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Red Seal Occupational Standard

Industrial Mechanic (Millwright)

INTERPROVINCIAL STANDARD
CANADA
NORME INTERPROVINCIALE

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Canada

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Foreword

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Red Seal Occupational Standard (RSOS) as the national 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) funds the Red Seal Program, which, under the guidance of the CCDA, develops a national occupational standard for each of the Red Seal trades.

Standards have the following objectives:

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

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

Trades and Apprenticeship Division
Skilled Trades and Mobility Directorate
Employment and Social Development Canada
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Gatineau, Quebec K1A 0J9

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

The following lists these participants and the province/territory or organization that nominated them to attend the national development workshop.

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This standard was prepared by the Skilled Trades and Mobility Directorate of ESDC. The coordinating, facilitating and processing of this standard 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

This standard contains the following sections:

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

Description of the Industrial Mechanic (Millwright) Trade: an overview of the trade's duties, work environment, task, 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

Skills for Success Summary: an overview of how each of the skills for success (formerly called essential skills) is applied in this trade

Roles and Opportunities for Skilled Trades in a Sustainable Future: an overarching description of how in the context of climate change, skilled trades play a large role in implementing solutions and adjusting to changes in the world. In addition to highlighting the importance of this awareness, the standard may also contain more details on activities, skills and knowledge elements that are specific to the trade

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

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

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

Task Matrix and Weightings: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard and the national percentages of exam questions assigned to the major work activities and tasks

Harmonization of Apprenticeship Training: the aspects of apprenticeship training that participating provinces and territories have agreed upon to substantively align apprenticeship systems across Canada

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

- **Task**: distinct actions that describe the activities within a major work activity
  - **Task Descriptor**: a general description of the task
    - **Sub-task**: distinct actions that describe the activities within a task
      - **Skills**:
        - **Performance Criteria**: description of the activities that are done as the sub-task is performed
        - **Evidence of Attainment**: proof that the activities of the sub-task meet the expected performance of a tradesperson who has reached journeyperson level
        - **Range of Variables**: elements and examples (not all-inclusive) that provide a more in-depth description of a term used in the performance criteria and evidence of attainment
      - **Knowledge**:
        - **Learning Outcomes**: describes what should be learned relating to a sub-task while participating in technical or in-school training
        - **Learning Objectives**: topics to be covered during technical or in-school training in order to meet the learning outcomes for the sub-task
        - **Range of Variables**: elements and examples (not all-inclusive) that provide a more in-depth description of a term used in the learning outcomes and learning objectives

- **Appendix A—Acronyms**: a list of acronyms used in the standard with their full name
- **Appendix B—Tools and Equipment / Outils et Équipement**: a bilingual non-exhaustive list of tools and equipment used in this trade
- **Appendix C—Glossary / Glossaire**: bilingual definitions or explanations of selected technical terms used in the standard

Methodology

Development of the Standard

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

Harmonization of Apprenticeship Training

An analysis of all provinces' and territories' apprenticeship programs is performed and recommendations are made on harmonizing the name of the trade, the hours of training required and the number of levels of training. Provinces and territories consult with their respective industry stakeholders on these elements and revisions are discussed until consensus is reached. Following the development of the workshop draft of the RSOS, participants discuss and come to consensus on the sequence of training topics, as expressed in the new standard. Their sequencing recommendations are reviewed by stakeholders in participating provinces and territories and further discussions are convened to reach consensus and to identify any exceptions.

Online Survey

Stakeholders are asked to review and validate the activities described in the new standard via an online survey. These stakeholders are invited to participate in this consultation through apprenticeship authorities, as well as national stakeholder groups.

Draft Review

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

Validation and Weighting

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

- MWA - Each jurisdiction assigns a percentage of questions to each MWA for an examination that would cover the entire trade.
- Tasks - Each jurisdiction assigns a percentage of exam questions to each task within a MWA.
- Sub-tasks - Each jurisdiction indicates, with a "yes" or "no", whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction.

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

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

Definitions for Validation and Weighting

yes	sub-task performed by qualified workers in the occupation in that province or territory
no	sub-task not performed by qualified workers in the occupation in that province or territory
NV	standard Not Validated by that province or territory
ND	trade Not Designated in a province or territory
Not Common Core (NCC)	sub-task, task or MWA performed less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade
National Average %	average percentage of questions assigned to each MWA and task in Interprovincial Red Seal Examination for the trade

Provincial/Territorial Abbreviations

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

Description of the Industrial Mechanic (Millwright) Trade

“Industrial Mechanic (Millwright)” is this trade’s official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by 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. 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, fabricating, aligning, commissioning, maintaining, repairing, diagnosing, inspecting, dismantling, demolishing, moving and decommissioning equipment and components. 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, preparing bases for equipment, rigging and machining as required. 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 the 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.

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) are not electricians and they are restricted or prohibited from performing electrical work by provincial and territorial regulations. However, in certain jurisdictions they may perform limited work with certain electromechanical components when installing and diagnosing equipment in areas such as hydraulics, pneumatics, and automation. Due to the integration of electromechanical components in many pieces of industrial equipment, an understanding of basic electrical terms and concepts is very important. These may include voltage, amperage, resistance, Ohm's Law, series circuits, parallel circuits, and AC/DC current. Some of the electromechanical components worked with may include switches, fuses, ground fault circuit interrupters (GFCI), relays, solenoids and diodes. Industrial mechanics (millwrights) should know how to use a multimeter to perform functions like voltage, resistance and continuity checks.

Industrial mechanics (millwrights) often possess overlapping skills with other tradespeople such as steamfitter/pipefitters, instrumentation and control technicians, 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

Technology

Technology is evolving rapidly in the industrial mechanic (millwright) trade. Virtual reality and augmented reality (AR) are now being used for training and real-time data. AR technology allows industrial mechanics to visualize complex machinery and access step-by-step instructions for repairs. This enhances training programs and speeds up troubleshooting.

Specialized equipment and software are often wireless, allowing for greater mobility and efficiency in performing tasks. The Internet allows information to be stored, saved and accessed easily through cloud services and resource material is quickly obtained, streamlining the workflow and enhancing productivity.

Using technology as a predictive tool, such as monitoring patterns in equipment behaviour, can help identify possible upcoming failures and schedule maintenance. As this becomes more common, being able to use the data and interpret graphs is an important skill for an industrial mechanic (millwright).

Greater awareness is needed for the various systems currently operating across the trade. There is an increase in integrating automation and robotics into new and existing facilities. This may include SMART or interconnected devices, smart sensors, monitoring systems, quality assurance/quality control (QA/QC) data collections and software-enabled devices. These technologies enable new maintenance strategies and practices. Companies are investing heavily in automation.

Health and Safety

The culture of health and safety continues to improve in the trade. Companies are looking for zero injuries, and track and enforce safety and employee health using various methods such as safety software and apps. This software makes it easier to follow safety rules, prevent accidents, and ensure compliance with regulations. It helps record and manage data like incident reports and employee training.

There are continual improvements in safety practices and technology such as working in confined spaces, fall arrest, and the use of respiratory protection when working in hazardous situations. There is a greater focus on ergonomics and protecting the worker. There are improved lifting and handling tools, and more use of equipment automation. Improvements have been made to ensure proper fit of personal protective equipment (PPE) for all body types. There is also continuous improvement in guarding standards and signage on equipment.

There is more attention on creating a better work environment, such as improved safe work practices in extreme hot or cold weather, worker rotation and remaining hydrated. There is also a stronger focus on employee wellness.

Laws, standards, guidelines and company policies are continuously updated to make sure safety standards are always met. Regular training and recertification help employees stay updated on the latest safety practices. This ongoing education is important to keep safety a top priority.

Tools and Equipment

Tools and equipment continue to improve in the trade; equipment such as laser alignment, torque wrenches and impact tools, are designed to enhance productivity, safety, precision and efficiency for industry. The shift from air tools to cordless alternatives continues, with new battery-powered tools offering greater convenience and efficiency. Also, new and improved portable power stations are revolutionizing job sites by providing robust, portable energy solutions. These units can power multiple devices simultaneously, making them ideal for remote or large-scale projects.

3D printing technology enables industrial mechanics (millwrights) to utilize replacement parts, minimizing downtime and improving maintenance efficiency.

Some automated equipment require adjustments to be made through programming. Industrial mechanics (millwrights) need to have a solid understanding of how/what is being done as they may be required to make these adjustments using software.

The proper use of tools and certain equipment is important from a safety perspective. Specialized or manufacturer training is sometimes necessary.

Products/Materials

Advancements in materials technology are significantly enhancing performance and durability. Alloys designed for wear resistance, carbon fibre composites, and new types of plastics are leading the way. Some wear-resistant materials even incorporate piezoelectric technology, which can generate an electric charge in response to mechanical stress. Additionally, nanotechnologies are being applied to lubricants and oils, improving their effectiveness and longevity. Synthetic lubricants are quickly increasing in popularity.

Environmental

There is a greater focus on the environment in many industries. Industrial ’mechanics (’millwrights) are using dust collection systems that remove harmful particulates and gas fumes to improve worker safety and air quality, and to protect the environment. Companies are increasingly replacing old machines with newer, more efficient processing equipment. They are also implementing practices such as prioritizing environmental cleanup, documentation and spill response/prevention. Energy efficiency is improved by recycling water and using cogeneration for steam and heat in their processes. There is a heightened awareness of toxic and hazardous materials in facilities, leading to better waste management practices and more recycling efforts. These changes reflect a commitment to sustainability and environmental responsibility.

Legislative and Regulatory

Legislative and regulatory changes are constantly evolving, bringing both rewards and challenges to the trade. Industrial mechanics (millwrights) are expected to understand and update their knowledge of changing legislation and regulations, both provincially and nationally, that apply to their trade. These changes often lead to improved safety standards, better equipment, and more efficient processes, enhancing working conditions and productivity.

Skills for Success Summary

Skills for Success are needed in a quickly changing world for work, learning and life. They are foundational for building other skills and important for effective social interaction. Everyone benefits from having these skills as they help individuals get a job, progress at their current job and change jobs. They also help individuals become active members of their community and succeed in learning.

Through extensive research and consultations, the Government of Canada launched the new Skills for Success model renewing the previous Essential Skills framework to better reflect the needs of the current and future labour market.

The summary presented here is based on existing Essential Skills profiles and will be updated to align with the new Skills for Success model over time.

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, electrical, structural and hydraulic) to identify malfunctions. Industrial mechanics (millwrights) may also retrieve and study data from scale drawings to identify the location of equipment to be installed and verify location. They monitor and update apprentice evaluation and progress books. They also complete forms such as purchase orders, maintenance forms, logbooks and work orders.

Writing

Industrial mechanics (millwrights) maintain various trade-related documentation such as logbooks, forms, incident reports and drawings. They may write maintenance, repair and safe work procedures. They may also write emails to supervisors and co-workers about ongoing work, and to suppliers about equipment specifications.

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 approval from them. Industrial mechanics (millwrights) may discuss work with clients and advise them about maintenance actions. They also discuss safety, productivity, and procedural and policy changes at meetings with co-workers, supervisors, engineers and clients. Communication with other tradespeople and personnel from other departments is also important.

Numeracy

Industrial mechanics (millwrights) measure various physical properties of equipment. Calculations are required in multiple aspects of the industrial mechanics (millwrights) trade, such as for 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 forces 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. 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, durability and availability of replacement parts. Industrial mechanics (millwrights) evaluate conditions of parts and equipment, and the safety of their work environment. They may assess the feasibility of designs for small modifications to equipment, ensuring that designs meet technical specifications, performance requirements and regulations.

Working with Others

Industrial mechanics (millwrights) may be required to work independently or with colleagues, personnel from other departments and jurisdictional organizations depending on the scope of the work. They actively participate with apprentice training and progression on the job.

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 the operation of manufacturing and machining equipment. Industrial mechanics (millwrights) use hand-held computerized alignment,

levelling 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.

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.

Roles and Opportunities for Skilled Trades in a Sustainable Future

Climate change and the environment is an important issue for many Canadians and the skilled trades play a large role in implementing solutions.

Throughout this standard, there may be specific references to tasks, skills and knowledge that clearly show the trade's role in a more sustainable future. Each trade has different roles to play and contributions to make in their own way.

Here are a few examples:

- Construction tradespeople need to consider the materials they are using, building methods, and technological improvements to mechanical and electrical installations. Efficiency upgrades and advanced materials are changing the construction industry in Canada. Improvements to energy efficiency in building structures and systems are continual, and codes, specifications and designs such as Leadership in Energy and Environmental Design (LEED) and the Zero Carbon Building (ZCB) standards outline how the construction trades can improve the efficiency and sustainability of the industry.
- Automotive and mechanical trades are seeing shifts to more efficient vehicles and advanced materials, including alternate fuels and electric vehicles. With the continual and rapid evolution of technology in this sector, there is a need for skilled workers to always be learning.
- Manufacturing sectors face global competition resulting in a move towards increased efficiency and automation. Many industrial and commercial facilities are being upgraded to improve efficiency in areas such as lighting systems, building envelope airtightness, mechanical insulation, heat pumps and new production processes and technologies. New control technologies allow better monitoring of processes resulting in less waste and higher-quality products.
- Industrial trades are being encouraged to reduce greenhouse gas and carbon emissions by supporting development of carbon capture, utilization and storage (CCUS) and renewable energy generation such as solar, wind, hydro, geothermal and nuclear generation, as well as upgrades to transmission and distribution infrastructure. Systems designed to recover natural gas (RNG) produced by landfill, digesters, and biogas facilities, and hydrogen production and utilization provide many opportunities for future projects.
- Landscape horticulturists will have opportunities to design and develop biodiverse ecosystems to mitigate the effects of climate change. Concerns such as erosion, species diversity and ecosystem health can be addressed through the use of green infrastructure systems.
- Service sector trades may also need to be aware of responsible sourcing, as well as the efficient use of products and materials. The increasing popularity of ecotourism will provide opportunities in new areas.

There are fast-moving changes in guidelines, codes, regulations, international agreements, and manufacturers' specifications implemented for the purpose of energy efficiency and mitigating climate change. Tradespeople need to continually stay on top of new and changing requirements to stay competitive.

Apprentices and tradespeople need to increase their climate literacy and reinforce their own understanding of current climate change, energy conservation and environmental practices. Most trades are encouraged to use ecologically friendly products and follow requirements related to the reuse, recycling or disposal of materials. While individual tradespeople and apprentices may not be able to choose certain elements (like the architectural design of buildings, building material selection, regulatory requirements, or use of electric vehicles and technologies), understanding the impact of using these elements and how to apply them in their work is still important. This helps ensure that energy and environmental specifications are fully met.

In apprenticeship training, as well as in ongoing professional development, employers and instructors should encourage learning about these concepts, why they are important, how they are implemented, and the overarching targets they are aiming to achieve.

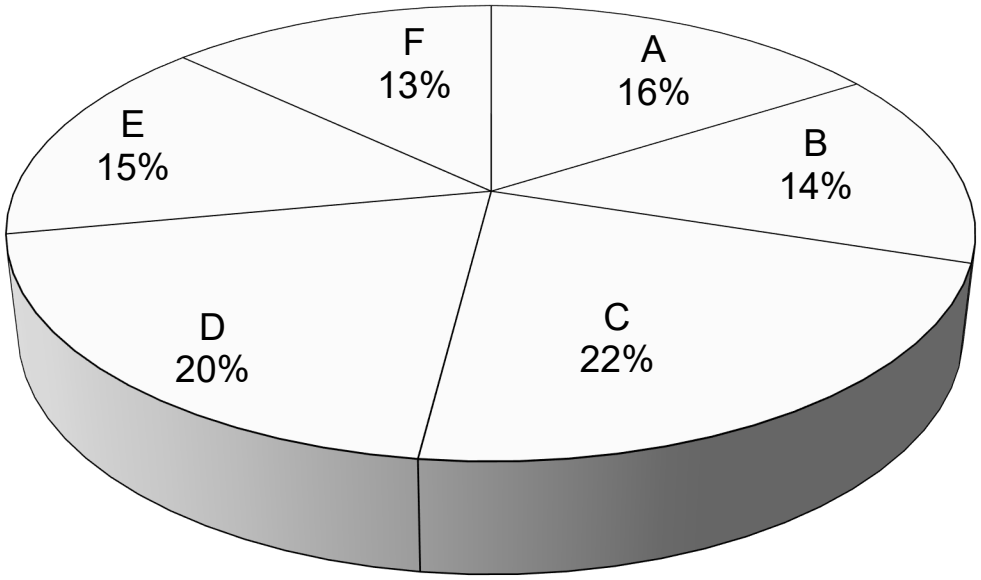
Industry Expected Performance

All tasks must be performed according to the applicable jurisdictional codes, standards, regulations and company policies. All health and safety standards must be respected and observed. Work should be performed efficiently and to a high quality, minimizing material waste and environmental impact. All work requirements, specifications and contractual obligations must be met. At a journeyperson level of performance, all tasks must be done with minimal direction and supervision. As a journeyperson progresses in their career, there is an expectation they continue to upgrade their skills and knowledge to maintain pace with industry and promote continuous learning in their trade through mentoring of apprentices.

