D-16.01.10P	connect inlet/outlet	inlet/outlet is connected according to manufacturers' specifications, engineered drawings and plant requirements, and to jurisdictional regulations
D-16.01.11P	connect and align fans and blowers to driver	fans and blowers are connected and aligned to driver by using ***appropriate processes***
D-16.01.12P	install safety guards and ***safety devices***	safety guards and ***safety devices*** are installed according to site and manufacturers' specifications, and jurisdictional regulations
D-16.01.13P	energize equipment, start it up and return to operation	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: hand tools, dial indicators, precision levels, optical or laser alignment equipment, hydraulic rams, rigging/lifting equipment

methods include: filing, sandblasting and buffing

appropriate processes include: co-linear shaft alignment, parallel shaft alignment

safety devices include: interlocking devices, heat shields, guards, access covers, screens, inspection doors, portals, sensors (heat, motion, vibration), barriers, electronic eyes, amperage meters, electronic overloads, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-16.01.01L	demonstrate knowledge of fans and blowers, their components and operation	define terminology associated with fans and blowers
D-16.01.02L	demonstrate knowledge of ***safe work practices*** related to fans and blowers	identify hazards and describe ***safe work practices*** pertaining to fans and blowers
D-16.01.03L	demonstrate knowledge of the procedures used to remove and install fans and blowers	interpret jurisdictional regulations and manufacturers' specifications pertaining to fans and blowers
		identify ***tools and equipment*** used to remove and install fans and blowers, and describe their applications and procedures
		identify types of fans and blower systems, and describe their components and operation
		identify types of fan blades and describe their applications
		describe the procedures used to remove and install fans and blowers
		describe the procedures used to regulate output for fans and blowers
		describe the procedures used to balance fans and blowers

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: hand tools, dial indicators, precision levels, optical or laser alignment equipment, hydraulic rams, rigging/lifting equipment

D-16.02 Diagnoses fans and blowers

Essential Skills Thinking, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-16.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained by ***sensory inspection*** or verbal communication
D-16.02.02P	perform ***sensory inspection*** of ***components*** for defects	***sensory inspection*** of ***components*** is performed to determine ***next steps***
D-16.02.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to results of ***sensory inspection***
D-16.02.04P	use ***test/evaluation procedures***	***test/evaluation procedures*** are used according to results of ***sensory inspection***
D-16.02.05P	perform condition-based monitoring routine procedures	condition-based monitoring routine procedures are performed to detect defects not identified through ***sensory inspection*** and to determine ***next steps***
D-16.02.06P	verify lubrication levels and condition	lubrication levels and condition are verified by ***physical inspection***
D-16.02.07P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
D-16.02.08P	measure clearances of fans and blowers	clearances of fans and blowers are measured according to manufacturers' specifications
D-16.02.09P	assess and detect faulty or damaged components	faulty or damaged components are assessed and detected to determine repair or replacement, based on site and manufacturers recommendations
D-16.02.10P	determine type of ***repair*** required	type of ***repair*** required is determined according to inspection and vibration analysis results
D-16.02.11P	identify conditions that led to failure or breakdown of fans and blowers	conditions that led to failure or breakdown of fans and blowers are identified

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat

components include: sheaves, louvers, bearings, belts, fan blades

next steps include: repair, replace, overhaul, adjust, continue operation

tools and equipment include: hand tools, dial indicators, precision levels, optical or laser alignment equipment, hydraulic rams, rigging/lifting equipment

test/evaluation procedures include: monitoring temperature and vibration levels with specialized equipment

physical inspection includes: lock-out machine, visually inspect lubrication levels of couplings, clutches or brakes

safety devices include: interlocking devices, heat shields, guards, access covers, screens, inspection doors, portals, sensors (heat, motion, vibration), barriers, electronic eyes, amperage meters, electronic overloads, lock-outs, physical guards

repair includes: bearing and coupling replacement, re-balancing

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-16.02.01L	demonstrate knowledge of fans and blowers, their components and operation	define terminology associated with fans and blowers
D-16.02.02L	demonstrate knowledge of ***safe work practices*** related to fans and blowers	identify hazards and describe ***safe work practices*** pertaining to fans and blowers
D-16.02.03L	demonstrate knowledge of the procedures used to diagnose fans and blowers	interpret jurisdictional regulations and manufacturers' specifications pertaining to fans and blowers
		identify ***tools and equipment*** used to diagnose fans and blowers, and describe their applications and procedures
		identify types of fans and blower systems, and describe their components and operation
		identify types of fan blades and describe their applications
		describe the procedures used to diagnose fans and blowers
		describe the procedures used to inspect fans and blowers
		identify the factors to consider when determining if fans and blowers need to be repaired or replaced

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: hand tools, dial indicators, precision levels, optical or laser alignment equipment, hydraulic rams, rigging/lifting equipment

D-16.03 Maintains fans and blowers

Essential Skills Document Use, Thinking, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-16.03.01P	use ***safe work practices*** related to fans and blowers	***safe work practices*** related to fans and blowers are used
D-16.03.02P	perform ***sensory inspection*** of fans and blowers components	***sensory inspection*** of fan and blower components is performed using ***tools and equipment*** to locate ***defects***
D-16.03.03P	access fans and blowers	fans and blowers are accessed by removing ***auxiliary equipment***
D-16.03.04P	verify maintenance requirements	maintenance requirements are verified according to site and manufacturers' specifications
D-16.03.05P	clean fan blades	fan blades are cleaned according to site and manufacturers' specifications
D-16.03.06P	lubricate bearings and couplings	bearings and couplings are lubricated according to site and manufacturers' specifications
D-16.03.07P	re-align, replace and adjust fan and blower components	fan and blower components are re-aligned, replaced and adjusted according to site and manufacturers' specifications
D-16.03.08P	document and replace faulty components	faulty components are documented or replaced according to engineered drawings, and site and manufacturers' specifications
D-16.03.09P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to site and manufacturers' specifications, and jurisdictional regulations
D-16.03.10P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat

tools and equipment include: tachometers, thermal imaging equipment, laser alignment equipment, strobe light

defects include: wear, misalignment, debris build-up

auxiliary equipment includes: guards, shrouding, scrolls, casings

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-16.03.01L	demonstrate knowledge of fans and blowers, their components and operation	define terminology associated with fans and blowers
D-16.03.02L	demonstrate knowledge of ***safe work practices*** related to fans and blowers	identify hazards and describe ***safe work practices*** pertaining to fans and blowers
D-16.03.03L	demonstrate knowledge of the procedures used to maintain fans and blowers	interpret jurisdictional regulations and manufacturers' specifications pertaining to fans and blowers
D-16.03.04L	demonstrate knowledge of the procedures used to maintain fans and blowers	identify ***tools and equipment*** used to maintain fans and blowers, and describe their applications and procedures
		identify types of fans and blower systems, and describe their components and operation
		identify types of fan blades and describe their applications
		describe the procedures used to maintain fans and blowers
		identify the factors to consider when determining if fans and blowers need to be repaired or replaced
		describe the procedures used to regulate output for fans and blowers
		describe the procedures used to balance fans and blowers

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: tachometers, thermal imaging equipment, laser alignment equipment, strobe light

D-16.04 Repairs fans and blowers

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-16.04.01P	use ***safe work practices*** related to fans and blowers	***safe work practices*** related to fans and blowers are used
D-16.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job
D-16.04.03P	correct imbalances	imbalances are corrected by appropriate ***methods***
D-16.04.04P	access fans and blowers	fans and blowers are accessed by removing ***auxiliary equipment***
D-16.04.05P	dismantle, remove and reassemble fans and blowers, and their components	fans and blowers, and their components are dismantled, removed and reassembled to specifications
D-16.04.06P	recondition, rebuild or replace fans and blowers, and their components	fans and blowers, and their components are reconditioned, rebuilt or replaced according to engineered drawings, and site and manufacturers' specifications
D-16.04.07P	adjust clearances of fans and blowers, and their components	clearances of fans and blowers, and their components are adjusted according to manufacturers' specifications
D-16.04.08P	lubricate bearings and couplings	bearings and couplings are lubricated
D-16.04.09P	level and align drive components	drive components are aligned according to manufacturers' specifications
D-16.04.10P	reinstall safety guards and safety devices	safety guards and safety devices are reinstalled according to manufacturers' specifications and jurisdictional regulations
D-16.04.11P	energize equipment, start it up and return to operations	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: laser alignment equipment, strobe light, hand tools, rigging and lifting/hoisting equipment

methods include: cleaning, static and dynamic balancing

auxiliary equipment includes: guards, shrouding, scrolls, casings

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-16.04.01L	demonstrate knowledge of fans and blowers, their components and operation	define terminology associated with fans and blowers, their components and operation
D-16.04.02L	demonstrate knowledge of ***safe work practices*** related to fans and blowers	identify hazards and describe ***safe work practices*** pertaining to fans and blowers
D-16.04.03L	demonstrate knowledge of the procedures used to maintain fans and blowers, and their components	interpret jurisdictional regulations and manufacturers' specifications pertaining to fans and blowers, and their components
D-16.04.04L	demonstrate knowledge of the procedures used to maintain fans and blowers, and their components	identify ***tools and equipment*** used to repair fans and blowers, and their components, and describe their applications and procedures
		identify types of fans and blower systems, and describe their components and operation
		identify types of fan blades and describe their applications
		identify the factors to consider when determining if fans and blowers need to be repaired or replaced
		describe the procedures used to repair fans and blowers
		describe the procedures used to regulate output for fans and blowers
		describe the procedures used to balance fans and blowers

RANGE OF VARIABLES

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: laser alignment equipment, strobe light, hand tools, rigging and lifting/hoisting equipment

TASK D-17 Services pumps

TASK DESCRIPTOR

Pumps are used to move fluid and other media by positive or non-positive displacement. Proper and safe servicing practices ensure machine reliability and efficiency. This task includes installation, diagnosis, repair and maintenance of pumps. Servicing includes installing, diagnosing, maintaining and repairing.

D-17.01 Installs pumps

Essential Skills Numeracy, Digital Technology, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-17.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications
D-17.01.02P	determine location and elevation for installation	location and elevation for installation is determined according to manufacturers' specifications and engineered drawings
D-17.01.03P	prepare base, base plates and structure for ***pump*** installation	base, base plates and structure for ***pump*** installation are prepared using ***methods*** according to site and manufacturers' specifications
D-17.01.04P	prepare foundation for installation	foundation is prepared for installation according to manufacturers' specifications and engineered drawings
D-17.01.05P	position ***pump***	***pump*** is positioned on foundation manually or using rigging, hoisting/lifting and moving equipment according to manufacturers' specifications
D-17.01.06P	secure, level and align ***pump***	***pump*** is secured, leveled and the prime mover is aligned to the pump according to manufacturers' specifications and engineered drawings
D-17.01.07P	finish foundation	foundation is finished according to manufacturers' specifications
D-17.01.08P	set ***pump*** clearances	***pump*** clearances are set according to site manufacturers' specifications
D-17.01.09P	install seals and gaskets and adjust ***components***	seals and gaskets are installed and ***components*** are adjusted according to site and manufacturers' specifications

D-17.01.10P	connect suction and discharge piping	suction and discharge piping is connected according to site and manufacturers' specifications
D-17.01.11P	eliminate stress on ***pump***	stress on ***pump*** is eliminated by relieving pipe strain

RANGE OF VARIABLES

tools and equipment include: hand tools, levelling and alignment tools, measuring tools, monitoring equipment, rigging and hoisting equipment, manual for troubleshooting

pumps include: non-positive (centrifugal), positive displacement (reciprocating), API pumps

methods include: filing, sandblasting, buffing, levelling, alignment

components include: filters, gaskets, wear sleeves, seals, impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-17.01.01L	demonstrate knowledge of ***pumps***, their ***components*** and operation	define terminology associated with ***pumps***
		identify types of ***pumps*** and their ***components*** and accessories, and describe their purpose, applications and operation
		identify the types of ***seals*** and gaskets and describe their applications
		explain the method used to interpret pump curves
D-17.01.02L	demonstrate knowledge of safety practices related to ***pumps***	identify hazards and describe ***safe work practices*** associated with ***pumps*** and their ***components*** and accessories
		interpret jurisdictional regulations, site and manufacturers' specifications pertaining to the use of ***pumps***
D-17.01.03L	demonstrate knowledge of the procedures used to remove and install ***pumps***	identify ***tools and equipment*** used to remove and install ***pumps*** and describe their applications and procedures
		describe the procedures used to remove and install ***pumps*** and their ***components*** and accessories

RANGE OF VARIABLES

pumps include: non-positive (centrifugal), positive displacement (reciprocating), API pumps

components include: filters, gaskets, wear sleeves, seals, impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings

seals include: packings, O-Rings, mechanical seal, V-rings

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: hand tools, levelling and alignment tools, measuring tools, monitoring equipment, rigging and hoisting equipment, manual for troubleshooting

D-17.02 Diagnoses pumps

Essential Skills Thinking, Oral Communication, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-17.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
D-17.02.02P	perform ***sensory inspection*** of pump ***components*** for ***defects***	***sensory inspection*** is performed to determine ***next steps***
D-17.02.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications
D-17.02.04P	***test and evaluate pumps***	***pumps*** are ***tested and evaluated*** by using specialized equipment and referring to manufacturers' specifications
D-17.02.05P	perform ***condition-based monitoring methods*** and analysis	***condition-based monitoring methods*** and analysis are performed to detect defects not identified through ***sensory inspection***
D-17.02.06P	inspect pump ***components***	pump ***components*** are inspected for ***defects*** and to determine ***next steps***
D-17.02.07P	determine type of ***repair*** required	type of ***repair*** required is determined according to inspection methods
D-17.02.08P	identify and assess conditions that led to failure or breakdown of ***pumps***	conditions that led to failure or breakdown of ***pumps*** are identified and assessed

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, visually inspecting

components include: filters, gaskets, wear sleeves, seals, impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings

defects include: leaks, noise, excessive wear, corrosion, looseness, excessive heat

next steps include: repair, replace, overhaul, adjust, continue operation

tools and equipment include: hand tools, levelling and alignment tools, measuring tools, monitoring equipment, rigging and hoisting equipment, manual for troubleshooting

test and evaluate include: monitoring temperature and vibration levels with specialized equipment, oil analysis

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

repair includes: rebuild pump, replace components of pump, replace auxiliary components of pump, align pump

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-17.02.01L	demonstrate knowledge of ***pumps***, their ***components*** and operation	define terminology associated with ***pumps***
		identify types of ***pumps*** and their ***components*** and accessories, and describe their purpose, applications and operation
		identify the types of ***seals*** and gaskets and describe their applications
		explain the method used to interpret pump curves
D-17.02.02L	demonstrate knowledge of safety practices related to ***pumps***	identify hazards and describe ***safe work practices*** associated with ***pumps***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***pumps***
D-17.02.03L	demonstrate knowledge of the procedures used to diagnose ***pumps***	identify tools and equipment used to diagnose ***pumps*** and describe their applications and procedures
		describe the procedures used to inspect ***pumps*** and their ***components***
		describe the procedures used to diagnose ***pumps*** and their ***components***
		identify the factors to consider when determining if ***pumps*** need to be repaired or replaced

RANGE OF VARIABLES

pump includes: non-positive (centrifugal), positive displacement (reciprocating)

components include: filters, gaskets, wear sleeves, seals, impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings

seals include: packings, O-Rings, mechanical seal, V-rings

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-17.03 Maintains pumps

Essential Skills Thinking, Working with Others, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-17.03.01P	inspect, modify and adjust ***pumps***	***pumps*** are inspected, modified and adjusted according to maintenance schedule using ***condition-based monitoring*** methods
D-17.03.02P	use ***tools and equipment***	***tools and equipment*** are used according to job requirements and manufacturers' specifications
D-17.03.03P	align ***components***	***components*** are aligned according to manufacturers' specifications
D-17.03.04P	check fluid levels	fluid levels are checked according to manufacturers' specifications
D-17.03.05P	check temperatures, vacuum, pressure and flow rates	temperatures, vacuum, pressure and flow rates are checked according to manufacturers' specifications
D-17.03.06P	perform ***sensory inspection*** and use ***condition-based monitoring methods***	***sensory inspection*** is performed and ***condition-based monitoring methods*** are used to locate ***defects***
D-17.03.07P	verify maintenance requirements	maintenance requirements are verified according to site and manufacturers' specifications
D-17.03.08P	clean or replace oil filters and strainers	oil filters and strainers are cleaned or replaced according to site and manufacturers' specifications
D-17.03.09P	verify operation of valves	operation of valves is verified according to site and manufacturers' specifications

D-17.03.10P	adjust packing and monitor mechanical seals	packing is adjusted and mechanical seals are monitored according to site and manufacturers' specifications
D-17.03.11P	check clearances against manufacturers' specifications	clearances are checked against manufacturers' specifications

RANGE OF VARIABLES

pump includes: non-positive (centrifugal), positive displacement (reciprocating)

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

tools and equipment include: hand tools, levelling and alignment tools, measuring tools, monitoring equipment, rigging and hoisting equipment, manual for troubleshooting

components include: filters, gaskets, wear sleeves, seals, impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for abnormalities

defects include: leaks, noise, excessive wear, corrosion, looseness, excessive heat

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-17.03.01L	demonstrate knowledge of ***pumps***, their ***components*** and operation	define terminology associated with ***pumps***
		identify types of ***pumps*** and their ***components*** and accessories, and describe their purpose, applications and operation
		identify the types of seals and gaskets and describe their applications
		explain the method used to interpret pump curves
D-17.03.02L	demonstrate knowledge of safety practices related to ***pumps***	identify hazards and describe ***safe work practices*** associated with ***pumps***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***pumps***
D-17.03.03L	demonstrate knowledge of the procedures used to maintain ***pumps***	identify tools and equipment used to maintain ***pumps*** and describe their applications and procedures
		identify the factors to consider when determining if ***pumps*** or their ***components*** need to be repaired or replaced
		components describe the procedures used to maintain ***pumps*** and their ***components***

RANGE OF VARIABLES

pump includes: non-positive (centrifugal), positive displacement (reciprocating)

components include: filters, gaskets, wear sleeves, seals, impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-17.04 Repairs pumps

Essential Skills	Working with Others, Thinking, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-17.04.01P	perform ***sensory inspection*** and use ***condition-based monitoring methods***	***sensory inspection*** is performed and ***condition-based monitoring methods*** are used to locate ***defects***
D-17.04.02P	verify maintenance requirements	maintenance requirements are verified according to site and manufacturers' specifications
D-17.04.03P	clean or replace oil filters and strainers	oil filters and strainers are cleaned or replaced according to site and manufacturers' specifications
D-17.04.04P	check fluid levels	fluid levels are checked according to site and manufacturers' specifications
D-17.04.05P	check temperatures, vacuum, pressures and flow rates	temperatures, vacuum, pressures and flow rates are checked according to site and manufacturers' specifications
D-17.04.06P	align ***components***	***components*** are aligned according to manufacturers' specifications
D-17.04.07P	verify operation of valves	operation of valves is verified according to site and manufacturers' specifications
D-17.04.08P	adjust packing and monitor mechanical seals	packing is adjusted and mechanical seals are monitored according to site and manufacturers' specifications
D-17.04.09P	verify rotation	rotation is checked prior to coupling up by performing bump test
D-17.04.10P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to site and manufacturers' specifications, and jurisdictional regulations

D-17.04.11P	check clearances against manufacturers' specifications	clearances are checked against manufacturers' specifications
D-17.04.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for abnormalities

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

defects include: leaks, noise, excessive wear, corrosion, looseness, excessive heat

components include: filters, gaskets, wear sleeves, seals, impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-17.04.01L	demonstrate knowledge of ***pumps***, their ***components*** and operation	define terminology associated with ***pumps***
		identify types of ***pumps*** and their ***components*** and accessories, and describe their purpose, applications and operation
		identify the types of seals and gaskets and describe their applications
		explain the method used to interpret pump curves
D-17.04.02L	demonstrate knowledge of safety practices related to ***pumps***	identify hazards and describe ***safe work practices*** associated with ***pumps***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***pumps***
D-17.04.03L	demonstrate knowledge of the procedures used to ***repair pumps***	identify tools and equipment used to ***repair pumps*** and describe their applications and procedures
		identify the factors to consider when determining if ***pumps*** or their ***components*** need to be ***repaired*** or replaced
		describe the procedures used to ***repair pumps*** and their ***components***

RANGE OF VARIABLES

pump includes: non-positive (centrifugal), positive displacement (reciprocating)

components include: filters, gaskets, wear sleeves, seals, impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

repair includes: rebuild pump, replace components of pump, replace auxiliary components of pump, align pump

TASK D-18 Services compressors

TASK DESCRIPTOR

Compressors are used to supply air or other gases at an increased pressure. The failure of compressors can result in safety issues and lost productivity when not installed, repaired and maintained properly. Servicing includes installing, diagnosing, maintaining and repairing.

D-18.01 Installs compressors

Essential Skills Thinking, Document Use, Numeracy

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-18.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications
D-18.01.02P	confirm flow/pressure requirement	flow/pressure requirement is confirmed according to engineered drawings and plant demand
D-18.01.03P	determine location and elevation for installation	location and elevation for installation is determined according to engineered drawings
D-18.01.04P	clean and rough up base for compressor	base for compressor is cleaned and roughed up by ***methods*** according to manufacturers' specifications
D-18.01.05P	prepare foundation	foundation is prepared according to manufacturers' specifications and engineered drawings

D-18.01.06P	prepare base, base plates and structure	base, base plates and structure are prepared using ***methods*** according to manufacturers' specifications and engineered drawings
D-18.01.07P	position compressor in place	compressors are positioned in place using rigging, hoisting/lifting and moving equipment according to manufacturers' specifications
D-18.01.08P	level, align and secure compressor	compressor is leveled, aligned and secured according to site and manufacturers' specifications and engineered drawings
D-18.01.09P	grout to distribute load and minimize vibration	load is distributed and vibration is minimized by grouting according to manufacturers' specifications and engineered drawings
D-18.01.10P	lubricate compressor	compressors are lubricated according to site and manufacturers' specifications
D-18.01.11P	verify rotation	rotation is verified according to manufacturers' specifications and before engaging to drive unit
D-18.01.12P	connect and align compressors to prime mover	compressors are connected and aligned to prime mover through couplings, sheaves and belts according to manufacturers' specifications
D-18.01.13P	install safety guards and ***safety devices***	safety guards and ***safety devices*** are installed according to site and manufacturers' specifications, and jurisdictional regulations
D-18.01.14P	check for vibration	vibration is checked according to manufacturers' specifications
D-18.01.15P	connect inlet/outlet	inlet/outlet is connected according to manufacturers' specifications and engineered drawings
D-18.01.16P	install ***accessories***	***accessories*** are installed according to manufacturers' specifications and engineered drawings
D-18.01.17P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

tools and equipment include: straight edge, hand tools, impact wrenches, dial indicators, precision levels, optical or laser alignment equipment, rigging/lifting equipment, grouting equipment

methods include: filing, sandblasting and buffing

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

accessories include: silencers, filters, air dryers, lubricators, scrubbers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-18.01.01L	demonstrate knowledge of ***compressors***, their ***components*** and operation	define terminology associated with ***compressors***
		identify classifications and types of ***compressors***
D-18.01.02L	demonstrate knowledge of safety practices related to compressors	identify hazards and describe ***safe work practices*** associated with compressors
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of compressors
D-18.01.03L	demonstrate knowledge of the procedures used to remove, install and align compressors	identify ***tools and equipment*** used to install compressors and describe their applications and procedures
		describe the procedures used to remove, install and align compressors and their ***components***

RANGE OF VARIABLES

compressors include: dynamic/centrifugal, positive displacement (reciprocating, radial, screw, vane)

components include**:** filters, pressure relief valves, temperature controllers, regulators, unloading valve

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: straight edge, hand tools, impact wrenches, dial indicators, precision levels, optical or laser alignment equipment, rigging/lifting equipment, grouting equipment

D-18.02 Diagnoses compressors

Essential Skills	Reading, Thinking, Numeracy

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-18.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
D-18.02.02P	perform ***sensory inspection*** of ***components*** for defects	***sensory inspection*** of ***components*** is performed to determine ***next steps***
D-18.02.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications

D-18.02.04P	test and evaluate ***compressors***	***compressors*** are tested and evaluated by using specialized equipment and referring to manufacturers' specifications
D-18.02.05P	perform ***condition-based monitoring methods*** and analysis	***condition-based monitoring methods*** and analysis are performed to detect defects not identified through ***sensory inspection*** and to determine ***next steps***
D-18.02.06P	inspect ***compressors*** and ***components***	***compressors*** and ***components*** are inspected to determine type of ***repair*** required according to manufacturers' specifications and condition-based monitoring methods
D-18.02.07P	assess and detect faulty or damaged ***components***	faulty or damaged ***components*** are assessed and detected to determine ***repair*** or replacement

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for abnormalities

components include: temperature gauges, sheaves, piping, valves, bearings, belts, filters, pressure relief valves, temperature controllers, regulators, unloading valve

next steps include: repair, replace, overhaul, adjust, continue operation

tools and equipment include: straight edge, hand tools, impact wrenches, dial indicators, precision levels, optical or laser alignment equipment, rigging/lifting equipment, grouting equipment

compressors include: dynamic/centrifugal, positive displacement (reciprocating, radial, screw, vane)

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

repair includes: bearing and coupling replacement, refurbishing of valves

KNOWLEDGE		
	Learning Outcomes	**Learning Objectives**
D-18.02.01L	demonstrate knowledge of ***compressors***, their ***components*** and operation	define terminology associated with the operation of ***compressors*** and their ***components***
		identify ***compressors***, their ***components*** and ***accessories***, and describe their purpose and operation
		describe the procedure to diagnose ***compressors*** and their ***components***
D-18.02.02L	demonstrate knowledge of safety practices related to ***compressors*** and their ***components***	identify hazards and describe ***safe work practices*** associated with ***compressors*** and their ***components***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***compressors*** and their ***components***

D-18.02.03L	demonstrate knowledge of the procedures used to diagnose ***compressors*** and their ***components***	identify tools and equipment used to diagnose ***compressors*** and their ***components*** and describe their applications and procedures
		describe the procedures used to inspect ***compressors*** and their ***components***
		describe the procedures used to diagnose ***compressors*** and their ***components***
		identify the ***factors*** to consider when determining if ***compressors*** and their ***components*** need to be repaired or replaced

RANGE OF VARIABLES

compressors include: dynamic/centrifugal, positive displacement (reciprocating, radial, screw, vane)

components include: temperature gauges, sheaves, piping, valves, bearings, belts, filters, pressure relief valves, temperature controllers, regulators, unloading valve

accessories include: silencers, filters, air dryers, lubricators, scrubbers

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

factors include: condition-based monitoring reports (worn bearings, oil analysis, vibration analysis, temperature analysis), Reliability Centered Maintenance (RCM)

D-18.03 Maintains compressors

Essential Skills Document use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-18.03.01P	perform ***sensory inspection*** of compressor and ***components***	***sensory inspection*** of compressor and ***components*** is performed to locate ***defects***
D-18.03.02P	use ***tools and equipment***	***tools and equipment*** are used according to job requirements and manufacturers' specifications
D-18.03.03P	verify maintenance requirements	maintenance requirements are identified according to ***condition-based monitoring methods***, maintenance schedule and manufacturers' specifications

D-18.03.04P	clean or replace oil filters and air filters	oil filters and air filters are cleaned or replaced according to site and manufacturers' specifications
D-18.03.05P	check ***fluid*** levels	***fluid*** levels are checked according to manufacturers' specifications
D-18.03.06P	check temperatures and pressures	temperatures and pressures are checked according to manufacturers' specifications
D-18.03.07P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
D-18.03.08P	align shafts	shafts are aligned or re-aligned according to site and manufacturers' specifications
D-18.03.09P	adjust loading and unloading set points	loading and unloading set points are adjusted according to engineered drawings, and site and manufacturers' specifications
D-18.03.10P	drain moisture from compressors, coolers and receivers	moisture from compressors, coolers and receivers is drained according to site and manufacturers' specifications
D-18.03.11P	verify operation of relief valves, check valves and auto drain valves	operation of relief valves, check valves and auto drain valves is verified according to manufacturers' specifications and jurisdictional regulations
D-18.03.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
D-18.03.13P	identify faulty or damaged equipment	faulty or damaged equipment is identified to determine repair or replacement

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat

components include**:** filters, pressure relief valves, temperature controllers, regulators, unloading valve

defects include: wear, misalignment, broken parts, faulty sensors or gauges

tools and equipment include: tachometers, alignment tools, wrenches

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

fluids include: coolant (water, glycol), oil and grease

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-18.03.01L	demonstrate knowledge of compressors, their ***components*** and operation	define terminology associated with compressors and their ***components***
		identify compressors, their ***components*** and accessories, and describe their purpose, applications and operation
		describe the procedure to repair compressors and their ***components***
D-18.03.02L	demonstrate knowledge of safety practices related to compressors and their ***components***	identify hazards and describe ***safe work practices*** associated with compressors and their ***components***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of compressors and their ***components***
D-18.03.03L	demonstrate knowledge of the procedures used to maintain, diagnose and repair compressors and their ***components***	identify ***tools and equipment*** used to maintain compressors and their ***components*** and describe their applications and procedures
		identify the ***factors*** to consider when determining if compressors or their ***components*** need to be repaired or replaced
		describe the procedures used to maintain compressors and their ***components***
		describe the procedures used to diagnose compressors and their ***components***
		describe the procedures used to repair compressors and their ***components***

RANGE OF VARIABLES

components include**:** filters, pressure relief valves, temperature controllers, regulators, unloading valve

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: tachometers, alignment tools, wrenches

factors include: condition-based monitoring reports (worn bearings, oil analysis, vibration analysis, temperature analysis), RCM