Language Requirements

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

Pie Chart of Red Seal Examination and Weightings



Major Work Activity	Percentage
A—Performs common occupational skills	16%
B—Performs rigging, hoisting/lifting and moving	14%
C—Services mechanical power transmission components and systems	22%
D—Services material handling/process systems	20%
E—Services fluid power systems	15%
F—Performs maintenance, testing, commissioning and decommissioning methods	13%

This pie chart represents a breakdown of the interprovincial Red Seal examination. Percentages are based on the collective input from workers from the trade from across Canada. The Task Matrix on the next pages indicates the breakdown of tasks and sub-tasks within each Major Work Activity and the breakdown of questions assigned to the Tasks. The Interprovincial examination for this trade has 135 questions.

Task Matrix and Weightings

Major Work Activity A—Performs common occupational skills 16%

Task A-1 Maintains safe and healthy workplace 13%	Sub-task A-1.01 Uses personal protective equipment (PPE) and safety equipment	Sub-task A-1.02 Maintains safe work environment	Sub-task A-1.03 Protects environment
	Sub-task A-1.04 Performs lockout/tagout (LOTO) and zero energy procedures	Sub-task A-1.05 Participates in healthy and respectful work environment and practices	
Task A-2 Uses tools and equipment 21%	Sub-task A-2.01 Uses hand tools and portable power tools	Sub-task A-2.02 Uses shop tools and equipment	Sub-task A-2.03 Uses access equipment
Task A-3 Organizes tasks 11%	Sub-task A-3.01 Plans tasks	Sub-task A-3.02 Interprets codes, standards and regulations	Sub-task A-3.03 Uses drawings and schematics
	Sub-task A-3.04 Uses documentation and reference material		
Task A-4 Performs trade tasks 20%	Sub-task A-4.01 Fabricates workpiece	Sub-task A-4.02 Lubricates systems and components	Sub-task A-4.03 Performs levelling and aligning of components and systems
	Sub-task A-4.04 Uses fastening and retaining devices	Sub-task A-4.05 Performs material identification	Sub-task A-4.06 Performs heat treatment of metal

Task A-5 Performs measuring and layout 19%	Sub-task A-5.01 Prepares work area, tools and materials	Sub-task A-5.02 Measures materials and components	Sub-task A-5.03 Lays out components
	Sub-task A-5.04 Maintains precision measuring, layout and levelling tools		
Task A-6 Performs cutting and welding operations 16%	Sub-task A-6.01 Cuts material with oxy-fuel, plasma arc and air carbon arc cutting equipment	Sub-task A-6.02 Joins material using oxy-fuel welding equipment	Sub-task A-6.03 Welds material using arc welding (SMAW) equipment
	Sub-task A-6.04 Welds material with gas metal arc welding (GMAW) equipment and flux core arc welding (FCAW) equipment	Sub-task A-6.05 Welds material with gas tungsten arc welding (GTAW) equipment	Sub-task A-6.06 Maintains welding equipment
Task A-7 Maintains continuous learning 0%	Sub-task A-7.01 Upskills in new trade practices and procedures	Sub-task A-7.02 Upskills in emerging technologies	
Task A-8 Uses communication and mentoring techniques 0%	Sub-task A-8.01 Uses communication techniques	Sub-task A-8.02 Uses mentoring techniques	

Major Work Activity B—Performs rigging, hoisting/lifting and moving 14%

Task B-9 Plans rigging, hoisting/lifting and moving 51%	Sub-task B-9.01 Determines load	Sub-task B-9.02 Selects rigging equipment	Sub-task B-9.03 Selects hoisting/lifting and moving equipment
	Sub-task B-9.04 Secures area		
Task B-10 Rigs, hoists/lifts and moves load 49%	Sub-task B-10.01 Sets up rigging, hoisting/lifting and moving equipment	Sub-task B-10.02 Performs hoist/lift and move	Sub-task B-10.03 Maintains rigging, hoisting/ lifting and moving equipment

Major Work Activity C—Services mechanical power transmission components and systems 22%

Task C-11 Services prime movers 16%	Sub-task C-11.01 Installs prime movers	Sub-task C-11.02 Diagnoses prime movers	Sub-task C-11.03 Maintains prime movers
	Sub-task C-11.04 Repairs prime movers		
Task C-12 Services shafts, bearings and seals 18%	Sub-task C-12.01 Installs shafts, bearings and seals	Sub-task C-12.02 Diagnoses shafts, bearings and seals	Sub-task C-12.03 Maintains shafts, bearings and seals
	Sub-task C-12.04 Repairs shafts, bearings and seals		

Task C-13 Services couplings, clutches and brakes 18%	Sub-task C-13.01 Installs couplings, clutches and brakes	Sub-task C-13.02 Diagnoses couplings, clutches and brakes	Sub-task C-13.03 Maintains couplings, clutches and brakes
	Sub-task C-13.04 Repairs couplings, clutches and brakes		
Task C-14 Services chain and belt drive systems 17%	Sub-task C-14.01 Installs chain and belt drive systems	Sub-task C-14.02 Diagnoses chain and belt drive systems	Sub-task C-14.03 Maintains chain and belt drive systems
	Sub-task C-14.04 Repairs chain and belt drive systems		
Task C-15 Services gear systems 15%	Sub-task C-15.01 Installs gear systems	Sub-task C-15.02 Diagnoses gear systems	Sub-task C-15.03 Maintains gear systems
	Sub-task C-15.04 Repairs gear systems		
Task C-16 Performs shaft alignment procedures 16%	Sub-task C-16.01 Performs rough alignment	Sub-task C-16.02 Performs dial alignment	Sub-task C-16.03 Performs laser alignment

Major Work Activity D—Services material handling/process systems 20%

Task D-17 Services robotics and automated equipment 9%	Sub-task D-17.01 Installs robotics and automated equipment	Sub-task D-17.02 Diagnoses robotics and automated equipment	Sub-task D-17.03 Maintains robotics and automated equipment
	Sub-task D-17.04 Repairs robotics and automated equipment		
Task D-18 Services fans and blowers 16%	Sub-task D-18.01 Installs fans and blowers	Sub-task D-18.02 Diagnoses fans and blowers	Sub-task D-18.03 Maintains fans and blowers
	Sub-task D-18.04 Repairs fans and blowers		
Task D-19 Services pumps 21%	Sub-task D-19.01 Installs pumps	Sub-task D-19.02 Diagnoses pumps	Sub-task D-19.03 Maintains pumps
	Sub-task D-19.04 Repairs pumps		
Task D-20 Services compressors 20%	Sub-task D-20.01 Installs compressors	Sub-task D-20.02 Diagnoses compressors	Sub-task D-20.03 Maintains compressors
	Sub-task D-20.04 Repairs compressors		

Task D-21 Services process piping, tanks and containers 13%	Sub-task D-21.01 Installs process tanks and containers	Sub-task D-21.02 Installs process piping	Sub-task D-21.03 Diagnoses process tanks and containers
	Sub-task D-21.04 Diagnoses process piping	Sub-task D-21.05 Maintains process tanks and containers	Sub-task D-21.06 Maintains process piping
	Sub-task D-21.07 Repairs process tanks and containers	Sub-task D-21.08 Repairs process piping	
Task D-22 Services conveying systems 21%	Sub-task D-22.01 Installs conveying systems	Sub-task D-22.02 Diagnoses conveying systems	Sub-task D-22.03 Maintains conveying systems
	Sub-task D-22.04 Repairs conveying systems		

Major Work Activity E—Services fluid power systems 15%

Task E-23 Services hydraulic systems 53%	Sub-task E-23.01 Installs hydraulic systems	Sub-task E-23.02 Diagnoses hydraulic systems	Sub-task E-23.03 Maintains hydraulic systems
	Sub-task E-23.04 Repairs hydraulic systems		
Task E-24 Services pneumatic and vacuum systems 47%	Sub-task E-24.01 Installs pneumatic and vacuum systems	Sub-task E-24.02 Diagnoses pneumatic and vacuum systems	Sub-task E-24.03 Maintains pneumatic and vacuum systems

	Sub-task E-24.04 Repairs pneumatic and vacuum systems		

Major Work Activity F—Performs maintenance, testing, commissioning and decommissioning methods 13%

Task F-25 Performs maintenance and testing 70%	Sub-task F-25.01 Performs preventative maintenance activities	Sub-task F-25.02 Performs vibration analysis procedures	Sub-task F-25.03 Performs balancing procedures
	Sub-task F-25.04 Performs non-destructive testing (NDT) procedures	Sub-task F-25.05 Performs fluid analysis procedures	Sub-task F-25.06 Performs predictive maintenance activities
Task F-26 Commissions and decommissions equipment 30%	Sub-task F-26.01 Commissions systems and components	Sub-task F-26.02 Decommissions systems and components	

Harmonization of Apprenticeship Training

Provincial and territorial apprenticeship authorities are each responsible for their respective apprenticeship programs. In the spirit of continual improvement, and to facilitate mobility among apprentices in Canada, participating authorities have agreed to work towards harmonizing certain aspects of their programs where possible. After consulting with their stakeholders in the trade, they have reached consensus on the following elements. Note that implementation of these elements may vary from jurisdiction to jurisdiction, depending on their own circumstances. For more information on the implementation in any province and territory, please contact that jurisdiction's apprenticeship authority.

1. Trade Name

The official Red Seal name for this trade is Industrial Mechanic (Millwright).

2. Number of Levels of Apprenticeship

The number of levels of technical training recommended for this trade is 4.

3. Total Training Hours

The total hours of training, including both on-the-job and in-school training for this trade is 7200.

4. Sequencing Topics and Related Sub-tasks

The topic titles in the table below are placed in a column for each apprenticeship level for technical training. Each topic is accompanied by the sub-tasks and their reference number. The topics in the grey shaded cells represent those that are covered "in context" with other training in the subsequent years.

Level 1	Level 2	Level 3	Level 4
	Context	Context	Context
	Safety and Health Related Functions	Safety and Health Related Functions	Safety and Health Related Functions
	Tools and Equipment	Tools and Equipment	Tools and Equipment
	Organizes Tasks	Organizes Tasks	Organizes Tasks
	Trade Tasks	Trade Tasks	Trade Tasks

Safety and Health Related Functions 1.01 Uses personal protective equipment (PPE) and safety equipment 1.02 Maintains safe work environment 1.03 Protects the environment 1.04 Performs lock-out/tag-out and zero energy procedures 1.05 Participates in healthy and respectful work environment and practices	**Safety and Health Related Functions** 1.01 Uses personal protective equipment (PPE) and safety equipment 1.04 Performs lock-out/tag-out and zero energy procedures	**Safety and Health Related Functions** 1.01 Uses personal protective equipment (PPE) and safety equipment 1.04 Performs lock-out/tag-out and zero energy procedures	**Safety and Health Related Functions** 1.01 Uses personal protective equipment (PPE) and safety equipment 1.04 Performs lock-out/tag-out and zero energy procedures
Tools and Equipment 2.01 Uses hand tools and portable power tools 2.02 Uses shop tools and equipment 2.03 Uses access equipment			
Organizes Tasks 3.01 Plans tasks 3.02 Interprets codes, standards and regulations 3.03 Uses drawings and schematics 3.04 Uses documentation and reference material			

Trade Tasks 4.01 Fabricates work piece 4.02 Lubricates systems and components 4.03 Performs leveling and aligning of components and systems 4.04 Uses fastening and retaining devices 4.05 Performs material identification 4.06 Performs heat treatment of metal	**Trade Tasks** 4.01 Fabricates work piece 4.02 Lubricates systems and components 4.03 Performs leveling and aligning of components and systems 4.05 Performs material identification 4.06 Performs heat treatment of metal	**Trade Tasks** 4.01 Fabricates work piece 4.02 Lubricates systems and components 4.03 Performs leveling and aligning of components and systems	**Trade Tasks** 4.01 Fabricates work piece 4.02 Lubricates systems and components 4.03 Performs leveling and aligning of components and systems

Measuring and Layout 5.01 Prepares work area, tools and materials 5.02 Measures materials and components 5.03 Lays out components 5.04 Maintains precision measuring, layout and levelling tools

Cutting and Welding
6.01 Cuts material with oxy-fuel, plasma arc and air carbon arc cutting equipment
6.02 Joins material using oxy-fuel welding equipment
6.06 Maintains welding equipment

Cutting and Welding
6.03 Welds material using arc welding equipment (SMAW)
6.04 Welds material with gas metal arc welding (GMAW) equipment and flux core arc welding (FCAW) equipment
6.05 Welds material with gas tungsten arc welding (GTAW) equipment

Continuous Learning
7.01 Upskills in new trade practices and procedures
7.02 Upskills in emerging technologies

Communications Techniques
8.01 Uses communication techniques

Mentoring Techniques
8.02 Uses mentoring techniques

Planning Rigging, Hoisting/Lifting and Moving
9.01 Determines load
9.02 Selects rigging equipment
9.03 Selects hoisting/lifting and moving equipment
9.04 Secures area

Rigging, Hoisting/Lifting and Moving Loads
10.01 Sets up rigging, hoisting/lifting and moving equipment
10.02 Performs hoist/lift and move
10.03 Maintains rigging, hoisting/ lifting and moving equipment

Prime Movers
11.01 Installs prime movers
11.02 Diagnoses prime movers
11.03 Maintains prime movers
11.04 Repairs prime movers

Shafts, Bearings and Seals
12.01 Installs shafts, bearings and seals
12.02 Diagnoses shafts, bearings and seals
12.03 Maintains shafts, bearings and seals
12.04 Repairs shafts, bearings and seals

Couplings, Clutches and Brakes
13.01 Installs couplings, clutches and brakes
13.02 Diagnoses couplings, clutches and brakes
13.03 Maintains couplings, clutches and brakes
13.04 Repairs couplings, clutches and brakes

Chain and Belt Drive Systems
14.01 Installs chain and belt drive systems
14.02 Diagnoses chain and belt drive systems
14.03 Maintains chains and belt drive systems
14.04 Repairs chains and belt drive systems

Gear Systems
15.01 Installs gear systems
15.02 Diagnoses gear systems
15.03 Maintains gear systems
15.04 Repairs gear systems

Shaft Alignment Procedures
16.01 Performs rough alignment
16.02 Performs dial alignment

Shaft Alignment Procedures
16.02 Performs dial alignment
16.03 Performs laser alignment

Robotics and Automated Equipment
17.01 Installs robotics and automated equipment
17.02 Diagnoses robotics and automated equipment
17.03 Maintains robotics and automated equipment
17.04 Repairs robotics and automated equipment

Fans and Blowers
18.01 Installs fans and blowers
18.02 Diagnoses fans and blowers
18.03 Maintains fans and blowers
18.04 Repairs fans and blowers

Pumps
19.01 Installs pumps
19.02 Diagnoses pumps
19.03 Maintains pumps
19.04 Repairs pumps

Compressors
20.01 Installs compressors
20.02 Diagnoses compressors
20.03 Maintains compressors
20.04 Repairs compressors

Process Piping, Tanks and Containers
21.01 Installs process tanks and containers
21.02 Installs process piping
21.03 Diagnoses process tanks and containers
21.04 Diagnoses process piping
21.05 Maintains process tanks and containers
21.06 Maintains process piping
21.07 Repairs process tanks and containers
21.08 Repairs process piping

Conveying Systems
22.01 Installs conveying systems
22.02 Diagnoses conveying systems
22.03 Maintains conveying systems
22.04 Repairs conveying systems

Hydraulic Systems
23.01 Installs hydraulic systems
23.02 Diagnoses hydraulic systems
23.03 Maintains hydraulic systems
23.04 Repairs hydraulic systems

Pneumatic and Vacuum Systems
24.01 Installs pneumatic and vacuum systems
24.02 Diagnoses pneumatic and vacuum systems
24.03 Maintains pneumatic and vacuum systems
24.04 Repairs pneumatic and vacuum systems

Maintenance and Testing
25.01 Performs preventative maintenance activities
25.02 Performs vibration analysis procedures
25.03 Performs balancing procedures
25.04 Performs non-destructive testing (NDT) procedures
25.05 Performs fluid analysis procedures
25.06 Performs predictive maintenance activities

Commissioning and Decommissioning Equipment
26.01 Commissions systems and components
26.02 Decommissions systems and components

Major Work Activity A—Performs common occupational skills

Task A-1 Maintains safe and healthy workplace

Task Descriptor

Industrial mechanics (millwrights) participate in ensuring a safe and healthy workplace. They 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. They must participate in ensuring a healthy and inclusive workplace.