D-18.04 Repairs compressors

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-18.04.01P	rebuild and replace faulty compressor ***components*** or accessories	faulty compressor ***components*** or accessories are rebuilt or replaced according to manufacturers' specifications and inspection report
D-18.04.02P	use ***tools and equipment***	***tools and equipment*** are used according to job requirements and manufacturers' specifications
D-18.04.03P	prepare compressor and ***components*** for repair	compressors and ***components*** are prepared for repair using various ***methods***
D-18.04.04P	identify faulty or damaged ***components*** or accessories	faulty or damaged ***components*** or accessories are identified to determine repair or replacement
D-18.04.05P	replace faulty ***components*** or ***accessories***	***components*** or ***accessories*** are replaced according to manufacturers' specifications and inspection report
D-18.04.06P	set/adjust clearances	clearances of ***compressors*** and ***components*** are set/adjusted according to manufacturers' specifications
D-18.04.07P	re-align drive ***components***	drive ***components*** are re-aligned according to manufacturers' specifications
D-18.04.08P	adjust loading and unloading set points	loading and unloading set points are adjusted according to manufacturers' specifications and plant demand
D-18.04.09P	ensure operation of relief valves, check valves and auto drain valves	operation of relief valves, check valves and auto drain valves is confirmed according to manufacturers' specifications and jurisdictional regulations
D-18.04.10P	install safety guards and ***safety devices***	safety guards and ***safety devices*** are installed according to site and manufacturers' specifications, and jurisdictional regulations
D-18.04.11P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

components include**:** filters, pressure relief valves, temperature controllers, regulators, unloading valve

tools and equipment include: rigging/hoisting equipment, plasti-gauge, blueing, measuring tools, tachometers, alignment tools, wrenches

accessories include: silencers, air dryers, lubricators, scrubbers

compressors include: dynamic/centrifugal, positive displacement (reciprocating, radial, screw, vane)

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-18.04.01L	demonstrate knowledge of compressors, their ***components*** and operation	define terminology associated with compressors and their ***components***
		identify compressors, their ***components*** and ***accessories***, and describe their purpose, applications and operation
		describe the procedure to repair compressors and their ***components***
D-18.04.02L	demonstrate knowledge of safety practices related to compressors and their ***components***	identify hazards and describe ***safe work practices*** associated with compressors and their ***components***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of compressors and their ***components***
D-18.04.03L	demonstrate knowledge of the procedures used to repair compressors and their ***components***	identify ***tools and equipment*** used to repair compressors and their ***components*** and describe their applications and procedures
		identify the ***factors*** to consider when determining if compressors or their ***components*** need to be repaired or replaced
		describe the procedures used to repair compressors and their ***components***

RANGE OF VARIABLES

components include**:** filters, pressure relief valves, temperature controllers, regulators, unloading valve

accessories include: silencers, air dryers, lubricators, scrubbers

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: rigging/hoisting equipment, plasti-gauge, blueing, measuring tools, tachometers, alignment tools, wrenches

factors include: condition-based monitoring reports (worn bearings, oil analysis, vibration analysis, temperature analysis)

TASK D-19 Services process piping, tanks and containers

TASK DESCRIPTOR

Process piping, tanks and containers are usually used to transport, store and mix materials. Tanks and containers may be pressurized or open to atmosphere. This task includes installation, diagnosis, maintenance and repair of process tanks and containers such as bins and hoppers, and process piping. Servicing includes installing, diagnosing, maintaining and repairing.

D-19.01 Installs process tanks and containers

Essential Skills	Document Use, Numeracy, Reading

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-19.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job specifications
D-19.01.02P	determine location and elevation for installation	location and elevation for installation is determined according to engineered drawings
D-19.01.03P	prepare and rough up foundation	foundation is prepared and roughed up according to engineered drawings
D-19.01.04P	clean and prepare base	base is prepared by ***methods*** according to manufacturers' specifications and engineered drawings
D-19.01.05P	position ***process tanks and containers***	***process tanks and containers*** are positioned in place using rigging, hoisting/lifting and moving equipment and according to manufacturers' specifications and engineered drawings
D-19.01.06P	level, align and secure ***process tanks and containers***	***process tanks and containers*** are leveled, aligned and secured according to site and manufacturers' specifications and engineered drawings
D-19.01.07P	check orientation of tank	orientation of tank is checked according to engineered drawings
D-19.01.08P	grout ***process tanks and containers***	grout is applied to ***process tanks and containers*** to distribute load and minimize vibration
D-19.01.09P	connect inlet/outlet	inlet/outlet is connected according to engineered drawings

D-19.01.10P	install ***components***	***components*** are installed according to manufacturers' specifications and engineered drawings
D-19.01.11P	install safety guards and ***safety devices***	safety guards and ***safety devices*** are installed according to site and manufacturers' specifications and jurisdictional regulations
D-19.01.12P	perform ***final inspection and testing***	tanks and components are inspected, tested and the results documented according to manufacturers' specifications, engineered drawings and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: layout, levelling tools, lifting and moving equipment
methods include: filing, sandblasting, buffing, grinding
process tanks and containers include: bins, hoppers, receivers, thickeners, reservoirs, storage tanks
components include: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves
safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards
final inspection and testing includes: flow, pressure and leak tests, final cleaning, flushing tanks, visual inspection

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-19.01.01L	demonstrate knowledge of ***process tanks and containers***, their components and application	define terminology associated with ***process tanks and containers***
		identify types of ***process tanks and containers*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-19.01.02L	demonstrate knowledge of safety practices related to ***process tanks and containers***	identify hazards and describe ***safe work practices*** associated with ***process tanks and containers***
D-19.01.03L	demonstrate knowledge of the procedures used to remove and install	interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***process tanks and containers*** and their ***components***
D-19.01.03L	demonstrate knowledge of the procedures used to install ***process tanks and containers***	identify tools and equipment used with ***process tanks and containers*** and describe their applications and procedures

		describe the procedures used to install ***process tanks and containers*** and their ***components***
D-19.01.04L	demonstrate knowledge of the procedures used to test and inspect ***process tanks and containers*** and their ***components***	describe the procedures used to test and inspect ***process tanks and containers*** and their ***components***

RANGE OF VARIABLES

process tanks and containers include: bins, hoppers, receivers, thickeners, reservoirs, storage tanks
components include: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves
safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-19.02 Installs process piping

Essential Skills Document Use, Working with Others, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job specifications
D-19.02.02P	select ***process piping materials and components***	***process piping materials and components*** are selected according to site specifications, engineered drawings and jurisdictional regulations
D-19.02.03P	determine location and elevation for installation	location and elevation for installation is determined according to engineered drawings and piping & instrumentation diagrams (P&IDs)
D-19.02.04P	position ***process piping***	***process piping*** is positioned in place using rigging, hoisting/lifting and moving equipment and according to engineered drawings and P&IDs
D-19.02.05P	place and secure ***process piping***	***process piping*** is placed and secured using ***supports*** according to engineered drawings and P&IDs
D-19.02.06P	check orientation of ***process piping components***	orientation of ***process piping components*** is checked according to engineered drawings and P&IDs

D-19.02.07P	connect ***process piping*** and ***components***	***process piping*** and ***components*** are connected according to engineered drawings and P&IDs
D-19.02.08P	perform ***final inspection and testing***	***process piping*** is inspected, tested, and the results documented according to manufacturers' specifications, engineered drawings and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: layout, levelling tools, lifting and moving equipment

process piping materials and components include: fittings, valves, strainers, gaskets, connectors

process piping includes: ABS [acrylonitrile butadiene styrene], HDPE [high-density polyethylene], PVC [polyvinyl chloride], stainless, composite, carbon steel, tubing, copper

supports include: stands, hangers, brackets

final inspection and testing includes: flow, pressure and leak tests, final, cleaning, flushing pipes, visual inspection

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-19.02.01L	demonstrate knowledge of ***process piping***, components and application	define terminology associated with ***process piping***
		identify types of ***process piping*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-19.02.02L	demonstrate knowledge of safety practices related to ***process piping***	identify ***hazards*** and describe ***safe work practices*** associated with ***process piping***
D-19.02.03L	demonstrate knowledge of the procedures used to remove and install	interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***process piping*** and their ***components***
D-19.02.04L	demonstrate knowledge of the procedures used to remove and install ***process piping***	identify tools and equipment used to install ***process piping*** and describe their applications and procedures
		describe the procedures used to remove and install ***process piping*** and their ***components***
D-19.02.05L	demonstrate knowledge of the procedures used to test and inspect ***process piping*** and their ***components***	describe the procedures used to test and inspect ***process piping*** and their ***components***

RANGE OF VARIABLES

process piping includes: ABS [acrylonitrile butadiene styrene], HDPE [high-density polyethylene], PVC [polyvinyl chloride], stainless, composite, carbon steel, tubing, copper

process piping components include: fittings, valves, strainers, gaskets, connectors

hazards include: residual materials, pressure, heat, weight, acidic (caustic/corrosive) level of product (pH), cyanide, poisonous substances

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-19.03 Diagnoses process tanks and containers

Essential Skills Thinking, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.03.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
D-19.03.02P	determine if NDT or condition-based monitoring is required	NDT or condition-based monitoring is determined to be required according to the results of inspection
D-19.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications
D-19.03.04P	perform ***inspection*** of ***process tanks, containers*** and ***components*** for defects	***inspection*** of ***process tanks, containers*** and ***components*** is performed to determine ***next steps***
D-19.03.05P	identify conditions that led to failure or breakdown of ***process tanks and containers***	conditions that led to failure or breakdown of ***process tanks and containers*** is identified
D-19.03.06P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
D-19.03.07P	assess and detect faulty or damaged equipment	faulty or damaged equipment is assessed and detected to determine repair or replacement
D-19.03.08P	determine type of ***repair*** required	type of ***repair*** required is determined according to inspection and analysis results

RANGE OF VARIABLES

tools and equipment include: hand tools, NDT tools, pressure gauges

inspection includes: sensory inspection, gauge monitoring, gas detection monitoring

process tanks and containers include: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

process tanks and container components include: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves

next steps include: repair, replace, overhaul, adjust, continue operation

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

repair includes: patching, overlay, re-coating, piping, plastic welding, cleaning

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-19.03.01L	demonstrate knowledge of ***process tanks and containers***, their ***components*** and operation	define terminology associated with ***process tanks and containers***
		identify types of ***process tanks and containers*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-19.03.02L	demonstrate knowledge of safety practices related to ***process tanks and containers***	identify hazards and describe ***safe work practices*** associated with ***process tanks and containers***
D-19.03.03L	demonstrate knowledge of the procedures used to diagnose	interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***process tanks and containers***
D-19.03.04L	demonstrate knowledge of the procedures used to diagnose ***process tanks and containers***	identify tools and equipment used to diagnose ***process tanks and containers*** and their ***components***, describe their applications and procedures
		describe the procedures used to diagnose ***process tanks and containers*** and their ***components***
		identify the factors to consider when determining if ***process tanks and containers*** and their ***components*** need to be repaired or replaced

RANGE OF VARIABLES

process tanks and containers include: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

process tanks and container components include: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-19.04 Diagnoses process piping

Essential Skills Thinking, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.04.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
D-19.04.02P	determine if NDT or ***condition-based monitoring method*** is required	NDT or ***condition-based monitoring method*** is determined to be required according to the results of inspection
D-19.04.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications
D-19.04.04P	perform ***inspection*** of ***process pipes*** and ***components*** for defects	***inspection*** of ***process pipes*** and ***components*** is performed to determine ***next steps***
D-19.04.05P	identify conditions that led to failure or breakdown of process tanks and containers	conditions that led to failure or breakdown of process tanks and containers is identified
D-19.04.06P	assess and detect faulty or damaged equipment	faulty or damaged equipment is assessed and detected to determine ***next steps***
D-19.04.07P	determine type of ***repair*** required	type of ***repair*** required is determined according to inspection and analysis results

RANGE OF VARIABLES

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

tools and equipment include: hand tools, NDT tools, pressure gauges

inspection includes: sensory inspection, gauge monitoring, gas detection monitoring

process piping includes: ABS [acrylonitrile butadiene styrene], HDPE [high-density polyethylene], PVC [polyvinyl chloride], stainless, composite, carbon steel, tubing, copper

process piping components include: fittings, valves, strainers, gaskets, connectors

next steps include: repair, replace, overhaul, adjust, continue operation

repair includes: patching, overlay, re-coating

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-19.04.01L	demonstrate knowledge of ***process piping***, their components and operation	define terminology associated with ***process piping***
		identify types of ***process piping*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-19.04.02L	demonstrate knowledge of safety practices related to diagnosing ***process piping***	identify ***hazards*** and describe ***safe work practices*** associated with diagnosing ***process piping***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***process piping***
D-19.04.03L	demonstrate knowledge of the procedures used to diagnose ***process piping***	identify tools and equipment used to diagnose ***process piping*** and describe their applications and procedures
		describe the procedures used to diagnose ***process piping*** and their components
		identify the factors to consider when determining if ***process piping*** needs to be repaired or replaced

RANGE OF VARIABLES

process piping includes: ABS [acrylonitrile butadiene styrene], HDPE [high-density polyethylene], PVC [polyvinyl chloride], stainless, composite, carbon steel, tubing, copper

process piping components include: fittings, valves, strainers, gaskets, connectors

hazards include: residual materials, pressure, heat, weight, acidic (caustic/corrosive) level of product (pH), cyanide, poisonous substances

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-19.05 Maintains process tanks and containers

Essential Skills Document Use, Thinking, Reading

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.05.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements and manufacturers' specifications
D-19.05.02P	perform inspection of ***process tanks and containers*** and their ***components***	inspection is performed to locate ***defects***
D-19.05.03P	verify maintenance requirements	maintenance requirements are verified according to inspection, equipment history and manufacturers' specifications
D-19.05.04P	clean and replace filters and strainers	oil filters and strainers are cleaned and replaced according to indicators and manufacturers' specifications
D-19.05.05P	check temperatures, pressures, vacuum and flow rates	temperatures, pressures, vacuum and flow rates are checked according to process requirements
D-19.05.06P	verify operation of valves	operation of valves is verified by stroking the actuator
D-19.05.07P	adjust ***process tank and container components***	***process tank and container components*** are adjusted according to process requirements
D-19.05.08P	change liners	liners are changed according to site and manufacturers' specifications
D-19.05.09P	clear ventilation systems	ventilation systems are cleared of blockages and restrictions

RANGE OF VARIABLES

tools and equipment include: hand tools, NDT tools, pressure gauges

process tanks and containers include: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

process tanks and container components include: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves

defects include: leaks, wear

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-19.05.01L	demonstrate knowledge of ***process tanks and containers***, their ***components*** and operation	define terminology associated with ***process tanks and containers***
		identify types of ***process tanks and containers*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-19.05.02L	demonstrate knowledge of safety practices related to ***process tanks and containers***	identify ***hazards*** and describe ***safe work practices*** associated with ***process tanks and containers***
D-19.05.03L	demonstrate knowledge of the procedures used to maintain and repair	interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***process tanks and containers***
D-19.05.04L	demonstrate knowledge of the procedures used to maintain ***process tanks and containers***	identify tools and equipment used to maintain ***process tanks and containers*** and describe their applications and procedures
		identify the factors to consider when determining if ***process tanks and containers*** or their components need to be repaired or replaced
		describe the procedures used to maintain ***process tanks and containers*** and their components