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

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

Skills

Reference Code	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 regulations
A-1.01.02P	select PPE and safety equipment specific to job task	PPE and safety equipment are selected according to job task, site specifications and 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 regulations
A-1.01.04P	ensure fit of PPE and safety equipment	PPE and safety equipment fit according to site and manufacturers' specifications and 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 regulations

Knowledge

Reference Code	Learning Outcomes and Objectives
A-1.01.01L	demonstrate knowledge of PPE and safety equipment, their characteristics and applications
a.	identify types of PPE and clothing, and describe their characteristics and applications
b.	identify types of safety equipment and describe their characteristics and applications
c.	interpret information about PPE and safety equipment specifications
A-1.01.02L	demonstrate knowledge of procedures to select, use, maintain and store PPE and safety equipment
a.	identify tools and equipment to maintain PPE and safety equipment, and describe their procedures for use
b.	identify hazards and describe safe work practices to use, maintain and store PPE and safety equipment
c.	describe procedures to select, use, maintain and store PPE and safety equipment
d.	describe procedures to inspect PPE and safety equipment
A-1.01.03L	demonstrate knowledge of additional training and certification to use, maintain and store PPE and safety equipment
a.	identify additional training and certification to use, maintain and store PPE and safety equipment
A-1.01.04L	demonstrate knowledge of regulatory requirements to use, maintain and store PPE and safety equipment
a.	identify codes, standards and regulations to use, maintain and store PPE and safety equipment
A-1.01.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle PPE and safety equipment

A-1.02 Maintains safe work environment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-1.02.01P	recognize and address **hazards**	**hazards** that could cause personal injury, or damage to equipment, environment or worksite are recognized and addressed according to site specifications and regulations
A-1.02.02P	follow **safe work practices** while working on site and during transport of equipment and materials	**safe work practices** are followed working on site and during transport of equipment and materials **according** to site specifications and regulations
A-1.02.03P	identify and document **hazards**	**hazards** are identified and documented according to site-specific requirements
A-1.02.04P	execute **hazard** mitigation strategies	**hazard** mitigation strategies are executed according to Occupational Health and Safety (OHS) regulations, company policy and site-specific requirements to prevent equipment damage or injuries to self and others
A-1.02.05P	handle and store hazardous materials according to Workplace Hazardous Materials Information System (WHMIS)	hazardous materials are handled and stored according to WHMIS
A-1.02.06P	install **safety protection**	**safety protection** is installed according to manufacturers' specifications and regulations
A-1.02.07P	identify and implement ventilation in workspace	ventilation is identified and implemented in workspace according to manufacturers' specification and regulations

Reference Code	Performance Criteria	Evidence of Attainment
A-1.02.08P	maintain and organize work site	organized work site is maintained to avoid injuries to self and others
A-1.02.09P	coordinate tasks	tasks with other workers are coordinated to avoid injury to self and others
A-1.02.10P	place flagging, pylons and signage	flagging, pylons and signage are placed when working to avoid injury to others
A-1.02.11P	ensure clear path of access and egress	clear path is ensured for access and egress according to jurisdictional requirements, site specifications and regulations
A-1.02.12P	follow **confined space procedures and regulations**	confined space procedures are followed according to site specifications and regulations
A-1.02.13P	follow **safe work practices** working around lifting devices and mobile equipment	**safe work practices** related to lifting devices and mobile equipment are followed according to site specifications and regulations
A-1.02.14P	ensure cables and straps for monitoring equipment are secured	cables and straps are secured to ensure they do not get caught in equipment
A-1.02.15P	complete safety-related documentation	safety-related documentation is completed and submitted according to company policy
A-1.02.16P	complete and update **safety training and certification**	**safety training and certification** is completed according to specifications, policies and regulations

Range of Variables (include, but not limited to)

hazards: poor housekeeping, improper use of PPE, lack of monitoring devices, improper rigging of material, improper use of tools/equipment, improper hardware selection, poor air quality, poor ventilation, improper pre-use inspection, improper preparation for hot work, mobile or stationary equipment, improper storage, hazardous materials (e.g., chemical, biological), sparks, radiation, ultraviolet light, potential energy, other workers

safe work practices: use of PPE; following procedures relating to confined spaces and fall protection requirements; obtaining required permits; hazard identification; following company policies, site procedures, regulations and manufacturers' recommendations; disposing according to jurisdictional requirements; spill response procedures; storing materials

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

confined space procedures and regulations: test air quality, emergency response plan, ventilation, certification

safety training and certification: fall arrest, confined space, forklift, fit tests, radioactive hazards, working at heights

Knowledge

Reference Code	Learning Outcomes and Objectives
A-1.02.01L	demonstrate knowledge of **hazards** and **safe work practices**
a.	identify **hazards** and risks, and describe **safe work practices**
b.	interpret information about safety found in specifications
A-1.02.02L	demonstrate knowledge of processes to maintain safe work environment
a.	describe company safety policies and procedures
b.	identify work environment protection to maintain safe work environment, and describe procedures for use
c.	identify common causes of accidents and **hazards**, and describe procedures to mitigate and eliminate potential risks
d.	describe procedures to handle, store, label, transport, safely dispose of or recycle hazardous materials
e.	describe **procedures to ensure work area is safe for lifting**
f.	describe procedures to ensure work area is safe for mobile equipment
g.	describe procedures to safely work with **energized equipment**
h.	describe fundamentals of housekeeping
i.	describe procedures to inspect work environment

Reference Code	Learning Outcomes and Objectives
A-1.02.03L	demonstrate knowledge of documentation about workplace safety
a.	participate in workplace safety analysis and assessments
b.	document **hazards**
c.	identify safety-related documentation, and describe their purpose and application
A-1.02.04L	demonstrate knowledge of **safety training and certification** requirements
a.	identify **safety training and certification** requirements
A-1.02.05L	demonstrate knowledge of regulatory requirements for maintaining safe work environment
a.	identify jurisdictional health and safety regulations
b.	identify codes, standards and regulations for safety
c.	identify and interpret workplace health and safety regulations
d.	describe federal, jurisdictional and municipal regulations and practices related to safe disposal of hazardous products
e.	describe company or jurisdictional procedures for emergency response
f.	identify responsibilities regarding site-specific safety policies and procedures
A-1.02.06L	demonstrate knowledge of sustainability and environmental stewardship practices to maintain safe work environment
a.	identify environmental regulations and considerations when maintaining safe work environment
b.	identify environmentally friendly products that promote healthy work site
c.	demonstrate knowledge of sustainability and environmental stewardship practices
d.	identify practices that contribute to environmental protection
e.	describe procedures to dispose of and recycle products and materials

Range of Variables (include, but not limited to)

hazards: poor housekeeping, improper use of PPE, lack of monitoring devices, improper rigging of material, improper use of tools/equipment, improper hardware selection, poor air quality, poor ventilation, improper pre-use inspection, improper preparation for hot work, mobile or stationary equipment, improper storage, hazardous materials (e.g., chemical, biological), sparks, radiation, ultraviolet light, potential energy, other workers

safe work practices: use of PPE; following procedures relating to confined spaces and fall protection requirements; obtaining required permits; hazard identification; following company policies, site procedures, regulations and manufacturers' recommendations; disposing according to jurisdictional requirements; spill response procedures; storing materials

procedures to ensure work area is safe for lifting: supervision of lift, securing work area, communication, critical lift plan, engineered lift plan

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

safety training and certification: fall arrest, confined space, forklift, fit tests, radioactive hazards, working at heights

A-1.03 Protects the environment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-1.03.01P	select and use environmental protection tools and equipment	environmental protection tools and equipment are selected and used according to task, specifications and regulations
A-1.03.02P	recognize **environmental hazards** that could cause personal injury and harm the environment, and report potential **environmental hazards**	**environmental hazards** that could cause personal injury and harm the environment are recognized and reported according to site specifications and regulations
A-1.03.03P	follow procedures to avoid contamination	procedures are followed to avoid contamination of water, air and soil according to site specifications and regulations

Reference Code	Performance Criteria	Evidence of Attainment
A-1.03.04P	follow disposal procedures of hazardous material	disposal procedures of hazardous material are followed according to site specifications and regulations

Range of Variables (include, but not limited to)

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

Knowledge

Reference Code	Learning Outcomes and Objectives
A-1.03.01L	demonstrate knowledge of **environmental hazards** and describe procedures to protect the environment
a.	identify **environmental hazards** and describe their characteristics and consequences
b.	identify information about **environmental hazards** and risks found on site specifications
A-1.03.02L	demonstrate knowledge of procedures to identify **environmental hazards** and perform risk assessment
a.	identify tools and equipment to identify **environmental hazards**, perform risk assessment and protect the environment, and describe their procedures for use
b.	describe procedures to identify **environmental hazards**
c.	identify hazards and describe safe work practices to identify **environmental hazards**, perform risk assessment and protect the environment
d.	describe procedures to assess risks
e.	describe procedures to protect the environment
f.	identify and describe reporting requirements and procedures
A-1.03.03L	demonstrate knowledge of additional training and certification to ensure environmental safety and protection
a.	identify additional training and certification to ensure environmental safety and protection
A-1.03.04L	demonstrate knowledge of regulatory requirements to ensure environmental safety and protection
a.	identify codes, standards and regulations to ensure environmental safety and protection

Reference Code	Learning Outcomes and Objectives
A-1.03.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle materials to protect the environment

Range of Variables (include, but not limited to)

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

A-1.04 Performs lockout/tagout (LOTO) and zero-energy state procedures

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-1.04.01P	select and use tools and equipment	tools and equipment are selected and used according to lockout/tagout (LOTO) procedures and regulations
A-1.04.02P	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 they are de-energized according to site and manufacturers' specifications, and regulations and zero-energy state is confirmed
A-1.04.03P	follow recognized standard operating procedure (SOP) for shutdown and LOTO	SOP is followed for shutdown and LOTO according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

energy potential in machines, process systems and components: 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, radiation

Knowledge

Reference Code	Learning Outcomes and Objectives
A-1.04.01L	demonstrate knowledge of **energy potential in machines, process systems and components**
a.	identify **energy potential in machines, process systems and components** and describe consequences of incorrect LOTO
b.	describe methods to verify zero-energy state
c.	interpret information about **energy potential in machines, process systems and components** found in drawings and specifications
A-1.04.02L	demonstrate knowledge of procedures to perform LOTO and zero-energy procedures
a.	identify tools and equipment to perform LOTO and zero-energy procedures, and describe their procedures for use
b.	identify hazards and describe safe work practices to perform LOTO and zero-energy procedures
c.	identify and describe potential outcomes of not following procedures to lock out and tag out equipment and to return to zero-energy state
d.	describe procedures to perform LOTO and zero-energy procedures
A-1.04.03L	demonstrate knowledge of additional training and certification to LOTO equipment and to return to zero-energy state
a.	identify additional training and certification to LOTO equipment and to return to zero-energy state
A-1.04.04L	demonstrate knowledge of regulatory requirements to LOTO equipment and to return to zero-energy state
a.	identify codes, standards and regulations to LOTO equipment and to return to zero-energy state
A-1.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices related to LOTO
a.	identify LOTO practices that contribute to environmental protection
b.	identify LOTO practices that contribute to net-zero and carbon neutral commitments

Range of Variables (include, but not limited to)

energy potential in machines, process systems and components: 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, radiation

A-1.05 Participates in healthy and respectful work environment and practices

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-1.05.01P	perform self-assessment of physical and mental health	self-assessment of physical and mental health is performed, and health concerns are identified
A-1.05.02P	identify **supports and resources** for personal physical and mental health	**supports and resources** for personal physical and mental health are identified
A-1.05.03P	identify **techniques to manage health and wellness**	**techniques to manage health and wellness** are identified
A-1.05.04P	assess **personal job satisfaction**	**personal job satisfaction** is assessed, and concerns are discussed with management
A-1.05.05P	create plan to manage work-life balance	plan is created to manage work-life balance and discussed with supervisors when necessary
A-1.05.06P	support and promote anti-**harassment** and anti-**discrimination** practices in workplace	workplace is **harassment** and **discrimination**-free

Range of Variables (include, but not limited to)

supports and resources: family and friends, professional networks and associations, collaboration with colleagues and community members, counselling, mentoring, peer support groups, paramedical services, employee assistance plan (EAP)

techniques to manage health and wellness: practicing techniques for remaining physically, mentally and emotionally "fit for work"; managing personal and work life; recognizing effects and consequences of alcohol, over-the-counter drugs, prescription drugs or illegal drugs before, during and after work; personal hygiene habits

personal job satisfaction: financial, hours, flexibility, supports, working conditions and environment, career advancement opportunities

harassment: as defined by Canadian and jurisdictional Human Rights Commissions

discrimination: as defined by Canadian Human Rights Act and jurisdictional human rights laws

Knowledge

Reference Code	Learning Outcomes and Objectives
A-1.05.01L	demonstrate knowledge of personal health and well-being
a.	describe how personal health and well-being impacts professional practice and healthy work environments
b.	identify and describe physical and emotional requirements of trade
c.	identify workplace stressors
d.	describe elements of healthy organizational cultures and importance of sense of collaboration and community
e.	identify **behaviours** that affect physical and mental health
A-1.05.02L	demonstrate knowledge of **techniques to manage health and wellness**
a.	describe stress and time management techniques
b.	identify **supports and resources** to manage personal health and wellbeing
c.	describe **techniques to manage health and wellness**
A-1.05.03L	demonstrate knowledge of professionalism and **professional ethics**
a.	identify characteristics and purpose of professionalism and **professional ethics**
b.	describe **factors** that impact professionalism
c.	identify **elements of codes of ethics, codes of conduct and other professional standards**, and describe their characteristics and applications

Reference Code	Learning Outcomes and Objectives
A-1.05.04L	demonstrate knowledge of value of diversity, equity, inclusion and belonging in workplace
a.	define diversity and differences between individuals
b.	define equity and importance of individual's access to opportunities and resources
c.	define inclusion and creation of respectful work environments
d.	identify conduct that constitutes **harassment** and **discrimination**
e.	demonstrate behaviours of inclusivity and acceptance of differences

Range of Variables (include, but not limited to)

behaviours: diet, fitness, sleep, managing stress and emotions

techniques to manage health and wellness: practicing techniques for remaining physically, mentally and emotionally "fit for work"; managing personal and work life; recognizing effects and consequences of alcohol, over-the-counter drugs, prescription drugs or illegal drugs before, during and after work; personal hygiene habits

supports and resources: family and friends, professional networks and associations, collaboration with colleagues and community members, counselling, mentoring, peer support groups, paramedical services, employee assistance plan (EAP)

professional ethics: personal and/or corporate standards of behaviour expected by professionals, values and guiding principles to guide individuals in performing job functions

factors: presentation of self (appearance, hygiene), communication (verbal, written, body language, social media profile), conduct

elements of codes of ethics, codes of conduct and other professional standards: professional obligations; signal accountability to the public; maintain public trust and credibility of the profession; define misconduct; support and promote anti-harassment and anti-discrimination practices

harassment: as defined by Canadian and jurisdictional Human Rights Commissions

discrimination: as defined by Canadian Human Rights Act and jurisdictional human rights laws

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 list of the tools and equipment used in this trade is found in Appendix B – Tools and Equipment

A-2.01 Uses hand tools and portable power tools

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

Skills

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

Knowledge

Reference Code	Learning Outcomes and Objectives
A-2.01.01L	demonstrate knowledge of hand tools and portable power tools, and their characteristics and applications
a.	identify types of hand tools, and describe their characteristics and applications

Reference Code	Learning Outcomes and Objectives
b.	identify types of portable power tools, and describe their applications and procedures for use
c.	interpret information about hand tools and portable power tools found in manufacturers' specifications
A-2.01.02L	demonstrate knowledge of procedures to use, clean, inspect, maintain and store hand tools and portable power tools
a.	identify tools and equipment to clean and maintain hand tools and portable power tools, and describe their procedures for use
b.	identify hazards and describe safe work practices to use, clean, maintain and store hand tools and portable power tools
c.	describe procedures to use, clean, inspect, maintain and store hand tools and portable power tools
d.	describe procedures to inspect and tag damaged or defective hand tools and portable power tools
e.	identify defects and criteria for replacement, repair or removal of hand tools and portable power tools
A-2.01.03L	demonstrate knowledge of training requirements for use of powder-actuated tools
a.	identify training requirements for use of powder-actuated tools
A-2.01.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle damaged hand tools and portable power tools

A-2.02 Uses shop tools and equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-2.02.01P	set up shop machines to perform task	shop machines are set up according to task, drawings and manufacturers' specifications
A-2.02.02P	apply coolants and cutting fluids	coolants and cutting fluids are applied according to speed, workpiece material and manufacturers' specifications
A-2.02.03P	clean and lubricate shop tools and equipment	shop tools and equipment are cleaned and lubricated according to manufacturers' specifications
A-2.02.04P	machine workpiece	workpiece is cut, drilled, turned, milled and ground according to drawings, specifications or instructions
A-2.02.05P	bend, cope, notch and roll workpiece	workpiece is bent, coped, notched and rolled according to drawings or instructions

Knowledge

Reference Code	Learning Outcomes and Objectives
A-2.02.01L	demonstrate knowledge of shop tools and equipment, characteristics, applications and procedures for use
a.	identify types of shop tools and equipment and describe their characteristics, applications and procedures for use
b.	interpret information about shop tools and equipment found in manufacturers' specifications
c.	identify hazards and describe safe work practices related to use of shop tools and equipment
d.	describe procedures to inspect and tag damaged or defective shop tools and equipment