RANGE OF VARIABLES

process tanks and containers include: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

process tanks and container components include: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves

hazards include: residual materials, pressure, heat, weight, acidic (caustic/corrosive) level of product (pH), cyanide, poisonous substances

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-19.06 Maintains process piping

Essential Skills Document Use, Thinking, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.06.01P	perform inspection of ***process piping*** and ***components***	inspection is performed to locate ***defects***
D-19.06.02P	verify maintenance requirements	maintenance requirements are verified according to manufacturers' specifications
D-19.06.03P	check ***supports***	***supports*** are checked to ensure pipes are supported according to manufacturers' specifications
D-19.06.04P	clean or replace filters and strainers	filters and strainers are cleaned or replaced according to site and manufacturers' specifications
D-19.06.05P	check temperatures, pressures, vacuum and flow rates	temperatures, pressures, vacuum and flow rates are checked according to process requirements
D-19.06.06P	verify operation of ***process piping components***	operation of ***process piping components*** is verified according to process requirements
D-19.06.07P	lubricate ***process piping components***	***process piping components*** are lubricated according to manufacturers' specifications
D-19.06.08P	adjust ***process piping components***	***process piping components*** are adjusted by re-working bolts or adjusting piping supports

RANGE OF VARIABLES

process piping includes: ABS [acrylonitrile butadiene styrene], HDPE [high-density polyethylene], PVC [polyvinyl chloride], stainless, composite, carbon steel, tubing, copper

defects include: leaks, wear

supports include: stands, hangers, brackets

process piping components include: fittings, valves, strainers, gaskets, connectors

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-19.06.01L	demonstrate knowledge of ***process piping***, their ***components*** and operation	define terminology associated with ***process piping***
		identify types of ***process piping*** and their ***components*** and accessories, and describe their purpose, applications and operation
		identify process piping ***supports*** and describe their purpose, applications and operation
D-19.06.02L	demonstrate knowledge of safety practices related to ***process piping***	identify ***hazards*** and describe ***safe work practices*** associated with ***process piping***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***process piping***
D-19.06.03L	demonstrate knowledge of the procedures used to maintain ***process piping***	identify tools and equipment used to maintain ***process piping*** and describe their applications and procedures
		identify the factors to consider when determining if ***process piping*** or their ***components*** need to be repaired or replaced
		describe the procedures used to maintain ***process piping*** and their ***components***

RANGE OF VARIABLES

process piping includes: ABS [acrylonitrile butadiene styrene], HDPE [high-density polyethylene], PVC [polyvinyl chloride], stainless, composite, carbon steel, tubing, copper

process piping components include: fittings, valves, strainers, gaskets, connectors

supports include: stands, hangers, brackets

hazards include: residual materials, pressure, heat, weight, acidic (caustic/corrosive) level of product (pH), cyanide, poisonous substances, confined spaces

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-19.07 Repairs process tanks and containers

Essential Skills	Thinking, Working with Others, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.07.01P	access ***process tanks and containers***	***process tanks and containers*** are accessed by removing ***components***
D-19.07.02P	use ***tools and equipment***	***tools and equipment*** are used according to job requirements and manufacturers' specifications
D-19.07.03P	prepare ***process tanks and containers***	***process tanks and containers*** are prepared for repair using various ***methods***
D-19.07.04P	repair leaks	leaks are repaired by replacing gaskets, tightening threads, torqueing fasteners, packing and glands, and patching tanks and containers
D-19.07.05P	clean ***process tanks and containers***	***process tanks and containers*** are cleaned to prevent flow restrictions
D-19.07.06P	replace faulty ***components*** and auxiliary equipment	faulty ***components*** and auxiliary equipment are replaced according to manufacturers' specifications and inspection reports
D-19.04.07P	align ***components***	***components*** are aligned according to manufacturers' specifications
D-19.07.08P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to site and manufacturers' specifications, and jurisdictional regulations
D-19.07.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

process tanks and containers include: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

components include: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, manholes

tools and equipment include: layout, levelling tools, lifting and moving equipment

methods include: filing, sandblasting, buffing, grinding

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-19.07.01L	demonstrate knowledge of ***process tanks and containers*** their ***components*** and operation	define terminology associated with ***process tanks and containers***
		identify types of ***process tanks and containers*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-19.07.02L	demonstrate knowledge of safety practices related to ***process tanks and containers***	identify ***hazards*** and describe ***safe work practices*** associated with ***process tanks and containers***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***tanks and containers***
D-19.07.03L	demonstrate knowledge of the procedures used to repair ***process tanks and containers***	identify ***tools and equipment*** used to repair ***process tanks and containers*** and describe their applications and procedures
		identify the factors to consider when determining if ***process tanks and containers*** or their components need to be repaired or replaced
		describe the procedures used to repair ***process tanks and containers*** and their ***components***

RANGE OF VARIABLES

process tanks and containers include: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

process tanks and containers components include: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, manholes

hazards include: residual materials, pressure, heat, weight, acidic (caustic/corrosive) level of product (pH), cyanide, poisonous substances, confined spaces

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: layout, levelling tools, lifting and moving equipment

D-19.08 Repairs process piping

Essential Skills Thinking, Working with Others, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.08.01P	use ***tools and equipment***	***tools and equipment*** are used according to job requirements and manufacturers' specifications
D-19.08.02P	prepare ***process piping*** for repair or replacement	***process piping*** is prepared for repair using various ***preparation methods***
D-19.08.03P	repair or replace ***supports***	***supports*** are repaired or replaced according to manufacturers' specifications and inspection reports
D-19.08.04P	repair leaks	leaks are repaired by replacing gaskets, tightening threads, torqueing fasteners, packing and glands, and patching process piping and components
D-19.08.05P	clean ***process piping***	***process piping*** are cleaned to prevent flow restrictions
D-19.08.06P	replace faulty ***components*** and auxiliary equipment	faulty ***components*** and auxiliary equipment are replaced according to manufacturers' specifications and inspection reports
D-19.08.07P	align ***components***	***components*** are aligned according to manufacturers' specifications

RANGE OF VARIABLES

tools and equipment include: hand tools, layout, levelling tools, lifting and moving equipment, threading and grooving machine, torque wrenches, various plastic welding tools

process piping includes: ABS [acrylonitrile butadiene styrene], HDPE [high-density polyethylene], PVC [polyvinyl chloride], stainless, composite, carbon steel, tubing, copper

preparation methods include: cleaning, grinding, pickling, plastic welding

supports include: stands, hangers, brackets

process piping components include: fittings, valves, strainers, gaskets, connectors

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-19.08.01L	demonstrate knowledge of ***process piping***, their components and operation	define terminology associated with ***process piping***
		identify types of ***process piping*** and their components and accessories, and describe their purpose, applications and operation
		identify process piping ***supports*** and describe their purpose, applications and operation
D-19.08.02L	demonstrate knowledge of safety practices related to ***process piping***	identify ***hazards*** and describe ***safe work practices*** associated with ***process piping*** and the removal of process piping
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***process piping***
D-19.08.03L	demonstrate knowledge of the procedures used to repair ***process piping***	identify ***tools and equipment*** used to repair ***process piping*** and describe their applications and procedures
		identify the factors to consider when determining if ***process piping*** or their components need to be repaired or replaced
		describe the procedures used to repair ***process piping*** and their components

RANGE OF VARIABLES

process piping includes: ABS [acrylonitrile butadiene styrene], HDPE [high-density polyethylene], PVC [polyvinyl chloride], stainless, composite, carbon steel, tubing, copper

supports include: stands, hangers, brackets

hazards include: residual materials, pressure, heat, weight, acidic (caustic/corrosive) level of product (pH), cyanide, poisonous substances

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: layout, levelling tools, lifting and moving equipment

TASK D-20 Services conveying systems

TASK DESCRIPTOR

Conveying systems are used to transfer products safely and efficiently. Servicing includes installing, diagnosing, maintaining and repairing of conveying systems.

D-20.01 Installs conveying systems

Essential Skills Numeracy, Thinking, Document Use

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-20.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job specifications
D-20.01.02P	determine location and elevation for installation	location and elevation for installation is determined according to engineered drawings
D-20.01.03P	prepare foundation	foundation is prepared according to engineered drawings
D-20.01.04P	prepare base or mounting brackets	base or mounting brackets are prepared according to design specifications and type of installation
D-20.01.05P	assemble ***conveying system***	***conveying system*** is assembled according to design specifications
D-20.01.06P	install ***conveying system components***	***conveying system components*** are installed according to engineered drawings and manufacturers' specifications
D-20.01.07P	position ***conveying system*** in place	***conveying system*** is positioned in place using rigging, hoisting/lifting and moving equipment
D-20.01.08P	align, level and secure ***conveying system***	***conveying system*** is aligned, leveled and secured according to type of system
D-20.01.09P	grout ***conveying system***	***conveying system*** is grouted to distribute load and minimize vibration
D-20.01.10P	set clearances	clearances are set according to manufacturers’ specifications
D-20.01.11P	check direction of rotation	direction of rotation is checked according to conveying requirements
D-20.01.12P	connect in-feed and discharge	in-feed and discharge is connected according to conveying requirements

D-20.01.13P	connect belts	belts are connected using ***splicing techniques***
D-20.01.14P	track belts	belts are tracked and operate according to manufacturers' specifications
D-20.01.15P	connect chains using ***chain conveyor components***	chains are connected using ***chain conveyor components***
D-20.01.16P	connect and align prime mover	prime mover is connected and aligned through ***mechanical power transmission***
D-20.01.17P	install ***sensory devices***	***sensory devices*** are installed according to conveying requirements and manufacturers' specifications
D-20.01.18P	install ***safety devices***	***safety devices*** are installed according to manufacturers' specifications and jurisdictional regulations
D-20.01.19P	energize equipment and release for operation	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

tools and equipment include: hand tools, levelling and alignment equipment

conveying systems include: pneumatic, belt, rollers, chain, screw, bucket, flume/water

conveying system components include: bearings, pulleys, rollers, gear reduction units, take-ups, scrapers

splicing techniques include: vulcanizing, cold splicing, mechanical

chain conveyor components to connect include: connecting links, rivets, locking clips

mechanical power transmissions include: couplings, sprockets and chains, sheaves and belts, hollow shaft gear boxes

sensory devices include: motion detectors, depth sensors

safety devices include: physical guards, emergency stops, electronic eyes, hand rails, lock-outs

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-20.01.01L	demonstrate knowledge of ***conveying systems***, their ***components*** and operation	define terminology associated with ***conveying systems***
		identify types of ***conveying systems*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-20.01.02L	demonstrate knowledge of safety practices related to ***conveying systems***	identify hazards and describe ***safe work practices*** associated with ***conveying systems***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***conveying systems***

D-20.01.03L	demonstrate knowledge of the procedures used to install ***conveying systems***	identify tools and equipment used to install ***conveying systems*** and describe their applications and procedures
		describe the procedures used to install ***conveying systems*** and their components
		identify the factors to consider and required calculations to determine ***conveying system*** requirements
		describe the procedures used to splice a conveyor belt

RANGE OF VARIABLES

conveying systems include: pneumatic, belt, rollers, chain, screw, bucket, flume/water

conveying system components include: bearings, pulleys, rollers, gear reduction units, take-ups, scrapers

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-20.02 Diagnoses conveying systems

Essential Skills Thinking, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-20.02.01P	obtain a description of the problem and symptoms	a description of the problem and symptoms is obtained
D-20.02.02P	perform ***sensory inspection*** of ***components***	***sensory inspection*** of ***components*** is performed to identify wear and damage
D-20.02.03P	inspect ***filters***	***filters*** are inspected to identify blockages, wear and damage
D-20.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to ***conveying system***
D-20.02.05P	perform condition-based monitoring routine procedures	condition-based monitoring routine procedures are performed to detect defects not identified through ***sensory inspection***

D-20.02.06P	determine ***type of repair required***	***type of repair required*** and ***next steps*** are is determined according to inspection, job requirements, engineered drawings and manufacturers' specifications
D-20.02.07P	identify conditions that led to failure or breakdown of ***conveying system***	conditions that led to failure or breakdown of ***conveying system*** are identified and recorded

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for abnormalities

components include: limit switches, gear reduction units, emergency stops, couplings, magnets, pulleys, rollers, bearings, sheaves, sprockets, chains and belts

filters include: cyclones, bag shakers, screens and precipitators

tools and equipment include: hand tools, gauges, levelling and alignment equipment

conveying systems include: pneumatic, belt, rollers, chain, screw, bucket, flume/water

type of repair required includes the replacement of: bearings, couplings, idlers, conveyor belts, mechanical splices, rotary valves, skirting

next steps include: repair, replace, overhaul, adjust, continue operation

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-20.02.01L	demonstrate knowledge of ***conveying systems***, their ***components*** and operation	define terminology associated with ***conveying systems***
		identify types of ***conveying systems*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-20.02.02L	demonstrate knowledge of safety practices related to ***conveying systems***	identify hazards and describe ***safe work practices*** associated with ***conveying systems***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***conveying systems***
D-20.02.03L	demonstrate knowledge of the procedures used to diagnose ***conveying systems***	identify ***tools and equipment*** used to diagnose ***conveying systems*** and describe their applications and procedures
		describe the procedures used to inspect ***conveying systems*** and their ***components***
		describe the procedures used to diagnose ***conveying systems*** and their ***components***
		identify the factors to consider when determining if ***conveying systems*** needs to be repaired or replaced

	identify the factors to consider and required calculations to determine ***conveying system*** requirements
	describe the procedures used to splice a conveyor belt

RANGE OF VARIABLES

conveying systems include: pneumatic, belt, rollers, chain, screw, bucket, flume/water

components include: limit switches, gear reduction units, emergency stops, couplings, magnets, pulleys, rollers, bearings, sheaves, sprockets, chains and belts

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

tools and equipment include: hand tools, gauges, levelling and alignment equipment

D-20.03 Maintains conveying systems

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-20.03.01P	perform ***sensory inspection***	***sensory inspection*** is performed to locate ***defects***
D-20.03.02P	select and use ***tools and equipment***	***tools and equipment*** are used according to job specifications
D-20.03.03P	verify maintenance requirements	maintenance requirements are verified according to manufacturers' specifications
D-20.03.04P	check ***conditions***	***conditions*** are checked according to manufacturers' specifications
D-20.03.05P	verify ***power transmission*** alignment and correct	alignment of ***power transmission*** is verified and corrected, if outside of tolerances
D-20.03.06P	check clearances	clearances are checked against manufacturers' specifications
D-20.03.07P	monitor ***components***	***components*** are maintained according to ***conveying system*** type
D-20.03.08P	monitor ***power transmission***	***power transmission*** is maintained by ***methods*** according to type of transmission

D-20.03.09P	adjust tracking of mechanical conveying systems	tracking of mechanical conveying systems are adjusted according to conveying requirements and manufacturers' specifications
D-20.03.10P	adjust ***conveying system accessories***	***conveying system accessories*** are adjusted according to manufacturers' specifications
D-20.03.11P	replace filters	filters are replaced according to indicators and manufacturers' specifications
D-20.03.12P	monitor safety device components and guards	safety device components and guards are maintained according to site and manufacturers' specifications and jurisdictional regulations

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for abnormalities
defects include: wear, misalignment
tools and equipment include: wrenches and tachometers as well as condition-based monitoring tools
conditions include: temperature, vibration, lubrication, pressure, flow rates
power transmissions include: couplings, sprockets and chains, sheaves and belts, gear boxes
components include: limit switches, emergency stops, magnets, pulleys, rollers, bearings
conveying systems include: pneumatic, belt, rollers, chain, screw, bucket, flume/water
methods include: cleaning, lubricating, adjusting, checking fluid levels, tensioning
conveying system accessories include: belt scraper, guides, training idlers, grizzlies, hoppers, chutes

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-20.03.01L	demonstrate knowledge of ***conveying systems***, their ***components*** and operation	define terminology associated with ***conveying systems***
		identify types of ***conveying systems*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-20.03.02L	demonstrate knowledge of safety practices related to ***conveying systems***	identify hazards and describe ***safe work practices*** associated with ***conveying systems***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***conveying systems***
D-20.03.03L	demonstrate knowledge of the procedures used to maintain ***conveying systems***	identify tools and equipment used to maintain ***conveying systems*** and describe their applications and procedures

	identify the factors to consider when determining if ***conveying systems*** or their ***components*** need to be repaired or replaced
	describe the procedures used to maintain ***conveying systems*** and their components
	identify the factors to consider and required calculations to determine ***conveying system*** requirements
	describe the procedures used to splice a conveyor belt
	describe the procedures used to track a conveyor belt

RANGE OF VARIABLES

conveying systems include: pneumatic, belt, rollers, chain, screw, bucket, flume/water
components include: limit switches, emergency stops, magnets, pulleys, rollers, bearings
safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

D-20.04 Repairs conveying systems

Essential Skills	Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-20.04.01P	access ***conveying systems***	***conveying systems*** are accessed by removing ***components*** and guards
D-20.04.02P	select and use ***tools and equipment***	***tools and equipment*** are used according to job specifications
D-20.04.03P	prepare ***conveying system*** for repair	***conveying system*** is prepared according to repair required and standard operating procedures (SOPs)
D-20.04.04P	dismantle ***conveying system***	***conveying system*** is dismantled according to type of repair required
D-20.04.05P	size, replace and align ***components***	***components*** are sized, replaced and aligned according to manufacturers' specifications
D-20.04.06P	repair ***power transmission***	***power transmission*** is repaired according to manufacturers' specifications

D-20.04.07P	patch, shorten or replace conveying belt	conveying belt is patched, shortened or replaced according to operating requirements and manufacturers' specifications
D-20.04.08P	verify rotation	rotation is checked prior to coupling up by performing bump test
D-20.04.09P	adjust tracking	tracking is adjusted according to conveying requirements and manufacturers' specifications
D-20.04.10P	adjust and replace ***conveying system accessories***	***conveying system accessories*** are adjusted and replaced according to manufacturers' specifications
D-20.04.11P	replace filters	filters are replaced according to indicators and manufacturers' specifications
D-20.04.12P	adjust and replace safety device components and guards	safety device components and guards are adjusted and replaced according to site and manufacturers' specifications and jurisdictional regulations

RANGE OF VARIABLES

conveying systems include: pneumatic, belt, rollers, chain, screw, bucket, flume/water
components include: limit switches, emergency stops, magnets, pulleys, rollers, bearings
tools and equipment include: wrenches, tachometers, condition-based monitoring tools
power transmissions include: couplings, sprockets and chains, sheaves and belts, gear boxes
conveying system accessories include: grizzlies, hoppers, chutes

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-20.04.01L	demonstrate knowledge of ***conveying systems***, their ***components*** and operation	define terminology associated with ***conveying systems***
		identify types of ***conveying systems*** and their ***components*** and accessories, and describe their purpose, applications and operation
D-20.04.02L	demonstrate knowledge of safety practices related to ***conveying systems***	identify hazards and describe ***safe work practices*** associated with ***conveying systems***
		interpret jurisdictional regulations and manufacturers' specifications pertaining to the use of ***conveying systems***
D-20.04.03L	demonstrate knowledge of the procedures used to repair ***conveying systems***	identify tools and equipment used to repair ***conveying systems*** and describe their applications and procedures
		identify the factors to consider when determining if ***conveying systems*** or their components need to be repaired or replaced

	identify the factors to consider and required calculations to determine ***conveying system*** requirements
	describe the procedures used to splice a conveyor belt
	describe the procedures used to track a conveyor belt

RANGE OF VARIABLES

conveying systems include: pneumatic, belt, rollers, chain, screw, bucket, flume/water

components include: limit switches, emergency stops, magnets, pulleys, rollers, bearings

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

MAJOR WORK ACTIVITY E

Services fluid power systems

TASK E-21 Services hydraulic systems

TASK DESCRIPTOR

Hydraulic systems are versatile systems that use high pressure, non-compressible fluids to transmit power in a variety of industries. Industrial mechanics (millwrights) service these systems to ensure proper and efficient operation. Servicing includes installing, diagnosing, maintaining and repairing.

E-21.01 Installs hydraulic systems

Essential Skills Numeracy, Document Use, Working with Others

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-21.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and manufacturers' specifications
E-21.01.02P	select system ***components***	system ***components*** are selected according to site specifications and engineered drawings
E-21.01.03P	select hydraulic fluids	hydraulic fluids are selected to meet system and environmental requirements, and manufacturers' specifications
E-21.01.04P	position and secure reservoirs for hydraulic systems	reservoirs for hydraulic systems are positioned and secured according to engineered drawings, manually or with rigging, hoisting/lifting and moving equipment, and according to jurisdictional regulations
E-21.01.05P	position, align and secure hydraulic ***components***	hydraulic ***components*** are positioned, aligned and secured according to manufacturers' specifications and engineered drawings, manually or with rigging, hoisting/lifting and moving equipment

E-21.01.06P	measure, cut, bend, assemble and connect piping, hoses and tubing	piping, hoses and tubing are measured, cut, bent, assembled and connected according to engineered drawings
E-21.01.07P	test system	system is tested by fine tuning pressure and fluid flow operation prior to startup according to manufacturers' specifications and jurisdictional regulations

RANGE OF VARIABLES

tools and equipment include: torque wrenches, pressure gauges, hand tools

components include: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-21.01.01L	demonstrate knowledge of the principles and applications of fluid power	explain the ***principles and theories of fluid power***
E-21.01.02L	demonstrate knowledge of hydraulic system related calculations	describe units of measure as they relate to hydraulic systems
		identify formulae related to hydraulic systems and describe their applications
		describe the calculations used to select and install hydraulic systems and ***components***
		perform hydraulic related calculations
E-21.01.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation	identify symbols and abbreviations related to hydraulic systems found on engineered drawings and schematics
		describe hydraulic systems engineered drawings and schematics and their applications
		interpret engineered drawings and schematics to determine the operation of hydraulic systems
		interpret information pertaining to piping systems found on engineered drawings and schematics
E-21.01.04L	demonstrate knowledge of safety practices related to hydraulic systems	identify hazards and describe ***safe work practices*** pertaining to hydraulic systems and ***components***
		identify hazards and describe ***safe work practices*** pertaining to piping systems
E-21.01.05L	demonstrate knowledge of hydraulic systems, their ***components*** and operation	define terminology associated with the installation of hydraulic systems and ***components***
		identify types of hydraulic systems and describe their applications and operation

		identify hydraulic systems ***components*** and describe their purpose and operation
		interpret jurisdictional regulations and manufacturers' specifications pertaining to installation of hydraulic systems and ***components***
		identify tools and equipment used to install hydraulic systems and ***components***, and describe their applications and procedures
E-21.01.06L	demonstrate knowledge of the procedures used to install hydraulic systems and ***components***	describe the procedures used to install hydraulic systems and ***components***
E-21.01.07L	demonstrate knowledge of piping systems, their ***components*** and operation	define terminology associated with piping systems
E-21.01.08L	demonstrate knowledge of the procedures used to install piping systems and their ***components***	interpret jurisdictional regulations and manufacturers' specifications pertaining to piping systems
		identify types of piping systems and describe their applications
		identify types of piping, tubing, and hoses and describe their compatibility, characteristics and applications
		identify types of fittings and describe their characteristics and applications
		identify piping system accessories and describe their characteristics and applications
		identify types of valves used in piping systems and describe their applications and operation
		describe the procedures used to install pipe, tubing and hoses

RANGE OF VARIABLES

principles and theories of fluid power include: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

components include: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors

E-21.02 Diagnoses hydraulic systems

Essential Skills Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-21.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
E-21.02.02P	perform ***sensory inspection*** of hydraulic systems	***sensory inspection*** of hydraulic systems is performed
E-21.02.03P	use ***tools and equipment***	***tools and equipment*** are used according to job and manufacturers' specifications
E-21.02.04P	visually inspect hydraulic system	visual inspection is performed to check for leaks, abnormal movements and oil conditions, and fluid levels
E-21.02.05P	perform ***condition-based monitoring*** and analysis	***condition-based monitoring*** and analysis are performed to detect defects not identified through sensory inspection and to determine ***next steps***
E-21.02.06P	interpret specifications	specifications from technical manuals, engineered drawings and manufacturers' specifications are interpreted
E-21.02.07P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations
E-21.02.08P	assess and detect faulty or damaged components	faulty or damaged components are assessed and detected to determine repair or replacement
E-21.02.09P	record hydraulic data	hydraulic data is recorded according to site specifications and jurisdictional regulations

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat, looking for leaks

tools and equipment include: hand tools, pressure loading valves, pressure/temperature/vacuum gauges, temperature gun, flowmeter

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

next steps include: repair, replace, overhaul, adjust, continue operation

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-21.02.01L	demonstrate knowledge of the principles and applications of ***fluid power***	explain the ***principles and theories of fluid power***
E-21.02.02L	demonstrate knowledge of hydraulic system related calculations	describe units of measure as they relate to hydraulic systems
		identify formulae related to hydraulic systems and describe their applications
		describe the calculations used during the diagnosis of hydraulic systems and ***components***
E-21.02.03L	demonstrate knowledge of engineered drawings, schematics and P&IDs, their use and interpretation	identify symbols and abbreviations related to hydraulic systems found on engineered drawings, schematics and P&IDs
		describe hydraulic systems engineered drawings, schematics and P&IDs and their applications
		interpret engineered drawings, schematics and P&IDs to determine the operation of hydraulic systems
		interpret information pertaining to piping systems found on engineered drawings, schematics and P&IDs
E-21.02.04L	demonstrate knowledge of safety practices related to hydraulic systems	identify hazards and describe ***safe work practices*** pertaining to hydraulic systems and ***components***
E-21.02.05L	demonstrate knowledge of hydraulic systems, their ***components*** and operation	define terminology associated with the diagnosis of hydraulic systems and ***components***
		identify types of hydraulic systems and describe their applications and operation
		identify hydraulic system ***components*** and describe their purpose and operation
		interpret jurisdictional regulations and manufacturers' specifications pertaining to hydraulic systems and ***components***

		identify tools and equipment used to diagnose hydraulic systems and ***components***, and describe their applications and procedures
E-21.02.06L	demonstrate knowledge of the procedures used to diagnose hydraulic systems and ***components***	describe the procedures used to diagnose hydraulic systems and ***components***
		describe the ***procedures used to inspect*** hydraulic systems and components
		identify the factors to consider when determining if hydraulic system ***components*** need to be repaired or replaced

RANGE OF VARIABLES

principles and theories of fluid power include: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

components include: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors

inspection procedures include: condition-based monitoring and sensory inspection

E-21.03 Maintains hydraulic systems

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-21.03.01P	inspect, modify and adjust hydraulic systems	hydraulic systems are inspected, modified and adjusted according to maintenance schedule using ***condition-based monitoring methods***
E-21.03.02P	use ***tools and equipment***	***tools and equipment*** are used according to job and manufacturers' specifications
E-21.03.03P	verify and adjust fluid levels	fluid levels are verified and adjusted according to site and manufacturers' specifications

E-21.03.04P	check and adjust system pressure, temperature, flow and lubrication	system pressure, temperature, flow and lubrication are checked and adjusted according to manufacturers' specifications, engineered drawings and schematics
E-21.03.05P	check and change filters	filters are checked and changed according to site and manufacturers' specifications
E-21.03.06P	validate overall performance of hydraulic systems	overall performance of hydraulic systems is validated according to performance specifications
E-21.03.07P	clean hydraulic systems and ***components***	hydraulic systems and ***components*** are cleaned according to site and manufacturers' specifications
E-21.03.08P	record maintenance results	maintenance results are recorded according to site specifications and jurisdictional regulations

RANGE OF VARIABLES

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

tools and equipment include: hand tools, torque wrenches

components include: pumps, motors, actuators, valves, accumulators, filters and strainers, fluid conductors

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-21.03.01L	demonstrate knowledge of the principles and applications of ***fluid power***	explain the ***principles and theories of fluid power***
E-21.03.02L	demonstrate knowledge of hydraulic systems related calculations	describe units of measure as they relate to hydraulic systems
		identify formulae related to hydraulic systems and describe their applications
		describe the calculations used during the maintenance of hydraulic systems and components
E-21.03.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation	identify symbols and abbreviations related to hydraulic systems found on engineered drawings and schematics
		describe hydraulic systems engineered drawings and schematics and their applications
		interpret engineered drawings and schematics to determine the operation of hydraulic systems
		interpret information pertaining to piping systems found on engineered drawings, and schematics

E-21.03.04L	demonstrate knowledge of safety practices related to hydraulic systems	identify hazards and describe ***safe work practices*** pertaining to hydraulic systems and ***components***
E-21.03.05L	demonstrate knowledge of hydraulic systems, their ***components*** and operation	define terminology associated with the maintenance of hydraulic systems and ***components***
		identify types of hydraulic systems and describe their applications and operation
		identify hydraulic system ***components*** and describe their purpose and operation
		interpret jurisdictional regulations and manufacturers' specifications pertaining to hydraulic systems and components
		identify tools and equipment used to maintain hydraulic systems and ***components***, and describe their applications and procedures
E-21.03.06L	demonstrate knowledge of the procedures used to maintain and repair hydraulic systems and ***components***	describe the ***procedures used to inspect and maintain*** hydraulic systems and ***components***
		identify the factors to consider when determining if hydraulic system ***components*** need to be repaired or replaced

RANGE OF VARIABLES

fluid power includes: hydraulic, pneumatic, vacuum

principles and theories of fluid power include: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

components include: pumps, motors, actuators, valves, accumulators, filters and strainers, fluid conductors

procedures used to inspect and maintain include: check hoses, piping and tubing, check fluids (condition and level), check/change filters, determine operating parameters, adjust system pressure, temperature and flow