Reference Code	Learning Outcomes and Objectives
e.	identify defects and criteria for replacement, repair or removal of shop tools and equipment
f.	describe procedures to dispose of and recycle damaged shop tools and equipment
A-2.02.02L	demonstrate knowledge of ironworker shop equipment, its characteristics, applications and procedures for use
a.	identify types of ironworker shop equipment and describe its characteristics, applications and procedures for use
b.	interpret information about ironworker shop equipment found in manufacturers' specifications
c.	identify hazards and describe safe work practices for slip-roll and brake applications
d.	describe procedures to set up ironworker equipment
e.	describe procedures to align, bend, cope and notch workpieces
A-2.02.03L	demonstrate knowledge of grinders, their characteristics, applications and procedures for use
a.	identify **types of grinders** and describe their characteristics and applications
b.	identify grinder components, accessories and attachments and describe their characteristics and applications
c.	interpret information about grinders and their components, accessories and attachments found in manufacturers' specifications
d.	identify hazards and describe safe work practices for grinding operations
e.	describe procedures to perform grinding operations
f.	describe **techniques to sharpen and dress tools** using grinders
g.	identify **factors to consider when selecting grinding wheels** or disks for specific operations
h.	describe procedures to change, ring test, mount and dress grinding wheels
i.	describe procedures to change, visually inspect, mount and dress grinding disks
A-2.02.04L	demonstrate knowledge of power metal saws and their characteristics, applications and procedures for use
a.	identify **types of power metal saws** and describe their characteristics and applications
b.	identify power metal saw components, accessories and attachments and describe their characteristics and applications

Reference Code	Learning Outcomes and Objectives
c.	interpret information about power metal saws and their components, accessories and attachments found in manufacturers' specifications
d.	identify hazards and describe safe work practices for power metal saws
e.	identify cutting fluids and coolants used during cutting operations
f.	identify factors to consider when selecting power metal saw blades for specific operations
g.	describe procedures to change power metal saw blades and tension
h.	describe procedures to select power metal saw feeds and speeds
i.	describe procedures to perform and troubleshoot cutting operations using power metal saws
A-2.02.05L	demonstrate knowledge of drilling machines their accessories, characteristics, applications and procedures for use
a.	identify **types of drilling machines**, their components and accessories and describe their characteristics and applications
b.	identify **types of drilling tools** and describe their characteristics and applications
c.	interpret information about drilling machines and their components, accessories and attachments found in drawings and specifications
d.	identify hazards and describe safe work practices for drilling operations
e.	identify cutting fluids and coolants used during drilling operations and describe their characteristics and applications
f.	describe procedures to set up, operate and troubleshoot drilling machines
g.	determine and calculate speeds and feeds for drilling operations
A-2.02.06L	demonstrate knowledge of lathes, their **accessories**, **attachments** characteristics, applications and procedures for use
a.	identify types of lathes and describe their applications and operation
b.	identify lathe components, **accessories and attachments**, and describe their characteristics and applications
c.	identify types of tool holding and work holding devices, and describe their characteristics and applications
d.	identify types of lathe tools and describe their characteristics and applications
e.	interpret information about lathes and their **accessories and attachments** found in manufacturers' specifications
f.	identify hazards and describe safe work practices for lathe operations
g.	describe procedures to perform basic lathe operations

Reference Code	Learning Outcomes and Objectives
h.	describe procedures to align workpieces
i.	describe procedures to prevent and correct problems that occur when performing lathe operations
j.	describe procedures to sharpen lathe cutting tools
k.	calculate and determine speeds, feeds and depth of cut for lathe operations
l.	describe procedures to set up lathes
m.	identify cutting fluids and coolants used during lathe operations
A-2.02.07L	demonstrate knowledge of milling machines, their characteristics, applications and procedures for use
a.	identify types of milling machines and describe their applications
b.	identify milling machine components, accessories and attachments, and describe their characteristics, applications and maintenance
c.	identify types of tool-holding and work-holding devices and describe their characteristics, applications and procedures for use
d.	identify types of cutting tools and describe their characteristics and applications
e.	interpret information about milling machines and their components, accessories and attachments found in manufacturers' specifications
f.	identify hazards and describe safe work practices for milling operations, materials and coolants
g.	describe procedures to align workpieces
h.	identify cutting fluids and coolants used during milling operations
i.	describe procedures to perform milling operations
j.	describe procedures to prevent and correct problems that occur when performing milling operations
k.	calculate and determine speeds, feeds and depth of cut for milling operations

Range of Variables (include, but not limited to)

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

techniques to sharpen or dress tools: sharpening chisels, sharpening drills, dressing grinding wheels

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

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

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

types of drilling tools: twist drills, step drill, center drills, metal spade, core drill (annular cutter), hammer drill

accessories and attachments (lathe): tool holders, knurling tools, live centers, dead centers, drill chucks, taper attachments, steady rests, follower rests, tool post grinders, three and four jaw chucks, safety guards

A-2.03 Uses access equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-2.03.01P	select access equipment	access equipment is selected according to task and taking into consideration **worksite conditions**
A-2.03.02P	complete **training and certification**	**training and certification** are completed according to specifications, policies and regulations
A-2.03.03P	set up and use access equipment	access equipment is set up and used according to site and manufacturers' specifications, and regulations
A-2.03.04P	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

Reference Code	Performance Criteria	Evidence of Attainment
A-2.03.05P	clean and lubricate access equipment	access equipment is cleaned and lubricated according to manufacturers' specifications
A-2.03.06P	store access equipment	access equipment is stored according to site and manufacturers' specifications and regulations

Range of Variables (include, but not limited to)

worksite conditions: soft ground, uneven terrain, slippery (winter conditions, grease), weather

training and certification: aerial work platform (AWP), mobile elevating work platform (MEWP)

Knowledge

Reference Code	Learning Outcomes and Objectives
A-2.03.01L	demonstrate knowledge of access equipment, their characteristics and applications
a.	identify types of access equipment and describe their characteristics and applications
b.	identify types of **access equipment safety features**, and describe their characteristics and applications
c.	describe operating principles of access equipment
d.	interpret information about access equipment found in manufacturers' specifications
A-2.03.02L	demonstrate knowledge of procedures to use and maintain access equipment
a.	identify hazards and describe safe work practices for using and maintaining access equipment
b.	describe procedures to erect, level and dismantle access equipment
c.	describe procedures to use access equipment
d.	describe procedures to erect and dismantle ladders and scaffolding
e.	describe procedures to inspect and tag worn, damaged and defective access equipment
f.	identify defects and criteria for replacement, repair or removal of access equipment
g.	describe procedures to clean, maintain and store access equipment
h.	describe procedures to dispose of and recycle damaged access equipment

Reference Code	Learning Outcomes and Objectives
A-2.03.03L	demonstrate knowledge of additional **training and certification** for access equipment
a.	identify additional **training and certification** to use access equipment
A-2.03.04L	demonstrate knowledge of regulatory requirements for access equipment
a.	identify codes, standards and regulations for access equipment

Range of Variables (include, but not limited to)

access equipment safety features: lanyard, outrigger, limit switch, tilt alarm, placard, tie-off points, fall arrest, fall restraint)
training and certification: aerial work platform (AWP), mobile elevating work platform (MEWP)

Task A-3 Organizes tasks

Task Descriptor

In order to organize their tasks, industrial mechanics (millwrights) must be able to plan their tasks, interpret codes, standards, regulations and procedures, and use mechanical drawings, schematics, documents and reference materials

A-3.01 Plans tasks

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-3.01.01P	determine scope of task	scope of task is determined according to work order
A-3.01.02P	develop safety plan	safety plan is developed according to task, site, regulations and manufacturers' specifications
A-3.01.03P	gather and prepare **documents**	**documents** are gathered and prepared according to task

Reference Code	Performance Criteria	Evidence of Attainment
A-3.01.04P	determine tools and equipment	tools and equipment needed are determined according to task
A-3.01.05P	identify required **materials**	required **materials** are identified according to task
A-3.01.06P	coordinate work activities and consult with other tradespersons and personnel	work activities are coordinated by consulting with other tradespersons and personnel
A-3.01.07P	estimate time to complete task	time to complete task is estimated

Range of Variables (include, but not limited to)

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

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

Knowledge

Reference Code	Learning Outcomes and Objectives
A-3.01.01L	demonstrate knowledge of task planning
a.	identify **sources of information** relevant to task planning
b.	identify **factors** to consider for determining task
c.	explain concept of job sequencing, and describe its application and purpose in job planning process
A-3.01.02L	demonstrate knowledge of procedures to plan and organize tasks
a.	describe **procedures to plan tasks**
b.	describe procedures to organize and store tools, equipment and materials on-site
A-3.01.03L	demonstrate knowledge of regulatory requirements to plan tasks
a.	identify codes, standards and regulations to plan tasks
A-3.01.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle materials

Range of Variables (include, but not limited to)

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

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

procedures to plan tasks: scheduling, estimating

A-3.02 Interprets codes, standards and regulations

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-3.02.01P	locate and follow **codes, standards and regulations** information	sections of **codes, standards and regulations** information that apply to task are located and followed
A-3.02.02P	determine requirements of **codes, standards and regulations**	requirements of **codes, standards and regulations** are determined and completed according to task
A-3.02.03P	interpret tables and charts in codes and standards	tables and charts are referred to and applied according to task
A-3.02.04P	interpret and apply jurisdictional and environmental regulations	jurisdictional and environmental regulations are applied according to task
A-3.02.05P	interpret and adhere to **specific facility procedures** and equipment procedures	**specific facility procedures** and equipment procedures are applied and adhered according to site conditions and tasks
A-3.02.06P	interpret and adhere to **company procedures**	**company procedures** are interpreted and adhered to

Range of Variables (include, but not limited to)

codes, standards and regulations: federal, provincial, municipal, insurance standards, environmental regulations, Transportation of Dangerous Goods (TDG), OHS regulations, jurisdictional health and safety regulations, site-specific regulations, Canadian Standards Association (CSA), Canadian Nuclear Safety Commission (CNSC), WHMIS, International Standards Organization (ISO), American Gear Manufacturers Association (AGMA), American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)/ American Society of Testing & Materials (ASTM) standards, Canadian Welding Bureau (CWB) standards

specific facility procedures: commercial, institutional, industrial, marine

company procedures: service reports, safety and communication procedures

Knowledge

Reference Code	Learning Outcomes and Objectives
A-3.02.01L	demonstrate knowledge of trade-related regulatory requirements
a.	identify trade-related **codes, standards and regulations**
b.	identify sources of **codes, standards and regulations**
A-3.02.02L	demonstrate knowledge of trade-related codes, standards, regulations, and their procedures and applications
a.	describe procedures and applications of trade-related **codes, standards and regulations**
b.	identify sources of **codes, standards and regulations**

Range of Variables (include, but not limited to)

codes, standards and regulations: federal, provincial, municipal, insurance standards, environmental regulations, TDG, OHS regulations, jurisdictional health and safety regulations, site-specific regulations, CSA, CNSC, WHMIS, ISO, AGMA, ANSI/ASME/ASTM standards, CWB standards

A-3.03 Uses drawings and schematics

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-3.03.01P	determine and recognize locations of equipment, components and parts	locations of equipment, components and parts are determined and recognized from **drawings**
A-3.03.02P	interpret and cross-reference specifications, technical manuals and **drawings**	specifications, technical manuals and **drawings** are interpreted and cross-referenced
A-3.03.03P	perform trade-related calculations	trade-related calculations are performed
A-3.03.04P	produce field **drawings** and sketches	field **drawings** and sketches are produced
A-3.03.05P	identify **symbols**	**symbols** are identified
A-3.03.06P	request updates to **drawings**	**drawings** are updated as requested

Range of Variables (include, but not limited to)

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

Knowledge

Reference Code	Learning Outcomes and Objectives
A-3.03.01L	demonstrate knowledge of **drawings**, their use and interpretation
a.	identify **views** found in **drawings** and describe their characteristics
b.	interpret **drawings** and instructions on **drawings**
c.	interpret material specifications found in **drawings**
d.	identify **purposes for drawings**
A-3.03.02L	demonstrate knowledge of calculations relevant to **drawings**
a.	describe procedures to perform calculations relevant to **drawings**
b.	identify metric and imperial systems of measurement and describe procedures to perform conversions between systems
c.	identify **drawing projections** and describe their applications
d.	interpret and extract **information** from **drawings**
e.	explain use of scales
f.	identify styles of dimensioning on **drawings** and describe their applications
A-3.03.03L	demonstrate knowledge of basic sketching techniques
a.	demonstrate basic sketching techniques
b.	demonstrate awareness of computer-aided design (CAD) systems
c.	create sketch using blueprint/drawing as starting point
A-3.03.04L	demonstrate knowledge of regulatory requirements for **drawings**
a.	identify codes, standards and regulations for **drawings**

Range of Variables (include, but not limited to)

drawings: civil/site, engineered, architectural, mechanical, structural, electrical, shop drawings, field drawings, sketches, as-builts, working, P&ID, ITP, drawing assembly
views: elevation, plan, section, detail, first or third angle projection
purposes for drawings: determine location of components, determine positioning of components, determine elevation of components, determine specifications of components
drawing projections: orthographic, oblique, isometric, section, auxiliary
information: dimensions, lines, legend, symbols and abbreviations, title block, notes and specifications, tolerances/allowances, bill of materials

A-3.04 Uses documentation and reference material

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-3.04.01P	access **work-related documents, reference materials** and **manuals**	**work-related documents, reference materials** and **manuals** are accessed
A-3.04.02P	interpret **reference materials**	**reference materials** are interpreted
A-3.04.03P	interpret technical bulletins and **manuals**	technical bulletins and **manuals** are interpreted
A-3.04.04P	submit as-built drawings	as-built drawings are submitted
A-3.04.05P	complete and submit **work-related documents**	**work-related documents** are completed and submitted
A-3.04.06P	interpret and follow change orders and site instructions	change orders and site instructions are interpreted and followed
A-3.04.07P	interpret and follow manufacturers' installation instructions	manufacturers' installation instructions are interpreted and followed
A-3.04.08P	convert between imperial and metric measurements	measurements between imperial and metric are converted

Range of Variables (include, but not limited to)

work-related documents: material and test sheets, progress reports, material reports, verification reports, deficiency lists, company-specific reports, machinery checklists, service requests, work orders, on-site change notices, accident and incident reports, hot work permits, time sheets, field level risk assessment (FLRA), pre-job safety instruction (PSI), lift plans, job hazard analysis (JHA), equipment inspections, PPE inspections, toolbox talk, safety meeting documents, quality control (QC) checklists, LOTO plan, job-specific, confined space plan

reference materials: bill of materials, job plans, job specifications, material traceability (mill reports), WHMIS (GHS) materials, manufacturers' specifications, technical drawings, specifications, codes, work orders, safety permits, technical bulletins, manuals, OHS reports, test certificates, commissioning papers, equipment operating certificates, deficiency lists, National Grease Lubrication Institute (NGLI)

manuals: codes, specifications, equipment manuals, quality manuals, health and safety manuals, industry/contractors safety manual (handbook), industry manuals

Knowledge

Reference Code	Learning Outcomes and Objectives
A-3.04.01L	demonstrate knowledge of **work-related documents**, **reference materials** and **manuals**, their characteristics and applications
a.	identify types of **work-related documents**, **reference materials** and **manuals**, and describe their characteristics and applications
b.	identify and interpret information found in **reference documentation** and **manuals**
A-3.04.02L	demonstrate knowledge of procedures to use and complete **work-related documents**
a.	describe procedures to use and complete documentation and reference material
b.	describe procedures to complete **work-related documents**
c.	explain responsibilities associated with completing and signing **work-related documents**
d.	describe procedures to convert between imperial and metric measurements
A-3.04.03L	demonstrate knowledge of regulatory requirements for documentation
a.	identify codes, standards and regulations for documentation

Range of Variables (include, but not limited to)

work-related documents: material and test sheets, progress reports, material reports, verification reports, deficiency lists, company-specific reports, machinery checklists, service requests, work orders, on-site change notices, accident and incident reports, hot work permits, time sheets, FLRA, PSI, lift plans, JHA, equipment inspections, PPE inspections, toolbox talk, safety meeting documents, QC checklists, LOTO plan, job-specific, confined space plan

reference materials: bill of materials, job plans, job specifications, material traceability (mill reports), WHMIS (GHS) materials, manufacturers' specifications, technical drawings, specifications, codes, work orders, safety permits, technical bulletins, manuals, OHS reports, test certificates, commissioning papers, equipment operating certificates, deficiency lists, NGLI

manuals: codes, specifications, equipment manuals, quality manuals, health and safety manuals, industry/contractors safety manual (handbook), industry manuals

Task A-4 Performs trade tasks

Task Descriptor

Industrial mechanics (millwrights) perform these trade tasks to support a variety of other trade activities and to optimize the efficiency and life expectancy of equipment.

A-4.01 Fabricates workpiece

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-4.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
A-4.01.02P	identify **fabrication requirements** and **materials**	**fabrication requirements** and **materials** are identified according to task, engineered drawings and manufacturers' specifications
A-4.01.03P	identify fit and assembly requirements	fit and assembly requirements are identified according to task requirements, engineered drawings and manufacturers' specifications
A-4.01.04P	lay out workpiece	workpiece is laid out according to task, engineered drawings and manufacturers' specifications
A-4.01.05P	perform **fabrication** of workpiece	workpiece is fabricated according to task, engineered drawings and manufacturers' specifications
A-4.01.06P	test fit and modify workpiece	workpiece is test fit and modified according to task, engineered drawings and manufacturers' specifications
A-4.01.07P	inspect fabricated workpiece	fabricated workpiece is inspected in accordance with task, engineered drawings and manufacturers' specifications

Range of Variables (include, but not limited to)

fabrication requirements: size, strength, weight, material properties
materials: ferrous metals, non-ferrous metals, plastics, wood
fabrication: cutting, drilling, sanding, machining, grinding, welding

Knowledge

Reference Code	Learning Outcomes and Objectives
A-4.01.01L	demonstrate knowledge of procedures to fabricate workpiece
a.	identify tools and equipment to fabricate workpiece, and describe their procedures for use
b.	identify hazards and describe safe work practices for fabrication of workpiece
c.	interpret information and **fabrication requirements** to fabricate workpiece found in drawings and specifications
d.	identify **materials** used in **fabrication** of workpieces
e.	describe procedures to perform **fabrication** of workpiece
A-4.01.02L	demonstrate knowledge of additional training and certification to fabricate workpiece
a.	identify additional training and certification to fabricate workpiece
A-4.01.03L	demonstrate knowledge of regulatory requirements to fabricate workpiece
a.	identify codes, standards and regulations to fabricate workpiece
A-4.01.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle fabrication **materials**

Range of Variables (include, but not limited to)

fabrication requirements: size, strength, weight, material properties
materials: ferrous metals, non-ferrous metals, plastics, wood
fabrication: cutting, drilling, sanding, machining, grinding, welding

A-4.02 Lubricates systems and components

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-4.02.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
A-4.02.02P	determine **lubricant** requirements	**lubricant** requirements are determined according to compatibility with the operational process, manufacturers' specifications, technical manuals and regulations
A-4.02.03P	select **lubricants**	**lubricants** are selected according to compatibility with the operational process, manufacturers' specifications, technical manuals and regulations
A-4.02.04P	identify points requiring **lubricants**	points requiring **lubricants** are identified according to manufacturers' specifications and engineered drawings
A-4.02.05P	maintain **lubricant** levels	levels of **lubricants** are maintained according to site and manufacturers' specifications, and engineered drawings
A-4.02.06P	remove and replace **lubricants**	**lubricants** are removed and replaced according to site and manufacturers' specifications, and regulations
A-4.02.07P	treat, clean and maintain **lubrication systems** and components	**lubrication systems** and components are treated, cleaned and maintained according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

lubricants: oil, grease, dry solid, water, air

lubrication systems: once through, oil bath, splash, oil mist, manual, enclosed circulating, pressurized, automated

Knowledge

Reference Code	Learning Outcomes and Objectives
A-4.02.01L	demonstrate knowledge of **lubricants** and **lubrication systems** and their components, characteristics, applications and operation
a.	identify types of **lubricants**, and describe their applications, **properties and characteristics**
b.	identify **lubrication systems**, and describe their characteristics and applications
c.	explain principles and **types of friction** and their effects on surfaces in contact
d.	describe operating principles of **lubricants** and **lubrication systems**
e.	identify **sources of information** and interpret information about **lubricants** and **lubrication systems** found in them
A-4.02.02L	demonstrate knowledge of procedures to use and store **lubricants**, and maintain and troubleshoot **lubrication systems**
a.	identify tools and equipment used with **lubricants** and **lubrication systems**, and describe their procedures for use
b.	identify **hazards** and describe safe work practices used with **lubricants** and **lubrication systems**
c.	describe procedures to use **lubricants**
d.	identify **factors** to consider when selecting **lubricants**
e.	explain effects of using incorrect **lubricants**
f.	describe **lubrication requirements**, **properties and characteristics** for applications
g.	describe procedures to store **lubricants**
h.	describe maintenance and troubleshooting procedures for **lubrication systems**
A-4.02.03L	demonstrate knowledge of regulatory requirements for **lubricants** and **lubrication systems**
a.	identify codes, standards and regulations for **lubricants** and **lubrication systems**

Reference Code	Learning Outcomes and Objectives
A-4.02.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **lubricants**

Range of Variables (include, but not limited to)

lubricants: oil, grease, dry solid, water, air

lubrication systems: once through, oil bath, splash, oil mist, manual, enclosed circulating, pressurized, automated

properties and characteristics: adhesion, cohesion, shear, viscosity, additives and inhibitors, consistency, drop point, flash point, classifications, grades

types of friction: static, sliding, rolling, fluid

sources of information: technical manuals, manufacturers' specifications

hazards: environmental, personal health, fire, contamination, slipping, spillage, leaks, poor housekeeping and storage

factors: application, temperature, pressure, compatibility with system and components, cost, availability

lubrication requirements: levels, amounts, locations, component-specific requirements (e.g., oil vs. grease, RPM)

A-4.03 Performs levelling and aligning of components and systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-4.03.01P	select and use **levelling** and **alignment tools**	**levelling** and **alignment tools** levelling are selected and used according to task, engineered drawings, site evaluation and **conditions**, specifications and regulations

Reference Code	Performance Criteria	Evidence of Attainment
A-4.03.02P	level and align machinery and components	machinery and components are levelled and aligned according to site and manufacturers' specifications and engineered drawings
A-4.03.03P	record levelling and alignment data	levelling and alignment data are recorded to demonstrate compliance to site and manufacturers' specifications, and engineered drawings

Range of Variables (include, but not limited to)

levelling tools: spirit levels, optical levels, laser levels, plumb bobs

alignment tools: dial indicators, precision square, taper gauge, feeler gauge, optical alignment tools, piano wire, laser

conditions: environmental conditions, vibration, ground conditions

Knowledge

Reference Code	Learning Outcomes and Objectives
A-4.03.01L	demonstrate knowledge of **procedures to level and align equipment**
a.	identify **levelling** and **alignment tools** and describe their procedures for use
b.	identify hazards and describe safe work practices for equipment levelling and alignment
c.	interpret information about equipment levelling and alignment found in drawings and specifications
d.	describe **procedures to level and align equipment**
e.	identify types of **bases** and describe their applications
A-4.03.02L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle materials

Range of Variables (include, but not limited to)

procedures to level and align equipment: planning, interpreting drawings, fabricating component supports, installing base, shimming, positioning equipment, align machine datums (e.g., reference lines, centre lines), relieving stresses/strains, anchoring and grouting, completing documentation

levelling tools: spirit levels, optical levels, laser levels, plumb bobs

alignment tools: dial indicators, precision square, taper gauge, feeler gauge, optical alignment tools, piano wire, laser

bases: base plate, sole plate, fabricated, skid-mounted, shock-mounted foundations

A-4.04 Uses fastening and retaining devices

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-4.04.01P	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-4.04.02P	select **fastening** and **retaining devices**	**fastening** and **retaining devices** are selected according to task, engineered drawings and manufacturers' specifications
A-4.04.03P	apply **fastening** and **retaining devices**	**fastening** and **retaining devices** are applied for securing according to task, engineered drawings, manufacturers' specifications and regulations
A-4.04.04P	achieve predetermined values using **tensioning techniques**	predetermined values are achieved using **tensioning techniques** according to engineered drawings, manufacturers' specifications and regulations

Reference Code	Performance Criteria	Evidence of Attainment
A-4.04.05P	select and verify thread pitch (imperial or metric) on threaded fasteners	thread pitch (imperial or metric) is selected and verified on threaded fasteners using measuring tools and gauges according to engineered drawings and manufacturers' specifications
A-4.04.06P	select **sealants, adhesives and lubricants** associated with threaded fasteners	**sealants, adhesives and lubricants** associated with threaded fasteners are selected according to task, engineered drawings, manufacturers' specifications and regulations
A-4.04.07P	clean, chase, drill and tap threads	threads are cleaned, chased, drilled and tapped to ensure secure fastening
A-4.04.08P	restore threads	threads are restored using **thread restoration methods**

Range of Variables (include, but not limited to)

fastening devices: mechanical (e.g., bolts, nuts, screws), chemical (e.g., thread locker, epoxy)

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

tensioning techniques: preload or tension fastener using hydraulic, pneumatic, mechanical (torque wrench) and electrical (rad torque gun) methods; degree torque (torque angle); fastener elongation measurement; mechanical tension indicators

sealants, adhesives and lubricants: lubrication, thread lockers, sealants, anti-seize

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

Knowledge

Reference Code	Learning Outcomes and Objectives
A-4.04.01L	demonstrate knowledge of **fastening** and **retaining devices**, and their applications
a.	identify types of **fastening devices** and materials, and describe their characteristics and applications
b.	identify strength of **fastening devices** by grade and applications
c.	identify types of **retaining devices** and describe their characteristics and applications

Reference Code	Learning Outcomes and Objectives
d.	identify thread types and classifications and describe procedures for thread identification
e.	identify types of **sealants, adhesives and lubricants**, and describe their characteristics and applications
f.	interpret information about **fastening** and **retaining devices** found in drawings and specifications
A-4.04.02L	demonstrate knowledge of procedures to install and remove **fastening** and **retaining devices**
a.	identify tools and equipment to install and remove **fastening** and **retaining devices**, and describe their applications and procedures
b.	identify hazards and describe safe work practices to install and remove **fastening** and **retaining devices**
c.	explain purpose of **tensioning fastening devices** and describe associated **tensioning techniques**
d.	describe procedures to install and remove **fastening devices**
e.	describe procedures to install and remove **retaining devices**
f.	describe **thread restoration methods**
g.	describe **procedures to cut internal and external threads**
A-4.04.03L	demonstrate knowledge of regulatory requirements for **fastening** and **retaining devices**
a.	identify codes, standards and regulations for **fastening** and **retaining devices**
A-4.04.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **fastening** and **retaining devices**

Range of Variables (include, but not limited to)

fastening devices: mechanical (e.g., bolts, nuts, screws), chemical (e.g., thread locker, epoxy)
retaining devices: snap rings, pins, keys, set screws, locking tabs
sealants, adhesives and lubricants: lubrication, thread lockers, sealants, anti-seize
tensioning techniques: preload or tension fastener using hydraulic, pneumatic, mechanical (torque wrench) and electrical (rad torque gun) methods; degree torque (torque angle); fastener elongation measurement; mechanical tension indicators
thread restoration methods: chasing, plugging, using thread inserts, thread filing
procedures to cut internal and external threads: external threading (dies), internal threading (taps), using threading machines

A-4.05 Performs material identification

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-4.05.01P	select and use **tools and equipment**	**tools and equipment** are selected and used according to visual inspection
A-4.05.02P	perform file, chisel and punch test	file, chisel and punch tests are performed to distinguish **types of materials** and their **properties**
A-4.05.03P	perform spark test	spark test is performed to identify metal by examining colour, shape, volume and length of sparks
A-4.05.04P	perform magnet test	magnet test is performed to identify magnetic and non-magnetic metals and materials
A-4.05.05P	perform **hardness test**	**hardness tests** are performed using specialized tools

Range of Variables (include, but not limited to)

tools and equipment: hammers, chisels, grinders, files, magnets, specialized tools for hardness testing
types of materials: ferrous and non-ferrous metals, composites, plastics, rubber
properties: hardness, colour, malleability, embeddability, ductility, conductivity, magnetism
hardness test: Rockwell, Brinell, Vickers, durometer

Knowledge

Reference Code	Learning Outcomes and Objectives
A-4.05.01L	demonstrate knowledge of material identification procedures
a.	identify metals, and describe their **properties**, characteristics and applications
b.	identify non-metallic materials, and describe their **properties**, characteristics and applications
c.	describe identification systems for metals
d.	identify methods and processes used in manufacturing of steel and alloys
e.	describe **problems** that may occur when working with metals
f.	describe procedures to prevent and correct **problems** that occur when working with metals
A-4.05.02L	demonstrate knowledge of **material testing techniques**
a.	identify common **material testing techniques** and describe their associated procedures
b.	describe safe work practices for identification and handling of materials
A-4.05.03L	demonstrate knowledge of **structural shapes** and their applications
a.	identify **structural shapes** and describe their characteristics and applications

Range of Variables (include, but not limited to)

properties: hardness, colour, malleability, embeddability, ductility, conductivity, magnetism
problems: stress, contraction, expansion, distortion, work hardening, galvanic action, fire
material testing techniques: hardness testing, spark, chisel, file, magnet, conductivity, visual inspection
structural shapes: tubing, piping, angle iron, I-beams, wide flange, channel iron, plates, sheets, bars

A-4.06 Performs heat treatment of metal

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-4.06.01P	select and use **tools and equipment**	**tools and equipment** are selected and used according to heat treatment process
A-4.06.02P	clean metal	metal is cleaned to remove contaminants for heat treatment
A-4.06.03P	heat metal	metal is heated to reach predetermined temperature according to engineered documentation and manufacturers' specifications
A-4.06.04P	quench metal	metal is quenched to achieve required **metal properties** according to engineered documentation and manufacturers' specifications
A-4.06.05P	temper metal	metal is tempered to achieve required **metal properties** according to engineered documentation and manufacturers' specifications
A-4.06.06P	anneal metal	metal is annealed to achieve required **metal properties** according to engineered documentation and manufacturers' specifications
A-4.06.07P	normalizes metal	metal is normalized to achieve required **metal properties** according to engineered documentation and manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
A-4.06.08P	tests heat-treated metal	heat-treated metal is tested to determine if it has achieved required properties according to engineered documentation and manufacturers' specifications

Range of Variables (include, but not limited to)

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

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

Knowledge

Reference Code	Learning Outcomes and Objectives
A-4.06.01L	demonstrate knowledge of metals, their **properties**, characteristics and applications
a.	identify metals, and describe their **properties**, characteristics and applications
b.	describe identification systems for metals
c.	describe **problems** that may occur when working with metals
d.	describe procedures to prevent and correct **problems** that occur when working with metals
A-4.06.02L	demonstrate knowledge of heat treatment techniques
a.	describe common **processes used in heat treatment of metals**
d.	describe **hazards** and safe work practices for heat treatment of metals
c.	identify types of heat-treating tools and equipment and accessories, and describe their applications
A-4.06.03L	demonstrate knowledge of regulatory requirements to perform heat treatment of metal
a.	identify codes, standards and regulations to perform heat treatment of metal
A-4.06.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle metals

Range of Variables (include, but not limited to)

properties (metal): hardness, malleability, toughness, ductility, elasticity
problems: stress, contraction, expansion, distortion, work hardening, galvanic action
processes used in heat treatment of metals: stress relieving, hardening, annealing, tempering, normalizing, quenching
hazards: extreme heat, inadequate ventilation, improper storage

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

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-5.01.01P	select and use tools and equipment	tools and equipment are selected and used
A-5.01.02P	acclimatize precision measuring, layout and levelling tools	precision measuring, layout and levelling tools are acclimatized
A-5.01.03P	verify calibration of precision measuring, layout and levelling tools	precision measuring, layout and levelling tools are verified for calibration
A-5.01.04P	prepare material to be measured	material to be measured is prepared
A-5.01.05P	clean and prepare **work area**	**work area** is cleaned and prepared

Range of Variables (include, but not limited to)

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

Knowledge

Reference Code	Learning Outcomes and Objectives
A-5.01.01L	demonstrate knowledge of measuring, layout and levelling tools, and describe their characteristics and applications
a.	identify types of measuring tools and describe their characteristics, applications and procedures for use
b.	identify types of layout and levelling tools and describe their characteristics, applications and procedures for use
c.	interpret information about measuring, layout and levelling tools found in manufacturers' specifications
A-5.01.02L	demonstrate knowledge of procedures to maintain, calibrate and store measuring, layout and levelling tools
a.	identify hazards and describe safe work practices to maintain, calibrate and store measuring, layout and levelling tools
b.	describe procedures to inspect, maintain, calibrate and store measuring, layout and levelling tools
A-5.01.03L	demonstrate knowledge of preparing **work area**
a.	identify types of tools that are required to prepare **work area** and describe their applications and procedures for use
b.	describe safe work practices for using measuring, layout and levelling tools
c.	describe safe work practices for preparing **work area**, tools and materials
A-5.01.04L	demonstrate knowledge of requirements to use, maintain and store measuring, layout and levelling tools
a.	identify standards and requirements to use, maintain and store measuring, layout and levelling tools
A-5.01.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle measuring, layout and levelling tools

Range of Variables (include, but not limited to)

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

A-5.02 Measures materials and components

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

Skills

Reference Code	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 drawing measurements	measurements are read and interpreted according to engineered drawings and manufacturers' specifications
A-5.02.03P	transfer measurements to **components**, work area and materials	measurements are transferred to **components**, work area and materials, according to engineered drawings and manufacturers' specifications
A-5.02.04P	**measure** workpiece	workpiece is **measured** according to engineered drawings and manufacturers' specifications

Range of Variables (include, but not limited to)

components: sole plates, bases, workpiece
measure: diameters, bores, lengths, thicknesses, depths, heights

Knowledge

Reference Code	Learning Outcomes and Objectives
A-5.02.01L	demonstrate knowledge of measuring and describe its characteristics and applications
a.	identify types of precision measuring tools and describe their characteristics, applications and procedures for use
b.	interpret information about measuring tools found in manufacturers' specifications

Reference Code	Learning Outcomes and Objectives
A-5.02.02L	demonstrate knowledge of procedures to perform measuring operations
a.	identify hazards and describe safe work practices to use measuring tools
b.	describe procedures to perform measuring operations
c.	describe procedures to transfer and document measurements
d.	interpret information from measuring tools
A-5.02.03L	demonstrate knowledge of requirements to use, maintain and store measuring tools
a.	identify requirements to use, maintain and store measuring tools
A-5.02.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle measuring tools