E-21.04 Repairs hydraulic systems

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-21.04.01P	use ***tools and equipment***	***tools and equipment*** are used according to job and manufacturers' specifications
E-21.04.02P	release pressure	pressure is released in a controlled fashion to ensure system is at a zero-energy state and to avoid injury and equipment damage
E-21.04.03P	lockout ***components*** in place	***components*** are mechanically locked out, and motors are de-energized
E-21.04.04P	prevent contamination	contamination is prevented during repairs by ensuring clean ***components***, according to environmental regulations
E-21.04.05P	repair and replace ***components***	***components*** are repaired and replaced according to manufacturers' specifications, engineered drawings, and P&IDs
E-21.04.06P	remove and replace ***component parts***	***component parts*** are removed and replaced according to manufacturers' specifications, engineered drawings, and P&IDs
E-21.04.07P	modify systems	systems are modified according to site and manufacturers' specifications, schematics, engineered drawings, and P&IDs
E-21.04.08P	test system	system is tested by fine tuning pressure and fluid flow operation, prior to returning to service and functionality of safety devices and related equipment
E-21.04.09P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to site and manufacturers' specifications and jurisdictional regulations
E-21.04.10P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

tools and equipment include: hand tools, torque wrenches

components include: pumps, motors, actuators, valves, accumulators, filters and strainers, fluid conductors

component parts include: seals, pistons, valve spools, valve assembly

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-21.04.01L	demonstrate knowledge of the principles and applications of ***fluid power***	explain the ***principles and theories of fluid power***
E-21.04.02L	demonstrate knowledge of hydraulic systems related calculations	describe units of measure as they relate to hydraulic systems
		identify formulae related to hydraulic systems and describe their applications
		describe the calculations used during the repair of hydraulic systems and ***components***
E-21.04.03L	demonstrate knowledge of engineered drawings, schematics, and P&IDs their use and interpretation	identify symbols and abbreviations related to hydraulic systems found on engineered drawings, schematics, and P&IDs
		describe hydraulic systems engineered drawings, schematics, and P&IDs and their applications
		interpret engineered drawings, schematics, and P&IDs to determine the operation of hydraulic systems
		interpret information pertaining to piping systems found on engineered drawings, schematics, and P&IDs
E-21.04.04L	demonstrate knowledge of safety practices related to hydraulic systems	identify hazards and describe ***safe work practices*** pertaining to hydraulic systems and ***components***
E-21.04.05L	demonstrate knowledge of hydraulic systems, their ***components*** and operation	define terminology associated with the repair of hydraulic systems and ***components***
		identify types of hydraulic systems and describe their applications and operation
		identify hydraulic system ***components*** and describe their purpose and operation
		interpret jurisdictional regulations and manufacturers' specifications pertaining to hydraulic systems and ***components***
		identify tools and equipment used to repair hydraulic systems and ***components***, and describe their applications and procedures

E-21.04.06L	demonstrate knowledge of the procedures used to repair hydraulic systems and ***components***	describe the ***procedures used to repair*** hydraulic systems and ***components***
		identify the factors to consider when determining if hydraulic system ***components*** need to be repaired or replaced

RANGE OF VARIABLES

fluid power includes: hydraulic, pneumatic, vacuum

principles and theories of fluid power include: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle

components include: pumps, motors, actuators, valves, accumulators, filters and strainers, fluid conductors

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

procedures used to repair include: replacing hoses, piping and tubing, fluids, check/change filters, adjust system pressure, temperature and flow

TASK E-22 Services pneumatic and vacuum systems

TASK DESCRIPTOR

Pneumatic and vacuum systems provide control and power for mechanical and process systems. Industrial mechanics (millwrights) are responsible for the installation, diagnosis, repair and maintenance of these systems. Servicing includes installing, diagnosing, maintaining and repairing.

E-22.01 Installs pneumatic and vacuum systems

Essential Skills Numeracy, Document Use, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-22.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and manufacturers' specifications
E-22.01.02P	select system ***components***	system ***components*** are selected according to site specifications and engineered drawings

E-22.01.03P	position and secure receivers	receivers for pneumatic and vacuum systems are positioned and secured according to engineered drawings, manually or with rigging, hoisting/lifting and moving equipment, and according to jurisdictional regulations
E-22.01.04P	position, align and secure pneumatic and vacuum system ***components***	pneumatic and vacuum system ***components*** are positioned, aligned and secured according to manufacturers' specifications and engineered drawings, manually or with rigging, hoisting/lifting and moving equipment
E-22.01.05P	measure, cut, bend, assemble and connect piping, hoses and tubing	piping, hoses and tubing are measured, cut, bent, assembled and connected according to engineered drawings
E-22.01.06P	test system	system is tested by fine tuning pressure and volumetrics prior to startup according to manufacturers' specifications, jurisdictional regulations and engineered drawings

RANGE OF VARIABLES

tools and equipment include: torque wrenches, pressure/vacuum gauges and hand tools

components include: hoses, seals, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blower, pumps, motors, actuators, valves

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-22.01.01L	demonstrate knowledge of the principles and applications of ***fluid power***	explain the ***principles and theories of fluid power***
E-22.01.02L	demonstrate knowledge of pneumatic and vacuum systems related calculations	describe units of measure as they relate to pneumatic and vacuum systems
		identify formulae related to pneumatic and vacuum systems and describe their applications
		describe the calculations used to select and install pneumatic and vacuum systems and ***components***
		perform pneumatic and vacuum related calculations
E-22.01.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation	identify symbols and abbreviations related to pneumatic and vacuum systems found on engineered drawings and schematics
		describe pneumatic and vacuum systems engineered drawings and schematics and their applications

		interpret engineered drawings and schematics to determine the operation of pneumatic and vacuum systems
		interpret information pertaining to piping systems found on engineered drawings and schematics
E-22.01.04L	demonstrate knowledge of safety practices related to pneumatic and vacuum systems	identify hazards and describe ***safe work practices*** pertaining to pneumatic and vacuum systems and ***components***
		identify hazards and describe ***safe work practices*** pertaining to piping systems
E-22.01.05L	demonstrate knowledge of pneumatic and vacuum systems, their ***components*** and operation	define terminology associated with the installation of pneumatic and vacuum systems and ***components***
		identify types of pneumatic and vacuum systems and describe their applications and operation
		identify pneumatic and vacuum systems ***components*** and describe their purpose and operation
		interpret jurisdictional regulations and manufacturers' specifications pertaining to installation of pneumatic and vacuum systems and components
		identify tools and equipment used to install pneumatic and vacuum systems and ***components***, and describe their applications and procedures
		describe the methods of ***air treatment*** in pneumatic systems
E-22.01.06L	demonstrate knowledge of the procedures used to install pneumatic and vacuum systems and ***components***	describe the procedures used to install pneumatic and vacuum systems and components
E-22.01.07L	demonstrate knowledge of piping systems, their ***components*** and operation	define terminology associated with piping systems
E-22.01.08L	demonstrate knowledge of the procedures used to install piping systems and their ***components***	interpret jurisdictional regulations and manufacturers' specifications pertaining to piping systems
		identify types of piping systems and describe their applications
		identify types of piping, tubing, and hoses and describe their compatibility, characteristics and applications
		identify types of fittings and describe their characteristics and applications
		identify piping system accessories and describe their characteristics and applications

	identify types of valves used in piping systems and describe their applications and operation
	describe the procedures used to install pipe, tubing and hoses

RANGE OF VARIABLES

fluid power includes: pneumatic, vacuum

principles and theories of fluid power include: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle

components include: hoses, seals, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blower, pumps, motors, actuators, valves

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

air treatment includes: dryers, after-coolers, de-icers

E-22.02 Diagnoses pneumatic and vacuum systems

Essential Skills Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-22.02.01P	obtain a description of the problem and symptoms	description of the problem and symptoms is obtained
E-22.02.02P	perform ***sensory inspection*** of pneumatic and vacuum systems	***sensory inspection*** of pneumatic and vacuum systems is performed
E-22.02.03P	use ***tools and equipment***	***tools and equipment*** are used according to job and manufacturers' specifications
E-22.02.04P	visually inspect pneumatic and vacuum systems	visual inspection is performed to check for leaks, abnormal movements and oil conditions, and fluid levels
E-22.02.05P	perform ***condition-based monitoring methods*** and analysis	***condition-based monitoring methods*** and analysis are performed to detect defects not identified through ***sensory inspection*** and to determine ***next steps***
E-22.02.06P	interpret specifications	specifications from technical manuals, engineered drawings and manufacturers' specifications are interpreted
E-22.02.07P	remove and replace safety guards and ***safety devices***	safety guards and ***safety devices*** are removed and replaced according to site and manufacturers' specifications, and jurisdictional regulations

E-22.02.08P	assess and detect faulty or damaged ***components***	faulty or damaged ***components*** are assessed and detected to determine repair or replacement
E-22.02.09P	record pneumatic and vacuum data	pneumatic and vacuum data is recorded according to site specifications and jurisdictional regulations

RANGE OF VARIABLES

sensory inspection includes: listening for excessive noise, smelling burned components, feeling for excessive vibration and heat

tools and equipment include: torque wrenches, pressure/vacuum gauges and hand tools

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

next steps include: repair, replace, overhaul, adjust, continue operation

safety devices include: light curtains, pressure sensitive matting, keyed switches, lock-outs, physical guards

components include: hoses, seals, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blower, pumps, motors, actuators, valves

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-22.02.01L	demonstrate knowledge of the principles and applications of ***fluid power***	explain the ***principles and theories of fluid power***
E-22.02.02L	demonstrate knowledge of pneumatic and vacuum system related calculations	describe units of measure as they relate to pneumatic and vacuum systems
		identify formulae related to pneumatic and vacuum systems and describe their applications
		describe the calculations used during the diagnosis of pneumatic and vacuum systems and ***components***
E-22.02.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation	identify symbols and abbreviations related to pneumatic and vacuum systems found on engineered drawings and schematics
		describe pneumatic and vacuum systems engineered drawings and schematics and their applications
		interpret engineered drawings and schematics to determine the operation of pneumatic and vacuum systems
		interpret information pertaining to piping systems found on engineered drawings, and schematics
E-22.02.04L	demonstrate knowledge of safety practices related to pneumatic and vacuum systems	identify hazards and describe ***safe work practices*** pertaining to pneumatic and vacuum systems and ***components***

E-22.02.05L	demonstrate knowledge of pneumatic and vacuum systems, their ***components*** and operation	define terminology associated with the diagnosis of pneumatic and vacuum systems and ***components***
		identify types of pneumatic and vacuum systems and describe their applications and operation
		identify pneumatic and vacuum systems ***components*** and describe their purpose and operation
		interpret jurisdictional regulations and manufacturers' specifications pertaining to pneumatic and vacuum systems and ***components***
		identify tools and equipment used to diagnose pneumatic and vacuum systems and ***components***, and describe their applications and procedures
		describe the methods of ***air treatment*** in pneumatic systems
E-22.02.06L	demonstrate knowledge of the procedures used to diagnose pneumatic and vacuum systems and ***components***	describe the procedures used to diagnose pneumatic and vacuum systems and ***components***
		describe the ***procedures used to inspect*** pneumatic and vacuum systems and ***components***
		identify the factors to consider when determining if pneumatic and vacuum systems ***components*** need to be repaired or replaced

RANGE OF VARIABLES

fluid power includes: pneumatic, vacuum

principles and theories of fluid power include: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle

components include: hoses, seals, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blower, pumps, motors, actuators, valves

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

air treatment includes: dryers, after-coolers, de-icers

E-22.03 Maintains pneumatic and vacuum systems

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-22.03.01P	inspect, modify and adjust pneumatic and vacuum systems	pneumatic and vacuum systems are inspected, modified and adjusted according to maintenance schedule using ***condition-based monitoring methods***
E-22.03.02P	use ***tools and equipment***	***tools and equipment*** are used according to job and manufacturers' specifications
E-22.03.03P	check and adjust system pressure, vacuum, lubricators, regulators, temperature, cycling and flow	system pressure, vacuum, lubricators, regulators, temperature, cycling and flow are checked and adjusted according to manufacturers' specifications, engineered drawings and schematics
E-22.03.04P	check and change gauges, filters and dryers	gauges, filters and dryers are checked and changed according to site and manufacturers' specifications
E-22.03.05P	validate overall performance of pneumatic and vacuum systems	overall performance of pneumatic and vacuum systems is validated according to performance specifications
E-22.03.06P	clean pneumatic and vacuum systems and ***components***	pneumatic and vacuum systems and ***components*** are cleaned according to site and manufacturers' specifications
E-22.03.07P	record maintenance results	maintenance results are recorded according to site specifications and jurisdictional regulations
E-22.03.08P	modify system	system is modified to accommodate a change in requirements according to schematics and site specifications

RANGE OF VARIABLES

condition-based monitoring methods include: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, rotation speed monitoring

tools and equipment include: torque wrenches, pressure/vacuum gauges and hand tools

components include: hoses, seals, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blowers, pumps, motors, actuators, valves

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-22.03.01L	demonstrate knowledge of the principles and applications of ***fluid power***	explain the ***principles and theories of fluid power***
E-22.03.02L	demonstrate knowledge of pneumatic and vacuum systems related calculations	describe units of measure as they relate to pneumatic and vacuum systems
		identify formulae related to pneumatic and vacuum systems and describe their applications
		describe the calculations used during the maintenance of pneumatic and vacuum systems and ***components***
E-22.03.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation	identify symbols and abbreviations related to pneumatic and vacuum systems found on engineered drawings and schematics
		describe pneumatic and vacuum systems engineered drawings and schematics and their applications
		interpret engineered drawings and schematics to determine the operation of pneumatic and vacuum systems
		interpret information pertaining to piping systems found on engineered drawings, and schematics
E-22.03.04L	demonstrate knowledge of safety practices related to pneumatic and vacuum systems	identify hazards and describe ***safe work practices*** pertaining to pneumatic and vacuum systems and ***components***
E-22.03.05L	demonstrate knowledge of pneumatic and vacuum systems, their ***components*** and operation	define terminology associated with the maintenance of pneumatic and vacuum systems and ***components***
		identify types of pneumatic and vacuum systems and describe their applications and operation
		identify pneumatic and vacuum systems ***components*** and describe their purpose and operation
		interpret jurisdictional regulations and manufacturers' specifications pertaining to pneumatic and vacuum systems and ***components***
		identify tools and equipment used to maintain pneumatic and vacuum systems and ***components***, and describe their applications and procedures
		describe the methods of ***air treatment*** in pneumatic systems

E-22.03.06L	demonstrate knowledge of the procedures used to maintain pneumatic and vacuum systems and ***components***	describe the ***procedures used to inspect and maintain*** pneumatic and vacuum systems and ***components***
		identify the factors to consider when determining if pneumatic and vacuum systems ***components*** need to be repaired or replaced

RANGE OF VARIABLES

fluid power includes: pneumatic, vacuum

principles and theories of fluid power include: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle

components include: hoses, seals, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blowers, pumps, motors, actuators, valves

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

air treatment includes: dryers, after-coolers, de-icers

procedures used to inspect and maintain include: check hoses, piping and tubing, check lubricating fluids (condition and level), check/change filters, determine operating parameters, adjust system pressure, temperature and flow

E-22.04 Repairs pneumatic and vacuum systems

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-22.04.01P	use ***tools and equipment***	***tools and equipment*** are used according to job and manufacturers' specifications
E-22.04.02P	release pressure	pressure is released in a controlled fashion to ensure system is at a zero-energy state and to avoid injury and equipment damage
E-22.04.03P	lockout ***components*** in place	***components*** are mechanically locked out, and motors are de-energized and locked
E-22.04.04P	prevent contamination	contamination is prevented during repairs by ensuring clean components, according to environmental regulations
E-22.04.05P	repair and replace ***components***	***components*** are repaired and replaced according to manufacturers' specifications and engineered drawings

E-22.04.06P	remove and replace ***component parts***	***component parts*** are removed and replaced according to manufacturers' specifications and engineered drawings
E-22.04.07P	modify systems	systems are modified according to schematics, site and manufacturers' specifications and engineered drawings
E-22.04.08P	test system	system is tested by fine tuning pressure and volumetrics, prior to returning to service and functionality of safety devices and related equipment
E-22.04.09P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to site and manufacturers' specifications and jurisdictional regulations
E-22.04.10P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

RANGE OF VARIABLES

tools and equipment include: torque wrenches, pressure/vacuum gauges and hand tools

components include: hoses, seals, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blowers, pumps, motors, actuators, valves

component parts include: hoses, seals, pistons, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blowers, pumps, motors, actuators, valves, springs, o-rings, spools, valve assemblies and spools, gaskets

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-22.04.01L	demonstrate knowledge of the principles and applications of fluid power	explain the ***principles and theories of fluid power***
E-22.04.02L	demonstrate knowledge of pneumatic and vacuum systems related calculations	describe units of measure as they relate to pneumatic and vacuum systems
		identify formulae related to pneumatic and vacuum systems and describe their applications
		describe the calculations used during the repair of pneumatic and vacuum systems and ***components***
E-22.04.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation	identify symbols and abbreviations related to pneumatic and vacuum systems found on engineered drawings and schematics
		describe pneumatic and vacuum systems, engineered drawings and schematics and their applications
		interpret engineered drawings and schematics to determine the operation of pneumatic and vacuum systems

		interpret information pertaining to piping systems found on engineered drawings, and schematics
E-22.04.04L	demonstrate knowledge of safety practices related to pneumatic and vacuum systems	identify hazards and describe ***safe work practices*** pertaining to pneumatic and vacuum systems and ***components***
E-22.04.05L	demonstrate knowledge of pneumatic and vacuum systems, their components and operation	define terminology associated with the repair of pneumatic and vacuum systems and ***components***
		identify types of pneumatic and vacuum systems and describe their applications and operation
		identify pneumatic and vacuum systems ***components*** and describe their purpose and operation
		interpret jurisdictional regulations and manufacturers' specifications pertaining to pneumatic and vacuum systems and ***components***
		identify tools and equipment used to repair pneumatic and vacuum systems and ***components***, and describe their applications and procedures
		describe the methods of ***air treatment*** in pneumatic systems
E-22.04.06L	demonstrate knowledge of the procedures used to repair pneumatic and vacuum systems and ***components***	describe the ***procedures used to repair*** pneumatic and vacuum systems and ***components***
		identify the factors to consider when determining if pneumatic and vacuum systems ***components*** need to be repaired or replaced

RANGE OF VARIABLES

principles and theories of fluid power include: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle

components include: hoses, seals, fittings, strainers, filter regulator lubricator (FRL), piping, receivers, tanks for pneumatic and vacuum systems, blowers, pumps, motors, actuators, valves

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

air treatment include: dryers, after-coolers, de-icers

procedures used to repair include: replacing hoses, piping and tubing, fluids, check/change filters, adjust system pressure, temperature and flow

MAJOR WORK ACTIVITY F

Performs preventative and predictive maintenance, commissioning and decommissioning

TASK F-23 Performs preventative and predictive maintenance

TASK DESCRIPTOR

Industrial mechanics (millwrights) may perform preventative and predictive maintenance tasks to ensure functional and consistent performance of machinery and equipment.

Preventative maintenance involves the routine scheduling of maintenance activities based on past history and manufacturers' recommendations as well as jurisdictional regulations. It is done to increase reliability of the equipment.

Predictive maintenance involves the application of predictive maintenance technologies for early detection of equipment defects that could lead to unplanned downtime or unnecessary expenditures.

This may include vibration analysis, balancing and alignment, NDT and fluid analysis. It is important to perform these tasks to optimize longevity and reliability of the equipment.

F-23.01 Performs preventative maintenance activities

Essential Skills Digital Technology, Document Use, Thinking

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-23.01.01P	perform ***sensory inspections*** of equipment and ***components***	***sensory inspections*** of equipment and ***components*** are performed at predetermined scheduled intervals to detect ***defects***
F-23.01.02P	perform hands-on inspections	hands-on inspections of equipment and ***components*** are performed
F-23.01.03P	check system condition	***components*** with ***defects*** are repaired, replaced or maintained according to site and manufacturers' specifications, and jurisdictional regulations

F-23.01.04P	check condition, level and temperature of fluids	condition, level and temperature of fluids are checked according to site and manufacturers' specifications, and jurisdictional regulations
F-23.01.05P	lubricate ***components***	***components*** are lubricated according to site and manufacturers' specifications, and jurisdictional regulations
F-23.01.06P	record information for future equipment evaluation and repair	information for future equipment evaluation and repair is recorded
F-23.01.07P	review collected data	collected data is reviewed to determine suitable maintenance scope and schedules

RANGE OF VARIABLES

sensory inspections include: visual, auditory, feel, smell
components include: filters, sight glasses, packing, seals, bearings, gaskets, belts, chains, tie rods
defects include: change in pitch, rattling, cracks, loose bolts, leaks

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-23.01.01L	demonstrate knowledge of preventative maintenance	define terminology associated with preventative maintenance
		interpret jurisdictional regulations, site and manufacturers' specifications pertaining to preventative maintenance procedures
		identify ***tools and equipment*** used for preventative maintenance, and describe their applications and procedures
		identify ***types of maintenance*** and describe their purpose and applications
		identify ***sources of information used to develop maintenance history***
F-23.01.02L	demonstrate knowledge of the procedures used to perform preventative maintenance	identify ***preventative maintenance practices***, and describe their applications
		describe the procedures used to perform preventative maintenance activities
		describe the procedures used to record preventative maintenance data
		describe the procedures used to schedule preventative maintenance activities
F-23.01.03L	demonstrate knowledge of safety practices related to preventative maintenance procedures	identify hazards and describe ***safe work practices*** pertaining to preventative maintenance procedures

RANGE OF VARIABLES

tools and equipment include: hand tools, gauges, strobe lights

types of maintenance include: breakdown, preventative, predictive, proactive, corrective, RCM

sources of information used to develop maintenance history include: reports, checklists, manufacturers' specifications, root cause analysis, equipment history (work order)

preventative maintenance practices include: non-destructive testing, fluid analysis, balancing, thermography, motor current analysis, reactive, scheduled overhauls, scheduled replacement, running preventative maintenance (PM's)

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

F-23.02 Performs vibration analysis procedures

Essential Skills Reading, Digital Technology, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-23.02.01P	select vibration analysis equipment	vibration analysis equipment is selected according to ***application***, site specifications and jurisdictional regulations
F-23.02.02P	install the necessary manufacturer components	necessary manufacturer components are installed to achieve consistent readings at predetermined access points
F-23.02.03P	set parameters to use vibration analysis equipment	parameters of vibration analysis equipment for desired data collection are set according to site and manufacturers' specifications
F-23.02.04P	collect readings at consistent points across rotating and non-rotating equipment	readings are collected at consistent points across rotating and non-rotating equipment
F-23.02.05P	identify vibration frequencies related to type of components on which data is being collected	vibration frequencies related to type of components on which data is being collected are identified
F-23.02.06P	identify ***causes of vibration***	***causes of vibration*** are identified based on interpretation of data collected

RANGE OF VARIABLES

application includes: overall vibration analysis

causes of vibration include: eccentricity, misalignment, shaft faults, mechanical looseness, mechanical frequencies, natural frequencies, imbalance

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-23.02.01L	demonstrate knowledge of the procedures used to perform vibration analysis	define terminology associated with vibration analysis
		identify ***tools and equipment*** used for vibration analysis and describe their applications and procedures
		identify and interpret ***sources of information pertaining to vibration analysis***
		identify ***causes of vibration***
		identify vibration analysis methods and describe their applications
		describe the procedures used to perform vibration analysis
		record and interpret data collected using vibration analysis equipment
F-23.02.02L	demonstrate knowledge of safety practices related to vibration analysis	identify hazards and describe ***safe work practices*** pertaining to vibration analysis

RANGE OF VARIABLES

tools and equipment include: data collector, probes, vibration pen, strobe, online monitor, transducers

sources of information pertaining to vibration analysis include: manufacturers' specifications, vibration standards and charts, Canadian Machinery Vibration Association (CMVA) interpretations and guidelines

causes of vibration include: eccentricity, misalignment, shaft faults, mechanical looseness, mechanical frequencies, natural frequencies, imbalance

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

F-23.03 Performs balancing procedures

Essential Skills	Document Use, Digital Technology, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-23.03.01P	inspect equipment	equipment is inspected for ***defects*** according to site and manufacturers' specifications, and jurisdictional regulations
F-23.03.02P	clean equipment	equipment is cleaned to confirm if balancing is necessary
F-23.03.03P	identify type of imbalance in equipment	type of imbalance in equipment is identified to determine corrective action needed
F-23.03.04P	use balancing equipment	balancing equipment is used to determine location of imbalance
F-23.03.05P	add or remove specific weights at identified locations	specific weights at identified locations are added or removed according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

defects include: broken fins, bent shafts, missing weights, loose fit, worn components

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-23.03.01L	demonstrate knowledge of balancing procedures	define terminology associated with balancing
		identify ***tools and equipment*** required for balancing and describe their applications and procedures
		identify and interpret ***sources of information pertaining to balancing***
		identify the ***conditions of imbalance*** and describe their characteristics
		identify the types of ***balancing methods*** and describe their applications
		describe ***balancing procedures***

		perform calculations required for balancing
F-23.03.02L	demonstrate knowledge of safety practices related to balancing procedures	identify hazards and describe ***safe work practices*** pertaining to balancing procedures

RANGE OF VARIABLES

tools and equipment include: hand tools, weights, polar graphing charts, protractor, balancing equipment (hand-held devices, shop balancing machines, knife edges, strobe)

sources of information pertaining to balancing include: manufacturers' specifications, vibration standards and charts, Canadian Machinery Vibration Association (CMVA) interpretations and guidelines

conditions of imbalance include: static, couple, quasi-static, dynamic

balancing methods include: single-plane, multi-plane

balancing procedures include: static, dynamic, multi-plane

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

F-23.04 Performs non-destructive testing (NDT) procedures

Essential Skills	Digital Technology, Document Use, Reading

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-23.04.01P	prepare the component for testing	component is prepared for testing to avoid false readings
F-23.04.02P	select NDT method based on ***component characteristics***	NDT method is selected based on ***component characteristics*** to detect ***defects*** according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

component characteristics include: ferrous, non-ferrous, hardness, ductility, composition, malleability, material thickness

defects include: cracks, thin walls, inclusions

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-23.04.01L	demonstrate knowledge of the procedures used to perform ***NDT methods***	define terminology associated with ***NDT methods***
		demonstrate an awareness of jurisdictional regulations pertaining to ***NDT methods***
		identify ***tools and equipment*** used for ***NDT methods,*** and describe their applications and procedures
		identify types of ***NDT methods*** and describe their applications
		describe the procedures used to perform ***NDT methods***
		record and interpret data collected using ***NDT methods***
F-23.04.02L	demonstrate knowledge of safety practices related to ***NDT methods***	identify hazards and describe ***safe work practices*** pertaining to ***NDT methods***

RANGE OF VARIABLES

non-destructive testing methods include: dye penetrant, magnetic particle, radiography, ultrasonic, visual, thermography, air or water pressure testing, eddy current analysis

tools and equipment include: hand tools, dye penetrant tool kit, ultrasonic thickness tester, thermographic camera, pressure gauges

F-23.05 Performs fluid analysis procedures

Essential Skills	Digital Technology, Document Use, Reading

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
F-23.05.01P	perform sensory inspections of fluid condition	sensory inspections of fluid condition is performed to detect ***defects***
F-23.05.02P	determine location and frequency of sample collection	location and frequency of sample collection is determined according to site and manufacturers' specifications, and jurisdictional regulations

F-23.05.03P	interpret ***test report information***	***test report information*** is interpreted
F-23.05.04P	direct information for corrective action	information for corrective action is directed from ***test report information*** according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

defects include: change in colour and odour, presence of sludge, impurities, too hot or too cold
test report information includes: contamination, abnormal viscosity, wear particles, corrective actions

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-23.05.01L	demonstrate knowledge of fluid analysis	define terminology associated with fluid analysis
		interpret fluid sampling results according to jurisdictional regulations
		identify ***tools and equipment*** used for fluid sampling, and describe their applications and procedures
		identify fluid contaminants and describe their causes and remedies
F-23.05.02L	demonstrate knowledge of the procedures used to collect and test fluid samples	describe the procedures used to collect and test fluid samples from systems
		record and interpret data from fluid analysis
F-23.05.03L	demonstrate knowledge of safety practices related to fluid sampling	identify hazards and describe ***safe work practices*** pertaining to fluid sampling

RANGE OF VARIABLES

tools and equipment include: hot plate, viscometer (viscosimeter), litmus paper, infrared, sample bottles, hand tools
safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

F-23.06 Performs predictive maintenance activities

Essential Skills	Digital Technology, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-23.06.01P	select specialized ***tools and equipment***	specialized ***tools and equipment*** are selected based on their applications, limitations, and accuracy of the result
F-23.06.02P	select ***NDT methods***	***NDT method*** is selected based on the characteristics of the component being tested
F-23.06.03P	detect faults, frequencies or defects in machine components	faults, frequencies or defects in the machine components are detected by reviewing ***historical data***
F-23.06.04P	record information for future equipment evaluation and repair	information for future equipment evaluation and repair is recorded
F-23.06.05P	review collected data	collected data is reviewed to determine suitable maintenance scope and schedules

RANGE OF VARIABLES

tools and equipment include: hand tools, dye penetrant tool kit, ultrasonic thickness tester, thermographic camera, pressure gauges, vibration analysis tools, balancing tools

non-destructive testing methods include: dye penetrant, magnetic particle, radiography, ultrasonic, visual, thermography, air or water pressure testing

historical data includes: spectrums, graphs, logbooks, lab reports, images, work order history, inspection reports

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-23.06.01L	demonstrate knowledge of predictive maintenance procedures	define terminology associated with predictive maintenance
		interpret site and manufacturers' specifications and jurisdictional regulations pertaining to predictive maintenance procedures
		identify ***tools and equipment*** used for predictive maintenance, and describe their applications and procedures
		identify ***types of maintenance*** and describe their purpose and applications

		identify ***sources of information used to develop maintenance history***
F-23.06.02L	demonstrate knowledge of the procedures used to perform predictive maintenance	identify ***predictive maintenance practices*** and describe their applications
		describe the procedures used to schedule predictive maintenance activities
		describe the procedures used to perform predictive maintenance activities
		describe the procedures used to record predictive maintenance data
F-23.06.03L	demonstrate knowledge of safety practices related to predictive maintenance procedures	identify hazards and describe ***safe work practices*** pertaining to predictive maintenance procedures

RANGE OF VARIABLES

tools and equipment include: hand tools, dye penetrant tool kit, ultrasonic thickness tester, thermographic camera, pressure gauges, vibration analysis tools, balancing tools

types of maintenance include: breakdown, preventive, predictive, proactive, corrective

sources of information used to develop maintenance history include: reports, checklists, manufacturers' specifications, root cause analysis, spectrums, graphs, logbooks, lab reports, images, work order history, inspection reports

predictive maintenance practices include: vibration analysis, non-destructive testing, fluid analysis, balancing, thermography, motor current analysis, ultrasonic

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

TASK F-24 Commissions and decommissions equipment

TASK DESCRIPTOR

After installation or repair, industrial mechanics (millwrights) commission equipment to ensure that it operates to specifications. Steps include startup, assessment and adjustment, and determining baseline operating specifications when necessary. Once a piece of equipment is removed from active service, a formal process of decommissioning is required.