A-5.03 Lays out components

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

Skills

Reference Code	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 task, specifications and regulations
A-5.03.02P	transfer measurements from drawings, benchmark and datum points to work area	measurements are transferred from drawings, benchmark and datum points to work area according to manufacturers' specifications and engineered drawings
A-5.03.03P	transfer measurements from drawings to workpiece	measurements are transferred from drawings to workpiece according to manufacturers' specifications and engineered drawings

Knowledge

Reference Code	Learning Outcomes and Objectives
A-5.03.01L	demonstrate knowledge of procedures to lay out components
a.	identify tools and equipment to lay out components, and describe their characteristics, applications and procedures for use
b.	identify hazards and describe safe work practices to lay out components
c.	interpret information about component layout found in drawings and specifications
d.	describe procedures to lay out components
A-5.03.02L	demonstrate knowledge of requirements to use, maintain and store layout tools
a.	identify requirements to use, maintain and store layout tools
A-5.03.03L	demonstrate knowledge of requirements to lay out components
a.	identify requirements to lay out components
A-5.03.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle components

A-5.04 Maintains precision measuring, layout and levelling tools

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-5.04.01P	clean and lubricate precision measuring, layout and levelling tools	precision measuring, layout and levelling tools are cleaned and lubricated according to manufacturers' specifications
A-5.04.02P	verify and set calibration of precision measuring, layout and levelling tools	precision measuring, layout and levelling tools are verified for calibration

Reference Code	Performance Criteria	Evidence of Attainment
A-5.04.03P	identify worn, damaged or defective precision measuring, layout and levelling tools	worn, damaged or defective precision measuring, layout and levelling tools are identified and removed from service for calibration, repair or disposal
A-5.04.04P	store precision measuring, layout and levelling tools	precision measuring, layout and levelling tools are stored according to manufacturers' specifications

Knowledge

Reference Code	Learning Outcomes and Objectives
A-5.04.01L	demonstrate knowledge of measuring and layout, and describe their characteristics and applications
a.	interpret information about precision measuring, layout and levelling tools found in manufacturers' specifications
A-5.04.02L	demonstrate knowledge of procedures to clean, inspect, maintain, calibrate and store precision measuring, layout and levelling tools
a.	identify hazards and describe safe work practices to clean, inspect, maintain, calibrate and store precision measuring, layout and levelling tools
b.	describe procedures to clean, inspect, maintain, calibrate and store precision measuring, layout and levelling tools
A-5.04.03L	demonstrate knowledge of requirements to clean, inspect, maintain, calibrate and store precision measuring, layout and levelling tools
a.	identify requirements to clean, inspect, maintain, calibrate and store precision measuring, layout and levelling tools
A-5.04.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle precision measuring, layout and levelling tools

Task A-6 Performs cutting and welding operations

Task Descriptor

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

A-6.01 Cuts material with oxy-fuel, plasma arc and air carbon arc equipment

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

Skills

Reference Code	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 task, manufacturers' specifications and engineered drawings
A-6.01.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
A-6.01.03P	select gas for cutting	gas for cutting is selected according to task, manufacturers' specifications and engineered drawings
A-6.01.04P	perform oxy-fuel cutting procedures	oxy-fuel cutting procedures are performed according to materials to be cut, site conditions and regulations
A-6.01.05P	perform plasma arc cutting procedures	plasma arc cutting procedures are performed according to materials to be cut, site conditions and regulations
A-6.01.06P	perform air carbon arc cutting procedures	air carbon arc cutting procedures are performed according to materials to be cut, site conditions and regulations

Knowledge

Reference Code	Learning Outcomes and Objectives
A-6.01.01L	demonstrate knowledge of oxy-fuel equipment and accessories
a.	identify types of oxy-fuel cutting equipment and accessories, and describe their applications
b.	interpret information about oxy-fuel cutting found in drawings and specifications
A-6.01.02L	demonstrate knowledge of procedures to cut with oxy-fuel equipment
a.	identify hazards and describe safe work practices for oxy-fuel cutting
b.	describe procedures to perform pre-cut safety check of oxy-fuel equipment
c.	describe procedures to set up, adjust and shut down oxy-fuel equipment
d.	describe procedures to inspect and maintain oxy-fuel equipment
e.	describe procedures to cut materials using oxy-fuel equipment
f.	describe procedures to prepare materials for oxy-fuel cutting
A-6.01.03L	demonstrate knowledge of regulatory requirements for oxy-fuel equipment
a.	identify codes, standards and regulations for oxy-fuel equipment
A-6.01.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to store, dispose of and recycle oxy-fuel equipment
A-6.01.05L	demonstrate knowledge of plasma arc equipment and accessories
a.	identify plasma arc equipment and accessories, and describe their applications
b.	interpret information about plasma arc cutting found in drawings and specifications
A-6.01.06L	demonstrate knowledge of procedures for plasma arc cutting
a.	identify hazards and describe safe work practices for plasma arc cutting
b.	describe plasma arc cutting processes and applications
c.	describe procedures to prepare materials for plasma arc cutting
d.	describe procedures to set up, adjust and shut down plasma arc equipment
e.	describe procedures to inspect and maintain plasma arc equipment
A-6.01.07L	demonstrate knowledge of regulatory requirements for plasma arc cutting
a.	identify codes, standards and regulations for plasma arc cutting

Reference Code	Learning Outcomes and Objectives
A-6.01.08L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle plasma arc cutting equipment
A-6.01.09L	demonstrate knowledge of air carbon arc equipment and accessories
a.	identify air carbon arc equipment and accessories, and describe their applications
b.	interpret information about air carbon arc cutting found in drawings and specifications
A-6.01.10L	demonstrate knowledge of procedures for air carbon arc cutting
a.	identify hazards and describe safe work practices for air carbon arc cutting
b.	describe air carbon arc cutting processes and applications
c.	describe procedures to prepare materials for air carbon arc cutting
d.	describe procedures to set up, adjust and shut down air carbon arc equipment
e.	describe procedures to inspect and maintain air carbon arc equipment
A-6.01.11L	demonstrate knowledge of regulatory requirements for air carbon arc cutting
a.	identify codes, standards and regulations for air carbon arc cutting
A-6.01.12L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle air carbon arc cutting equipment

A-6.02 Joins material using oxy-fuel welding equipment

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

Skills

Reference Code	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 task and material compatibility
A-6.02.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
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 workpiece	workpiece is prepared according to **procedural requirements**

Range of Variables (include, but not limited to)

oxy-fuel: acetylene, oxygen, propane, butane
procedural requirements: cleaning, preheating, joining, post-heating

Knowledge

Reference Code	Learning Outcomes and Objectives
A-6.02.01L	demonstrate knowledge of **oxy-fuel** equipment, their accessories consumables, components, characteristics, applications and operation
a.	identify types of **oxy-fuel** equipment, and describe their accessories consumables, characteristics and applications
b.	describe operating principles of **oxy-fuel** equipment and accessories
c.	interpret information about **oxy-fuel** heating, welding, brazing and soldering found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
A-6.02.02L	demonstrate knowledge of procedures to heat, weld, solder and braze with **oxy-fuel** equipment
a.	identify tools and equipment to heat, weld, solder and braze with **oxy-fuel** equipment, and describe their procedures for use
b.	identify hazards and describe safe work practices to heat, weld, solder and braze with **oxy-fuel** equipment
c.	describe procedures to **set up**, adjust and shut down **oxy-fuel** equipment
d.	describe procedures to inspect and maintain **oxy-fuel** heating, welding, brazing and soldering equipment and accessories
e.	describe procedures to heat, weld, braze and solder materials using **oxy-fuel** equipment
A-6.02.03L	demonstrate knowledge of additional training and certification to heat, weld, solder and braze with **oxy-fuel** equipment
a.	identify additional training and certification to heat, weld, solder and braze with **oxy-fuel** equipment
A-6.02.04L	demonstrate knowledge of regulatory requirements to heat, weld, solder and braze with **oxy-fuel** equipment
a.	identify codes, standards and regulations to heat, weld, solder and braze with **oxy-fuel** equipment
A-6.02.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **oxy-fuel** heating, welding, brazing and soldering equipment and accessories

Range of Variables (include, but not limited to)

oxy-fuel: acetylene, oxygen, propane, butane

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

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

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

Skills

Reference Code	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 task, material compatibility and engineered drawings
A-6.03.02P	select and use electrodes	electrodes are selected and used according to site conditions, task, material compatibility, manufacturers' specifications and engineered drawings
A-6.03.03P	perform shielded metal arc welding (SMAW) procedures	SMAW procedures are performed according to manufacturers' specifications and engineered drawings for 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

Reference Code	Learning Outcomes and Objectives
A-6.03.01L	demonstrate knowledge of SMAW equipment, their accessories, consumables, characteristics, applications and operation
a.	identify SMAW equipment, consumables and accessories, and describe their characteristics and applications
b.	describe operating principles of SMAW equipment
c.	interpret information about SMAW found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
A-6.03.02L	demonstrate knowledge of procedures to weld using SMAW equipment
a.	identify hazards and describe safe work practices to weld using SMAW equipment
b.	describe SMAW process and its applications
c.	describe procedures to set up and adjust SMAW equipment
d.	identify types of welds performed using SMAW equipment
e.	identify welding positions and describe their applications
f.	describe procedures to weld using SMAW equipment
g.	describe weld defects, their causes and prevention
A-6.03.03L	demonstrate knowledge of additional training and certification to weld using SMAW equipment
a.	identify additional training and certification to weld using SMAW equipment
A-6.03.04L	demonstrate knowledge of regulatory requirements to weld using SMAW equipment
a.	identify codes, standards and regulations to weld using SMAW equipment
A-6.03.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle SMAW equipment

A-6.04 Welds material with gas metal arc welding (GMAW) and flux core arc welding (FCAW) equipment

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

Skills

Reference Code	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 task, material compatibility and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
A-6.04.02P	select shielding gas for gas metal arc welding (GMAW)	shielding gas for GMAW is selected according to task, material compatibility, manufacturers' specifications and engineered drawings
A-6.04.03P	select and use wire	wire is selected and used according to task, material compatibility, manufacturers' specifications, and engineered drawings
A-6.04.04P	perform GMAW or flux core arc welding (FCAW) procedures	GMAW or FCAW procedures are performed according to task, material compatibility and manufacturers' specifications
A-6.04.05P	adjust amperage, shielding gas flow and wire speed	amperage, shielding gas flow and wire speed are adjusted to achieve proper fusion and penetration
A-6.04.06P	inspect welds	welds are inspected to confirm fusion and penetration according to task, material compatibility and manufacturers' specifications
A-6.04.07P	prepare workpiece	workpiece is prepared according to **procedural requirements**

Range of Variables (include, but not limited to)

procedural requirements: cleaning, preheating, joining, post-heating

Knowledge

Reference Code	Learning Outcomes and Objectives
A-6.04.01L	demonstrate knowledge of GMAW and FCAW equipment, their accessories, consumables, characteristics, applications and operation
a.	identify GMAW and FCAW equipment, accessories and consumables, and describe their characteristics and applications
b.	describe operating principles of GMAW and FCAW equipment
c.	interpret information about GMAW and FCAW found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
A-6.04.02L	demonstrate knowledge of procedures to weld using GMAW and FCAW equipment
a.	identify hazards and describe safe work practices to weld using GMAW and FCAW equipment
b.	describe GMAW and FCAW processes and their applications
c.	describe procedures to set up, adjust and shut down GMAW and FCAW equipment
d.	identify types of welds performed using GMAW and FCAW equipment
e.	identify welding positions and describe their applications
f.	describe procedures to weld using GMAW and FCAW equipment
g.	describe weld defects, their causes and prevention
A-6.04.03L	demonstrate knowledge of additional training and certification to weld using GMAW and FCAW equipment
a.	identify additional training and certification to weld using GMAW and FCAW equipment
A-6.04.04L	demonstrate knowledge of regulatory requirements to weld using GMAW and FCAW equipment
a.	identify codes, standards and regulations to weld using GMAW and FCAW equipment
A-6.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle GMAW and FCAW equipment

A-6.05 Welds material with gas tungsten arc welding (GTAW) equipment

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

Skills

Reference Code	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 task, material compatibility and manufacturers' specifications
A-6.05.02P	select shielding gas, current type, polarity and high frequency for gas tungsten arc welding (GTAW)	shielding gas, current type, polarity and high frequency for GTAW are selected according to task, material compatibility, manufacturers' specifications and engineered drawings
A-6.05.03P	select and use electrode and filler material	electrode and filler material are selected and used according to task, material compatibility, manufacturers' specifications and engineered drawings
A-6.05.04P	perform GTAW procedures	GTAW procedures are performed according to task, material compatibility, manufacturers' specifications, and engineered drawings
A-6.05.05P	adjust amperage and shielding gas flow	amperage and shielding gas flow are adjusted to achieve proper fusion and penetration
A-6.05.06P	inspect welds	welds are inspected to confirm fusion and penetration according to task, material compatibility and manufacturers' specifications

Knowledge

Reference Code	Learning Outcomes and Objectives
A-6.05.01L	demonstrate knowledge of GTAW equipment, their accessories, consumables, characteristics, applications and operation
a.	identify GTAW equipment, accessories and consumables, and describe their characteristics and applications
b.	describe operating principles of GTAW equipment
c.	interpret information about GTAW found in drawings and specifications
A-6.05.02L	demonstrate knowledge of procedures to weld using GTAW equipment
a.	identify hazards and describe safe work practices to weld using GTAW equipment
b.	describe GTAW process and its applications
c.	describe procedures to set up, adjust and shut down GTAW equipment
d.	identify types of welds performed using GTAW equipment
e.	identify welding positions and describe their applications
f.	describe procedures to weld using GTAW equipment
g.	describe weld defects, their causes and prevention
A-6.05.03L	demonstrate knowledge of additional training and certification to weld using GTAW equipment
a.	identify additional training and certification to weld using GTAW equipment
A-6.05.04L	demonstrate knowledge of regulatory requirements to weld using GTAW equipment
a.	identify codes, standards and regulations to weld using GTAW equipment
A-6.05.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle GTAW equipment

A-6.06 Maintains welding equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-6.06.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
A-6.06.02P	perform scheduled **maintenance on oxy-fuel equipment**	scheduled **maintenance on oxy-fuel equipment** is performed according to manufacturers' specifications and regulations
A-6.06.03P	perform scheduled **maintenance on electrically powered equipment**	scheduled **maintenance on electrically powered units** is performed according to equipment manufacturers' specifications and regulations
A-6.06.04P	perform scheduled **maintenance on mobile welding equipment**	scheduled **maintenance on mobile welding equipment** is performed according to manufacturers' specifications and regulations
A-6.06.05P	store equipment	equipment is stored according to company policies, manufacturers' specifications and regulations

Range of Variables (include, but not limited to)

maintenance on oxy-fuel equipment: inspecting, replacing and repairing hoses, gauges, regulators, valves, mixing chamber and flashback arrestors

maintenance on electrically powered equipment: inspecting, cleaning and replacing cables, clamps, bottles, gauges and hoses

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

Knowledge

Reference Code	Learning Outcomes and Objectives
A-6.06.01L	demonstrate knowledge of welding equipment, their **accessories**, consumables, characteristics, applications and operation
a.	identify types of welding equipment and **accessories**, and describe their characteristics, applications and procedures for use
b.	identify types of oxy-fuel equipment and **accessories** and describe their characteristics and applications
c.	identify types of plasma arc and air carbon arc cutting equipment and **accessories** and describe their characteristics and applications
d.	identify SMAW equipment, **accessories** and consumables, and describe their characteristics and applications
e.	identify GMAW and FCAW equipment, **accessories** and consumables, and describe their characteristics and applications
f.	identify GTAW equipment, **accessories** and consumables, and describe their characteristics and applications
g.	interpret information about welding equipment, **accessories** and consumables found in drawings and specifications
A-6.06.02L	demonstrate knowledge of procedures to maintain welding equipment
a.	identify tools and equipment to maintain welding equipment, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain welding equipment
c.	describe procedures to inspect, maintain and repair oxy-fuel equipment
d.	describe procedures to inspect, maintain and repair plasma arc and air carbon arc cutting equipment
e.	describe procedures to inspect, maintain and repair SMAW equipment
f.	describe procedures to inspect, maintain and repair GMAW and FCAW equipment
g.	describe procedures to inspect, maintain and repair GTAW equipment
A-6.06.03L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle welding equipment

Range of Variables (include, but not limited to)

accessories: flashback arrestors, fire extinguishers, emergency shut-off switches

Task A-7 Maintains continuous learning

Task Descriptor

Industrial mechanics (millwrights) must stay current on sustainable and emerging technologies being introduced in the trade. They need to keep informed about new and changing codes and regulations, types of equipment, energy sources, materials, procedures and sustainable practices.