F-24.01 Commissions systems and components

Essential Skills Document Use, Digital Technology, Reading

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-24.01.01P	review ***information sources and documentation***	checklist is developed or followed according to ***information sources and documentation***
F-24.01.02P	review mechanical system and component checklist	mechanical system and component checklist is reviewed to ensure that all procedures have been completed according to engineering and manufacturers' specifications
F-24.01.03P	review fluid power system and component checklist	fluid power system checklist is reviewed to ensure that all procedures have been completed according to engineering and manufacturers' specifications
F-24.01.04P	check mechanical systems ***safety components***	mechanical systems ***safety components*** are checked according to site and manufacturers' specifications, and jurisdictional regulations
F-24.01.05P	check fluid power systems ***safety components***	fluid power systems ***safety components*** are checked according to site and manufacturers' specifications and jurisdictional regulations
F-24.01.06P	start up systems and equipment	systems and equipment are started up and run-in according to site and manufacturers' specifications, and jurisdictional regulations
F-24.01.07P	perform ***monitoring activities***	***monitoring activities*** are performed according to site and manufacturers' specifications, and jurisdictional regulations

F-24.01.08P	confirm ***alignment*** of equipment and components	***alignment*** of equipment and components are confirmed before and after manufacturers' recommended run-in period
F-24.01.09P	perform and record ***baseline readings***	***baseline readings*** are performed and recorded according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

information sources and documentation include: manufacturers' specifications, operating parameters, jurisdictional codes and regulations

safety components include: guards, emergency stops, interlocks, over speed trips, pressure relief

monitoring activities include: packing adjustments, re-torque bolts, alignments, fluid levels, temperature, vibration

alignment includes: hot alignment, cold alignment, static

baseline readings include: vibration, temperature, fluid levels, ultrasound

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-24.01.01L	demonstrate knowledge of commissioning and its purpose	define terminology associated with commissioning
		explain the purpose of commissioning and identify the types of ***mechanical systems and components***
		explain the purpose of commissioning and identify the types of ***fluid power systems and components***
		interpret ***information sources and documentation*** pertaining to commissioning
F-24.01.02L	demonstrate knowledge of safety practices related to commissioning	identify hazards and describe ***safe work practices*** pertaining to commissioning ***mechanical systems and components***
		identify hazards and describe ***safe work practices*** pertaining to the commissioning of ***fluid power systems and components***
F-24.01.03L	demonstrate knowledge of the procedures used to commission systems and components	describe the procedures used to commission ***mechanical systems and components***
		describe the procedures used to commission ***fluid power systems and components***

RANGE OF VARIABLES

mechanical systems and components include: internal combustion engines, electric motors, conveying systems***,*** positive displacement pumps, centrifugal pumps, reciprocating compressors, gear drives, turbines

fluid power systems and components include: hydraulic, pneumatic, vacuum

safety components include: guards, emergency stops, interlocks, over speed trips, pressure relief

information sources and documentation include: manufacturers' specifications, operating parameters, jurisdictional codes and regulations

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

F-24.02 Decommissions systems and components

Essential Skills Document Use, Digital Technology, Reading

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-24.02.01P	review ***information sources and documentation***	checklist is developed or followed according to ***information sources and documentation***
F-24.02.02P	perform decontamination procedures	follow-up decommissioning checklist is complete according to site and manufacturers' specifications, and jurisdictional regulations
F-24.02.03P	sort, recycle and dispose of ***materials***	***materials*** are sorted, recycled and disposed of according to site and manufacturers' specifications, and jurisdictional regulations
F-24.02.04P	perform ***decommissioning***	***decommissioning*** is performed according to site and manufacturers' specifications, and jurisdictional regulations
F-24.02.05P	record ***decommissioning***	***decommissioning*** is recorded according to site and manufacturers' specifications, and jurisdictional regulations

RANGE OF VARIABLES

information sources and documentation include: manufacturers' specifications, operating parameters, jurisdictional codes and regulations (TDG, WHMIS, environmental assessment)

materials include: petro chemicals, effluents, hazardous waste, ferrous and non-ferrous metals

decommissioning includes: disassembly, removal of components, removal of machines

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-24.02.01L	demonstrate knowledge of decommissioning and its purpose	define terminology associated with decommissioning
		explain the purpose of decommissioning and identify the types of systems and components that need to be decommissioned
		interpret ***information sources and documentation*** pertaining to the decommissioning of systems, components and parts
F-24.02.02L	demonstrate knowledge of safety practices related to decommissioning systems or components	identify hazards and describe ***safe work practices*** pertaining to decommissioning systems or components
F-24.02.03L	demonstrate knowledge of the procedures used to decommission systems and components	describe the procedures used to decommission ***mechanical systems and components***
		describe the procedures used to decommission ***fluid power systems and components***
		describe the procedures used to conduct an environmental assessment

RANGE OF VARIABLES

information sources and documentation include: manufacturers' specifications, operating parameters, jurisdictional codes and regulations (transportation of dangerous goods (TDG), WHMIS, environmental assessment)

safe work practices include: company policies, site procedures, jurisdictional regulations, manufacturers' recommendations

mechanical systems and components include: internal combustion engines, electric motors, conveying systems***,*** positive displacement pumps, centrifugal pumps, reciprocating compressors, gear drives

fluid power systems include: hydraulic, pneumatic, vacuum

APPENDIX A
ACRONYMS

ABS	acrylonitrile butadiene styrene
AC / DC	alternating current / direct current
CAD	computer aided drawing/design
CMMS	computerized maintenance management system
EOAT	end of arm tooling
FCAW	flux-cored arc welding
GMAW	gas metal arc welding (also known as metal inert gas [MIG] welding)
GPS	Global Positioning System
GTAW	gas tungsten arc welding (also known as tungsten inert gas [TIG] welding)
HDPE	high-density polyethylene
ITP	Inspection and Test Plan
MCAW	metal-cored arc welding
MIG	See GMAW
NDT	non-destructive testing
P&ID	piping and instrumentation diagram
PLC	programmable logic controller
PME	powered mobile equipment
PPE	personal protective equipment
PVC	polyvinyl chloride
RCM	reliability-centered maintenance
SCARA	Selective Compliance Assembly Robot Arm
SDS	Safety Data Sheets
SMAW	shielded metal arc welding
SOP	standard operating procedures
TDG	transportation of dangerous goods
TIG	See GTAW
WHMIS	Workplace Hazardous Materials Information System
WLL	working load limit

APPENDIX B
TOOLS AND EQUIPMENT

Hand Tools

adjustable wrenches
hex keys
brushes (wire, cleaning, etc.)
calculators
clamps (C-Clamps)
chisels
drill bits
files
grease gun
hacksaw
hammer, ball peen
hammer, claw
hammer, dead blow
hammer, sledge
hammer, soft faced
hammer, rubber
hammer, chipping
honing stone
levels (machinist, torpedo, spirit, etc.)
alignment bars
locking pliers
locks
nibblers
oil can
parallel bars
piano wire
pipe and tube cutters
pipe wrenches
pliers
plumb bob
pop riveter
pry bars
pullers
scraper
screwdrivers
scribers
socket wrenches
tap and dies
tap extractors
reamers
thread chasers
threading accessories
grease guns (ultrasonic, cordless, air, etc)
tin snip
torque wrench
beam trammel
trowels
tube benders
wheel dresser
wrenches

Measuring and Layout Tools

bevel protractor
bore gauge
center gauge
chalk lines
combination square set
outside calipers
pi-tape
plasti-gauge
precision level
precision straightedge

Measuring and Layout Tools (*continued*)

deflection gauge
depth gauge
dial indicator
dividers
engineers' square (machinists' square)
feeler gauge
gauge blocks
gear pitch gauge
height gauge
indicator gauge
inside calipers
laser alignment equipment
lead wire
micrometers
optical levels
radius gauge
rulers
sheave gauge
sine bar
small hole gauge
solid square
string line
surface gauge
tape measures
taper gauge
telescopic gauge
tension gauge
transit
V-block
vernier calipers

Portable Power Tools

right angle drill
angle grinder
chainsaw
chop saw
circular saw
die grinder
hammer drill
heat gun
hydraulic ram
hydraulic nuts
hydraulic wrenches
impact drill
impact gun (rivet)
impact wrench
jack hammer
jig saw
portable bender
portable drill
explosive-actuated tool
portable band saw
portable threader
routers
reciprocating saw
tube rollers

Shop Tools and Equipment

band saw
bearing heater (induction, oil bath, oven)
pedestal grinder
brake press
chop saw
lathe
milling machine
parts washer
sand blaster
shears

Shop Tools and Equipment (*continued*)

drill press (bench, radial arm, upright)
hydraulic press (horizontal, vertical)
iron worker
surface grinder
vices
cribbing (dunnage)

Welding and Cutting Equipment

arc welding equipment
oxy-acetylene equipment
metal inert gas welding (MIG) equipment
plasma arc cutting equipment
rod ovens
tungsten inert gas welding (TIG) equipment
welding machines

Testing Equipment

balancing equipment
borescope
computers
dye penetrant test equipment
fluid analysis equipment
hardness test equipment
hydraulic gauge
laser alignment equipment
magnetic particle test equipment
multimeter
pressure/vacuum gauge
printers
radio transmitter
scales
strobe light
tachometer
theodolite
thermographic test equipment
ultrasonic test equipment
ultrasound test equipment
vibration analysis equipment

Access, Rigging, Hoisting and Lifting Equipment

aerial lifts
air bags
air jack
air tuggers
block and tackle
cable hoists
grip hoist (tirfor)
hydraulic blocks
hydraulic jack
ladders
lever actuated chain hoist
lifting eyes
power chain blocks
scaffolds
scissor lift
screw jack
shackles
sheave blocks
slings
snatch block
spreader bar
trolleys
equipment handling rollers (Hilman™)
chains

Access, Rigging, Hoisting and Lifting Equipment (*continued*)

- mobile crane
- outrigger
- overhead crane
- pinch bar
- chain fall
- dolly
- fibre rope
- gantry crane

Personal Protective Equipment and Safety Equipment

- apron
- arm bands (signalling sleeve)
- breathing protection (paper filter masks to self-contained breathing apparatus)
- coveralls - all types (acid/chemical/fire resistant, etc.)
- eye wash station
- eye protection (face shields, safety glasses, goggles)
- first aid kit
- gauntlet (forearm protector)
- gloves
- hearing protection
- hard hat
- life jackets
- safety footwear
- safety harness & fall arresting devices
- safety vests
- welding blinds

Resource Materials

- American Gear Manufacturers Association (AGMA)
- American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)/ American Society of Testing & Materials (ASTM) Standards
- blueprints
- Canadian Standards Association (CSA) documents
- Canadian Welding Bureau materials
- industry/contractors safety manual (handbook)
- industry manuals such as IPT’s Handbooks and Machinery’s Handbook
- Internet resources
- International Standards Organization (ISO)
- local licensing data
- Safety Data Sheets (SDS)
- National Building Code
- National Grease Lubrication Institute (NGLI)
- Occupational Health and Safety (OH&S) regulations
- rigging and hoisting manuals
- schematics
- sketches
- manufacturers' specifications
- standards documentation
- Transportation of Dangerous Goods (TDG)
- technical manuals
- WHMIS labels

APPENDIX C
GLOSSARY

agitator	a device which keeps material moving in a tank or vessel; the movement may be required to prevent settling and to mix material
arc of contact	surface contact between the sheave, the pulley and the belt, or the sprocket and the chain
axial flow	to flow along the axis of a fan or a pump
babbitt	material used in plain friction bearings (usually lead-based)
backlash	amount of clearance between mating teeth
bearing	device that allows two parts to rotate or move in contact with each other
blower	device that moves air at low or high pressures and volumes
centrifugal flow	to flow 90 degrees to the axis of a fan or a pump away from the centre
clutch	device used to engage or disengage a driver to a driven unit
condition-based monitoring methods	methods to identify issues not realized by sensory inspection, real-time data
conveying systems	system used to move material (usually solid) from one place to another
couplings	parts used to connect a driver to a driven unit
elastomeric element	flexible element used to join couplings and dampen energy
engineered lift	consulting an engineer for an approved design of a lifting apparatus or lifting procedure without exceeding the rated capacity of the rigging equipment; it should be noted that this is generally done when unusual circumstances of a lift dictate deviations from normal accepted trade practices
fans	device used to create air movement
ferrography	wear analysis of machine bearing surfaces by collection of ferrous (or nonferrous) wear particles from lubricating oil in a ferrograph analyzer
fluid	substance (either a liquid or gas) material that has the ability to flow
gear system	combination of gears used to alter the speed and power from a driver to a driven unit
hypoid gear	set of gearing whose shafts intersect on a different plane

maintain	keeping a machine or system running efficiently with a minimum amount of down-time; ror use in this analysis the term “maintain” can encompass: checking for worn parts, lubrication, adjustment, inspection and modification
manufacturers’ specifications	refers to the performance and engineering standards for a particular machine as detailed by the manufacturer; this information is usually available from drawings, manuals and bulletins provided by the manufacturer
multi-plane balancing	to balance a rotating part on more than two planes; multi-plane balancing is usually performed with computer software that is usually provided with vibration analysis and balancing instruments
non-destructive testing (NDT)	evaluation procedures that do not damage the material being tested; these may include magnetic particle testing, dye penetrant testing, and fluid sampling
positive displacement	transfer by pump without loss of pressure or material
predictive maintenance	activities utilizing information from past and current performance records to objectively predict mechanical problems; predictive maintenance is a proactive monitoring approach rather than a time-based or reactive approach
preventive maintenance	activities based on a periodic sampling and inspections; it normally involves the routine scheduling of maintenance activities; this schedule is based on past experience and manufacturers’ recommendations
prime mover	driver of the machine; it may be an electric, steam, gas or diesel powered
sensory inspection	inspecting through the senses (visual, hearing, feeling, smell)
service	for use in this analysis the term “service” refers to installing, diagnosing, repairing and maintaining
thermographic equipment	equipment that displays the temperatures of components by measuring infrared radiation
tooth contact	amount of engagement and pattern formed by mating teeth
tribology	the study of friction, wear, lubrication, and the design of bearings; the science of interacting surfaces in relative motion.
vibration analysis	the process of monitoring the condition of equipment and the diagnosis of faults in equipment through the measurement and analysis of vibration within that equipment