A-7.01 Upskills in new trade practices and procedures

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-7.01.01P	apply **continuous learning methods**	**continuous learning methods** are applied
A-7.01.02P	develop and maintain personal and professional development plan	personal and professional development plan is developed and maintained with established learning goals (short and long term) and time frames
A-7.01.03P	identify available **supports and resources** for learning	available **supports and resources** for learning are identified

Range of Variables (include, but not limited to)

continuous learning methods: actively engaging in performance review processes and taking action to address feedback; seeking out and actively participating in and embracing learning opportunities (seminars, webinars, training, podcasts, independent research); maintaining all required certifications and training; upgrading and maintaining computer and technology skills; sharing learning outcomes and concepts with others; transferring knowledge into practice; working with multiple journeypersons to learn different styles and methods

supports and resources: professional networks and associations, manufacturers' seminars, collaboration with colleagues and community members, counselling, mentoring, peer support groups, online resources, trade shows, language supports, accommodations

Knowledge

Reference Code	Learning Outcomes and Objectives
A-7.01.01L	demonstrate knowledge of upskilling in new trade practices and procedures
a.	identify **continuous learning methods**
b.	explain importance of staying current on new trade practices and procedures
c.	identify **supports and resources** for learning
A-7.01.02L	demonstrate knowledge of personal and professional development plan
a.	identify **elements of a professional portfolio**
b.	identify link between professionalism and continuous learning
c.	describe how to assess personal learning needs
d.	identify **factors** that may impact learning needs and goals

Range of Variables (include, but not limited to)

continuous learning methods: actively engaging in performance review processes and taking action to address feedback; seeking out and actively participating in and embracing learning opportunities (seminars, webinars, training, podcasts, independent research),; maintaining all required certifications and training; upgrading and maintaining computer and technology skills; sharing learning outcomes and concepts with others; transferring knowledge into practice; working with multiple journeypersons to learn different styles and methods

supports and resources: professional networks and associations, manufacturers' seminars, collaboration with colleagues and community members, counselling, mentoring, peer support groups, online resources, trade shows, language supports, accommodations

elements of a professional portfolio: resume, certificates, licenses, diplomas, degrees, transcripts, marketable skills, professional accomplishments, work samples, awards, references

factors: new technology, sector trends and practices, skills updating, legislative and regulatory changes, barriers to learning

A-7.02 Upskills in emerging technologies

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-7.02.01P	read **information** about latest advancements and emerging technologies	**information** about latest advancements and emerging technologies is read to stay informed
A-7.02.02P	attend seminars, webinars and information sessions	seminars, webinars and information sessions organized by manufacturers, suppliers, unions and employers are attended
A-7.02.03P	share **information** on emerging technologies with colleagues and management	**information** on emerging technologies is shared with colleagues and management, and advantages and disadvantages are explained

Range of Variables (include, but not limited to)

information: manufacturers' literature, online resources, trade journals and magazines, trade shows, conferences

Knowledge

Reference Code	Learning Outcomes and Objectives
A-7.02.01L	demonstrate knowledge of upskilling in emerging technologies
a.	identify sources for learning about emerging technologies
b.	explain importance of staying current on emerging technologies
c.	identify supports and resources to stay current about emerging technologies

Task A-8 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, which is learning workplace skills and passing them onto others. Because of the importance of this to the trade, this task covers the activities related to communication in the workplace and mentoring skills

A-8.01 Uses communication techniques

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-8.01.01P	demonstrate communication techniques with individuals or in a group	communication techniques with individuals or in a group are demonstrated
A-8.01.02P	listen using **active listening** techniques	**active listening** techniques are utilized
A-8.01.03P	speak clearly using correct industry terminology to ensure understanding	clear speech and correct industry terminology is used to ensure understanding
A-8.01.04P	receive and respond to instructions	instructions are received and responded to indicating understanding
A-8.01.05P	receive and respond to feedback on work completed or performed	feedback on work completed or performed is received and responded to
A-8.01.06P	explain and provide feedback	explanation and feedback are provided
A-8.01.07P	communicate understanding and comfort level in performing trade tasks	understanding and comfort level in performance trade tasks are communicated
A-8.01.08P	use questions to improve communication	questions are used to improve communication

Reference Code	Performance Criteria	Evidence of Attainment
A-8.01.09P	participate in safety and information meetings	safety and information meetings are attended and participated in
A-8.01.10P	send and receive **electronic messages**	**electronic messages** are sent and received
A-8.01.11P	use **online tools**	**online tools** are used

Range of Variables (include, but not limited to)

active listening: hearing, interpreting, reflecting, responding, paraphrasing, repeating
electronic messages: emails, text messages, chat platforms
online tools: video conferencing, teleconferencing, applications

Knowledge

Reference Code	Learning Outcomes and Objectives
A-8.01.01L	demonstrate knowledge of trade terminology
a.	define terminology used in trade
A-8.01.02L	demonstrate knowledge of effective communication practices
a.	describe importance of using effective verbal and non-verbal communication with **people in workplace**
b.	describe importance of teamwork
c.	identify **sources of information** to effectively communicate
d.	identify communication and **learning styles**
e.	describe effective listening and speaking skills
f.	describe how to receive and give instructions effectively
g.	identify **personal responsibilities and attitudes** that contribute to on-the-job success
h.	identify value of equity, diversity and inclusion in workplace
i.	identify verbal and non-verbal communication that constitutes bullying, **harassment** and **discrimination**
j.	identify communication styles appropriate to different systems and applications of **electronic messages** and **online tools**

Range of Variables (include, but not limited to)

people in workplace: other tradespeople, colleagues, apprentices, supervisors, clients, jurisdictional representatives, manufacturers, office administrators

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

learning styles: visual, auditory, kinesthetic

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

harassment: as defined by the Canadian and jurisdictional Human Rights Commissions

discrimination: as defined by the Canadian Human Rights Act and jurisdictional human rights laws

electronic messages: emails, text messages, chat platforms

online tools: video conferencing, teleconferencing, applications

A-8.02 Uses mentoring techniques

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
A-8.02.01P	identify and communicate learning objective and point of lesson	learning objective and point of lesson are identified and communicated
A-8.02.02P	link lesson to other lessons and projects	lessons are linked to other lessons and projects
A-8.02.03P	perform the **steps required to demonstrate a skill**	**steps required to demonstrate a skill** are performed
A-8.02.04P	establish **practice conditions** for an apprentice to learn a skill	**practice conditions** are established for an apprentice to learn a skill
A-8.02.05P	create conditions where apprentices feel comfortable communicating and asking questions	conditions are created where apprentices feel comfortable communicating and asking questions

Reference Code	Performance Criteria	Evidence of Attainment
A-8.02.06P	recognize and discuss multiple techniques for performing trade tasks and options that may be best for apprentices	multiple techniques for performing trade tasks and options that may be best for apprentices are recognized and discussed
A-8.02.07P	assess apprentice's ability to perform tasks with increasing independence	apprentice's ability to perform tasks with increasing independence is assessed
A-8.02.08P	give supportive and constructive feedback to apprentices	supportive and constructive feedback is given to apprentices
A-8.02.09P	support apprentices in pursuing technical training opportunities	technical training opportunities for apprentices are supported
A-8.02.10P	support anti-**harassment** and anti-**discrimination** practices in workplace	anti-**harassment** and anti-**discrimination** practices in workplaces are supported
A-8.02.11P	support accommodations and alternate work practices that are appropriate for apprentices	accommodations and alternate work practices that are appropriate for apprentices are supported
A-8.02.12P	assess apprentice suitability to trade during probationary period	apprentice suitability to trade is assessed during probationary period

Range of Variables (include, but not limited to)

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

practice conditions: guided, limited independence, full independence

harassment: as defined by the Canadian and jurisdictional Human Rights Commissions

discrimination: as defined by the Canadian Human Rights Act and jurisdictional human rights laws

Knowledge

Reference Code	Learning Outcomes and Objectives
A-8.02.01L	demonstrate knowledge of strategies for learning skills in workplace
a.	describe importance of individual experience
b.	describe shared responsibilities for workplace learning
c.	determine one's own learning preferences and explain how these relate to learning new skills
d.	describe importance of different types of skills in workplace

Reference Code	Learning Outcomes and Objectives
e.	describe importance of **skills for success (essential skills)** in workplace
f.	identify different **learning styles**
g.	identify different **learning needs** and strategies to meet them
h.	identify **strategies to assist in learning a skill**
A-8.02.02L	demonstrate knowledge of strategies for teaching workplace skills
a.	identify different roles played by workplace mentor
b.	explain importance of identifying point of lesson
c.	identify how to choose a good time to present lesson
d.	explain importance of linking lessons
e.	identify context for learning skills
f.	describe considerations in setting up opportunities for skill practice
g.	explain importance of providing feedback
h.	identify techniques for giving effective feedback
i.	describe a skills assessment
j.	identify methods of assessing progress
k.	explain how to adjust lesson to different situations

Range of Variables (include, but not limited to)

skills for success (essential skills): adaptability, collaboration, communication, creativity and innovation, digital, numeracy, problem solving, reading, writing

learning styles: visual, auditory, kinesthetic, reading/writing

learning needs: learning disabilities, learning preferences, language proficiency

strategies to assist in learning a skill: understanding basic principles of instruction, developing coaching skills, being mature and patient, providing feedback, practicing through repetition, understanding learning styles

Major Work Activity B—Performs rigging, hoisting/lifting and moving

Task B-9 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 this task, lifts include hoisting, lifting and moving of equipment, materials and components.

B-9.01 Determines load

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
B-9.01.01P	scale load using **measuring devices**	load is scaled using **measuring devices**
B-9.01.02P	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-9.01.03P	refer to nameplates, shipping information and manufacturers' manuals	load weight is referenced from nameplates, shipping information and manufacturers' manuals to determine **procedures to perform lift**
B-9.01.04P	participate in lift planning	lift planning is participated in according to workplace standards and regulations

Range of Variables (include, but not limited to)

measuring devices: scales, dynamometers, transit, theodolite

procedures to perform lift: planning, environment analysis, load determination, communication methods, pre-lift checks, safety factors (5-to-1 for equipment and 10-to-1 for humans), placement of load, post-lift inspection, supervision of lift, securing work area

Knowledge

Reference Code	Learning Outcomes and Objectives
B-9.01.01L	demonstrate knowledge of rigging, hoisting/lifting and moving equipment, their characteristics, applications, limitations and procedures for use
a.	identify types of rigging equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
b.	identify types of hoisting and lifting equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
c.	identify types of moving equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
d.	interpret information about rigging, hoisting/lifting and moving equipment found in drawings and specifications
B-9.01.02L	demonstrate knowledge of procedures to determine load
a.	identify tools, equipment and **measuring devices** to determine loads, and describe their procedures for use
b.	identify hazards and describe safe work practices when determining loads
c.	identify calculations required when calculating and performing hoisting/lifting operations
d.	identify **factors** to consider when selecting rigging, hoisting/lifting and moving equipment
e.	describe **procedures to determine weight and weight distribution of loads**
f.	identify **procedures to perform lift**
B-9.01.03L	demonstrate knowledge of additional training and certification for rigging, hoisting/lifting and moving
a.	identify additional training and certification for rigging, hoisting/lifting and moving
B-9.01.04L	demonstrate knowledge of regulatory requirements for rigging, hoisting/lifting and moving
a.	identify codes, standards and regulations for rigging, hoisting/lifting and moving

Reference Code	Learning Outcomes and Objectives
B-9.01.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection

Range of Variables (include, but not limited to)

measuring devices: scales, dynamometers, transit, theodolite

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

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

procedures to perform lift: planning, environment analysis, load determination, communication methods, pre-lift checks, safety factors (5-to-1 for equipment and 10-to-1 for humans), placement of load, post-lift inspection, supervision of lift, securing work area

B-9.02 Selects rigging equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
B-9.02.01P	determine rigging equipment needed	rigging equipment is determined based on characteristics of lift, **process**, number of items being lifted at one time and determined weight of load
B-9.02.02P	refer to load ratings for **sling arrangements**	load ratings are referred to for **sling arrangements**
B-9.02.03P	confirm rigging capacity	rigging capacity is determined to be appropriate for lift by taking into consideration working load limit (WLL) or safe working load limit (SWL), centre of gravity, design factors, and load weight and forces
B-9.02.04P	confirm certification of rigging equipment	certification of rigging equipment is confirmed by referring to equipment's tag or documentation

Reference Code	Performance Criteria	Evidence of Attainment
B-9.02.05P	assess, inspect and document rigging equipment condition	rigging equipment condition is assessed, inspected and documented according to site and manufacturers' specifications, and regulations
B-9.02.06P	remove from service and tag faulty or damaged rigging equipment	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 regulations

Range of Variables (include, but not limited to)

process: lifting, dragging (using rollers), pulling horizontally
sling arrangements: bridle hitches, basket hitches, double basket hitches, chokers, double chokers, single vertical hitch

Knowledge

Reference Code	Learning Outcomes and Objectives
B-9.02.01L	demonstrate knowledge of rigging equipment, their characteristics, applications, limitations and procedures for use
a.	identify types of rigging equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
b.	interpret information about rigging equipment found in drawings, manufacturers' specifications and regulations
B-9.02.02L	demonstrate knowledge of procedures to rig material, personnel or equipment for lifting
a.	identify tools and equipment to rig material, personnel or equipment for lifting, and describe their procedures for use
b.	identify hazards and describe safe work practices when rigging material, personnel or equipment for lifting
c.	identify **factors** to consider when selecting rigging equipment
d.	describe procedures to rig material or equipment for lifting
B-9.02.03L	demonstrate knowledge of additional training and certification for rigging
a.	identify additional training and certification for rigging
B-9.02.04L	demonstrate knowledge of regulatory requirements for rigging
a.	identify codes, standards and regulations for rigging

Reference Code	Learning Outcomes and Objectives
B-9.02.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle rigging equipment

Range of Variables (include, but not limited to)

factors: temperature, hazardous environment, sharp edges, angle loading, environmental condition

B-9.03 Selects hoisting/lifting and moving equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
B-9.03.01P	determine hoisting/lifting and moving equipment needed	hoisting/lifting and moving equipment needed is determined according to **job scope**, **process** and determined weight of load
B-9.03.02P	inspect and document condition of hoisting/lifting and moving equipment	condition of hoisting/lifting and moving equipment is inspected and documented
B-9.03.03P	confirm certification of hoisting/lifting and moving equipment	certification of hoisting/lifting and moving equipment is confirmed by referring to operators' manuals, and equipment's **document of certification** according to site and manufacturers' specifications, and regulations
B-9.03.04P	refer to load charts for boom angles and distance	load charts for boom angles and distance for mobile equipment are referred to, ensuring equipment is not overloaded

Reference Code	Performance Criteria	Evidence of Attainment
B-9.03.05P	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 regulations
B-9.03.06P	select hoisting/lifting and moving equipment	hoisting/lifting and moving equipment is selected according to environment

Range of Variables (include, but not limited to)

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

process: lifting, dragging (using rollers), pulling horizontally

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

Knowledge

Reference Code	Learning Outcomes and Objectives
B-9.03.01L	demonstrate knowledge of hoisting/lifting and moving equipment, their characteristics, applications, limitations and procedures for use
a.	identify types of hoisting/lifting equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
b.	identify types of moving equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
c.	interpret information about hoisting/lifting and moving equipment found in drawings and specifications
B-9.03.02L	demonstrate knowledge of procedures to select and use hoisting/lifting and moving equipment
a.	identify hazards and describe safe work practices when using hoisting/lifting and moving equipment
b.	identify hazards and describe safe work practices when using mobile and overhead cranes
c.	describe inspection requirements for hoisting/lifting and moving equipment and accessories
d.	describe sling angle when preparing for hoisting/lifting operations

Reference Code	Learning Outcomes and Objectives
e.	identify **factors** to consider when selecting hoisting/lifting and moving equipment
B-9.03.03L	demonstrate knowledge of additional training and certification for hoisting/lifting and moving
a.	identify additional training and certification for hoisting/lifting and moving
B-9.03.04L	demonstrate knowledge of regulatory requirements for hoisting/lifting and moving
a.	identify codes, standards and regulations for hoisting/lifting and moving
B-9.03.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle hoisting/lifting and moving equipment

Range of Variables (include, but not limited to)

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

B-9.04 Secures area

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
B-9.04.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
B-9.04.02P	assess site, ground and environmental conditions, and plan route	site, ground and environmental conditions are identified before route is planned
B-9.04.03P	determine and secure lift radius	lift radius is determined and secured using barricades and flagging tape
B-9.04.04P	confirm location of personnel	location of personnel is confirmed

Knowledge

Reference Code	Learning Outcomes and Objectives
B-9.04.01L	demonstrate knowledge of rigging, hoisting/lifting and moving equipment, their characteristics, applications, limitations and procedures for use
a.	identify types of rigging equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
b.	identify types of hoisting and lifting equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
c.	identify types of moving equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
d.	interpret information about rigging, hoisting/lifting and moving equipment found in drawings and specifications
B-9.04.02L	demonstrate knowledge of procedures to secure work area
a.	identify tools and equipment to secure work area, and describe their procedures for use
b.	identify hazards and describe safe work practices when rigging, hoisting/lifting and moving
c.	identify hazards and describe safe work practices when using mobile and overhead cranes
d.	identify factors to consider when securing work area when rigging, hoisting/lifting and moving
e.	describe **procedures to ensure work area is safe for lifting**
B-9.04.03L	demonstrate knowledge of additional training and certification for rigging, hoisting/lifting and moving
a.	identify additional training and certification for rigging, hoisting/lifting and moving
B-9.04.04L	demonstrate knowledge of regulatory requirements for rigging, hoisting/lifting and moving
a.	identify codes, standards and regulations for rigging, hoisting/lifting and moving
B-9.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection

Range of Variables (include, but not limited to)

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

Task B-10 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 and environment. Industrial mechanics (millwrights) must be skilled in the proper procedures for rigging, hoisting, lifting, drifting, dragging (using rollers) loads.

B-10.01 Sets up rigging, hoisting/lifting and moving equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
B-10.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
B-10.01.02P	perform pre-use inspection of equipment	pre-use inspection of equipment is performed to verify **conditions** and documented
B-10.01.03P	read and interpret load charts	load charts are read and interpreted
B-10.01.04P	prepare for lift	lift is prepared by using floats under outriggers, and using cribbing (dunnage)
B-10.01.05P	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-10.01.06P	adjust schedule of lift to address **environmental conditions**	schedule of lift is adjusted to address **environmental conditions**

Range of Variables (include, but not limited to)

conditions: fluid levels, tire pressure, absence of leaks

environmental conditions: wind, shifting ground, lightning, fog, rain, snow, temperature, lighting conditions

Knowledge

Reference Code	Learning Outcomes and Objectives
B-10.01.01L	demonstrate knowledge of rigging, hoisting/lifting and moving equipment, their characteristics, applications, limitations and procedures for use
a.	identify types of rigging equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
b.	identify types of hoisting and lifting equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
c.	identify types of moving equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
d.	interpret information about rigging, hoisting/lifting and moving equipment found in drawings and specifications
B-10.01.02L	demonstrate knowledge of procedures to perform rigging, hoisting/lifting and moving operations
a.	identify tools and equipment to perform rigging, hoisting/lifting and moving operations, and describe their procedures for use
b.	identify hazards and describe safe work practices when rigging, hoisting/lifting and moving
c.	identify hazards and describe safe work practices when using mobile and overhead cranes
d.	identify types of knots, hitches and bends, and describe their applications
e.	describe procedures to rig material or equipment for hoisting/lifting and moving operations
f.	describe sling angle when preparing for rigging, hoisting/lifting and moving operations
B-10.01.03L	demonstrate knowledge of additional training and certification for rigging, hoisting/lifting and moving
a.	identify additional training and certification for rigging, hoisting/lifting and moving
B-10.01.04L	demonstrate knowledge of regulatory requirements for rigging, hoisting/lifting and moving
a.	identify codes, standards and regulations for rigging, hoisting/lifting and moving
B-10.01.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle rigging, hoisting/lifting and moving equipment

B-10.02 Performs hoist/lift and move

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
B-10.02.01P	ensure direct line of sight between operator and signal person	direct line of sight between operator and signal person is ensured
B-10.02.02P	use hand signals and verbal communication	hand signals and verbal communication are used according to regulations
B-10.02.03P	use **alternate communication methods** when there is no direct line of sight	**alternate communication methods** are used when there is no direct line of sight
B-10.02.04P	assess and make adjustments to stabilize load	load is stabilized by assessing and making adjustments
B-10.02.05P	adjust schedule of lift to address **environmental conditions**	schedule of lift is adjusted to address **environmental conditions**
B-10.02.06P	perform post-lift inspection of rigging, hoisting/lifting and moving equipment	post-lift inspection of rigging, hoisting/lifting and moving equipment is performed

Range of Variables (include, but not limited to)

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

environmental conditions: wind, ground conditions, lightning, fog, rain, snow, temperature, lighting

Knowledge

Reference Code	Learning Outcomes and Objectives
B-10.02.01L	demonstrate knowledge of hoisting/lifting and moving equipment, their characteristics, applications, limitations and procedures for use
a.	identify types of hoisting and lifting equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
b.	identify types of moving equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
c.	interpret information about hoisting/lifting and moving equipment found in drawings and specifications
B-10.02.02L	demonstrate knowledge of procedures to perform hoisting/lifting and moving operations
a.	identify hazards and describe safe work practices when hoisting/lifting and moving
b.	identify hazards and describe safe work practices when using mobile and overhead cranes
c.	identify calculations required when calculating and performing hoisting and lifting operations
d.	describe **procedures to determine weight and weight distribution of loads**
e.	describe **procedures to perform lift**
B-10.02.03L	demonstrate knowledge of standard hand signals
a.	describe **procedures to communicate** during hoisting/lifting and moving operations
b.	perform standard hand signals
B-10.02.04L	demonstrate knowledge of additional training and certification for hoisting/lifting and moving
a.	identify additional training and certification for hoisting/lifting and moving
B-10.02.05L	demonstrate knowledge of regulatory requirements for hoisting/lifting and moving
a.	identify codes, standards and regulations for hoisting/lifting and moving
B-10.02.06L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle hoisting/lifting and moving equipment

Range of Variables (include, but not limited to)

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

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

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

B-10.03 Maintains rigging, hoisting/lifting and moving equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
B-10.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
B-10.03.02P	perform scheduled **maintenance** on equipment	scheduled **maintenance** is performed on equipment according to site and manufacturers' specifications, and regulations
B-10.03.03P	perform visual inspection of rigging, hoisting/lifting and moving equipment	visual inspection of rigging, hoisting/lifting and moving equipment is performed
B-10.03.04P	identify rejection criteria for hardware	rejection criteria for hardware are identified according to site and manufacturers' specifications, and regulations
B-10.03.05P	identify, tag, remove from service and replace damaged **hardware**	damaged **hardware** is identified, tagged, removed from service and replaced
B-10.03.06P	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 regulations

Reference Code	Performance Criteria	Evidence of Attainment
B-10.03.07P	store rigging, hoisting/lifting and moving equipment	rigging, hoisting/lifting and moving equipment is stored according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

maintenance: lubricating, cleaning, inspecting, repairing

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

NDT techniques: dye penetrant, magnetic particle, visual

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

Knowledge

Reference Code	Learning Outcomes and Objectives
B-10.03.01L	demonstrate knowledge of rigging, hoisting/lifting and moving equipment, their characteristics, applications, limitations and procedures for use
a.	identify types of rigging, hoisting and lifting equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
b.	identify types of moving equipment and accessories, and describe their characteristics, applications, limitations and procedures for use
c.	interpret information about rigging, hoisting/lifting and moving equipment found in drawings and specifications
B-10.03.02L	demonstrate knowledge of procedures to inspect, **maintain** and store rigging, hoisting/lifting and moving equipment
a.	identify tools and equipment to inspect, **maintain** and store rigging, hoisting/lifting and moving equipment, and describe their procedures for use
b.	identify hazards and describe safe work practices to inspect, **maintain** and store rigging, hoisting/lifting and moving equipment
c.	describe procedures to inspect, **maintain** and store rigging, hoisting/lifting and moving equipment
B-10.03.03L	demonstrate knowledge of additional training and certification to **maintain** rigging, hoisting/lifting and moving equipment
a.	identify additional training and certification to **maintain** rigging, hoisting/lifting and moving equipment

Reference Code	Learning Outcomes and Objectives
B-10.03.04L	demonstrate knowledge of regulatory requirements to **maintain** rigging, hoisting/lifting and moving equipment
a.	identify codes, standards and regulations to **maintain** rigging, hoisting/lifting and moving equipment
B-10.03.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle rigging, hoisting/lifting and moving equipment

Range of Variables (include, but not limited to)

maintain: lubricating, cleaning, inspecting, repairing

Major Work Activity C—Services mechanical power transmission components and systems

Task C-11 Services prime movers

Task Descriptor

Prime movers are the driver of the mechanical system and include equipment such as electric motors, turbines (e.g., 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-11.01 Installs prime movers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-11.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-11.01.02P	determine location and elevation for installation	location and elevation for installation are determined according to engineered drawings
C-11.01.03P	prepare foundation	foundation is prepared according to manufacturers' specifications and engineered drawings
C-11.01.04P	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-11.01.05P	prepare and inspect **prime movers**	**prime movers** are prepared and inspected for installation according to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
C-11.01.06P	position **prime movers**	**prime movers** are positioned manually or with rigging, hoisting/lifting and moving equipment according to site and manufacturers' specifications, and engineered drawings
C-11.01.07P	secure, level and align **prime mover**	**prime mover** is secured, levelled and aligned with driven equipment according to site and manufacturers' specifications, and engineered drawings
C-11.01.08P	install **auxiliary systems**	**auxiliary systems** are installed according to manufacturers' specifications and engineered drawings
C-11.01.09P	verify rotation	rotation is checked prior to coupling by performing bump test
C-11.01.10P	connect **prime mover** to driven equipment	**prime mover** is connected to driven equipment using **components** according to manufacturers' specifications and engineered drawings
C-11.01.11P	install safety guards and **safety devices**	safety guards and **safety devices** are installed according to manufacturers' specifications and regulations
C-11.01.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation

Range of Variables (include, but not limited to)

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

prime movers: electric motors, turbines (e.g., wind, water, gas or steam), internal combustion engines, hydraulic drives

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

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-11.01.01L	demonstrate knowledge of **prime movers**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **prime movers**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **prime movers**, and their **components** and accessories
c.	interpret information about **prime movers**, and their **components** and accessories found in drawings and specifications
C-11.01.02L	demonstrate knowledge of procedures to install **prime movers,** and their **components** and accessories
a.	identify tools and equipment to install **prime movers**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to install **prime movers**, and their **components** and accessories
c.	describe procedures to inspect **prime movers**, and their **components** and accessories
d.	describe procedures to install **prime movers**, and their **components** and accessories
e.	describe procedures to test **prime movers**, and their **components** and accessories

Range of Variables (include, but not limited to)

prime movers: electric motors, turbines (e.g., wind, water, gas or steam), internal combustion engines, hydraulic drives

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

C-11.02 Diagnoses prime movers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-11.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
C-11.02.02P	perform **sensory inspection** of **prime movers**	**sensory inspection** is performed
C-11.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-11.02.04P	test and evaluate **prime movers**	**prime movers** are tested and evaluated using specialized equipment according to manufacturers' recommendations
C-11.02.05P	perform monitoring and analysis	monitoring and analysis are performed to detect defects not identified through **sensory inspection**
C-11.02.06P	inspect **prime movers** and **components**	**prime movers** and **components** are inspected for **defects** and to determine **next steps**
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 regulations
C-11.02.08P	document findings	findings are documented according to site specifications

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

prime movers: electric motors, turbines (e.g., wind, water, gas or steam), internal combustion engines

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

defects: excessive wear, corrosion, looseness, eccentricity

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-11.02.01L	demonstrate knowledge of **prime movers**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **prime movers**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **prime movers**, and their **components** and accessories
c.	interpret information about **prime movers**, and their **components** and accessories found in drawings and specifications
C-11.02.02L	demonstrate knowledge of procedures to diagnose **prime movers**, and their **components** and accessories
a.	identify tools and equipment to diagnose **prime movers**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **prime movers**, and their **components** and accessories
c.	identify factors to consider when determining if **prime movers** or their **components** need to be repaired or replaced
d.	describe procedures to inspect **prime movers**, and their **components** and accessories
e.	describe procedures to diagnose **prime movers**, and their **components** and accessories
f.	describe procedures to test **prime movers**, and their **components** and accessories
g.	identify basic electrical principles and describe their associated procedures

Reference Code	Learning Outcomes and Objectives
C-11.02.03L	demonstrate knowledge of regulatory requirements to diagnose **prime movers**, and their **components** and accessories
a.	identify codes, standards and regulations to diagnose **prime movers**, and their **components** and accessories
C-11.02.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **prime movers**, and their **components** and accessories

Range of Variables (include, but not limited to)

prime movers: electric motors, turbines (e.g., wind, water, gas or steam), internal combustion engines

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

C-11.03 Maintains prime movers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-11.03.01P	inspect, modify and adjust **prime movers**	**prime movers** are inspected, modified and adjusted according to specifications and operating conditions
C-11.03.02P	select and use tools and equipment	tools and equipment are selected used according to task and manufacturers' specifications
C-11.03.03P	align components	components are aligned according to manufacturers' specifications
C-11.03.04P	check coolant and lubricant levels, seals and **equipment protection devices**	coolant and lubricant levels, seals and **equipment protection devices** are checked according to site and manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
C-11.03.05P	monitor temperature, vibration and pressure	temperature, vibration and pressure are monitored
C-11.03.06P	check automatic bearing and seal lubrication systems	automatic bearing and seal lubrication systems are checked
C-11.03.07P	adjust flow and pressure controls	flow and pressure controls for cooling and lubrication of **prime movers** are adjusted according to manufacturers' specifications
C-11.03.08P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
C-11.03.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation
C-11.03.10P	identify faulty or damaged equipment	faulty or damaged equipment is identified to determine repair or replacement
C-11.03.11P	document actions and findings	actions and findings are documented according to site specifications

Range of Variables (include, but not limited to)

prime movers: electric motors, turbines (e.g., wind, water, gas or steam), internal combustion engines

equipment protection devices: governors, emergency shutdown devices, fuses and circuit breakers

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-11.03.01L	demonstrate knowledge of **prime movers**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **prime movers**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **prime movers**, and their **components** and accessories
c.	interpret information about **prime movers**, and their **components** and accessories found in drawings and specifications
C-11.03.02L	demonstrate knowledge of procedures to maintain **prime movers**, and their **components** and accessories
a.	identify tools and equipment to maintain **prime movers**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain **prime movers**, and their **components** and accessories
c.	identify factors to consider when determining if **prime movers** or their **components** need to be repaired or replaced
d.	describe procedures to inspect **prime movers**, and their **components** and accessories
e.	describe procedures to maintain **prime movers**, and their **components** and accessories
f.	describe procedures to test **prime movers**, and their **components** and accessories
C-11.03.03L	demonstrate knowledge of regulatory requirements to maintain **prime movers**, and their **components** and accessories
a.	identify codes, standards and regulations to maintain **prime movers**, and their **components** and accessories
C-11.03.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **prime movers**, and their **components** and accessories

Range of Variables (include, but not limited to)

prime movers: electric motors, turbines (e.g., wind, water, gas or steam), internal combustion engines

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

C-11.04 Repairs prime movers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-11.04.01P	access **prime movers**	**prime movers** are accessed by removing **components**
C-11.04.02P	dismantle, remove and reassemble **prime movers** and **components**	**prime movers** and **components** are dismantled, removed and reassembled according to manufacturers' specifications and engineered drawings
C-11.04.03P	select and use tools and equipment	tools and equipment are selected and used according to task and manufacturers' specifications
C-11.04.04P	prepare **prime movers** for repair	**prime movers** are prepared for repair according to site and manufacturers' specifications
C-11.04.05P	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-11.04.06P	machine keys and keyways	keys and keyways are machined according to manufacturers' specifications and engineered drawings
C-11.04.07P	pour and scrape friction bearings	friction bearings are poured and scraped according to manufacturers' specifications and engineered drawings
C-11.04.08P	replace faulty **components** and auxiliary equipment	faulty **components** and auxiliary equipment are replaced according to manufacturers' specifications
C-11.04.09P	verify rotation	rotation is checked prior to coupling by performing bump test
C-11.04.10P	align **components**	**components** are aligned according to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
C-11.04.11P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to manufacturers' specifications and regulations
C-11.04.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation
C-11.04.13P	document actions	actions are documented according to site specifications

Range of Variables (include, but not limited to)

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

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

bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt

Knowledge

Reference Code	Learning Outcomes and Objectives
C-11.04.01L	demonstrate knowledge of **prime movers**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **prime movers**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **prime movers**, and their **components** and accessories
c.	interpret information about **prime movers**, and their **components** and accessories found in drawings and specifications
C-11.04.02L	demonstrate knowledge of procedures to repair **prime movers,** and their **components** and accessories
a.	identify tools and equipment to repair **prime movers**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to repair **prime movers**, and their **components** and accessories
c.	identify factors to consider when determining if **prime movers** or their **components** need to be repaired or replaced
d.	describe procedures to inspect **prime movers**, and their **components** and accessories

Reference Code	Learning Outcomes and Objectives
e.	describe procedures to repair **prime movers**, and their **components** and accessories
f.	describe procedures to test **prime movers**, and their **components** and accessories
C-11.04.03L	demonstrate knowledge of regulatory requirements to repair **prime movers**, and their **components** and accessories
a.	identify codes, standards and regulations to repair **prime movers**, and their **components** and accessories
C-11.04.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **prime movers**, and their **components** and accessories

Range of Variables (include, but not limited to)

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

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

Task C-12 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-12.01 Installs shafts, bearings and seals

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-12.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-12.01.02P	select **shafts**, **bearings** and **seals**	**shafts**, **bearings** and **seals** are selected according to **specifications** and engineered drawings
C-12.01.03P	measure fits and tolerances	fits and tolerances of **shafts**, **bearings**, **seals** and housings are measured within manufacturers' specifications
C-12.01.04P	position **shafts**, **bearings** and **seals**	**shafts**, **bearings** and **seals** are positioned manually or with rigging, hoisting/lifting and moving equipment according to site and manufacturers' specifications, and engineered drawings
C-12.01.05P	mount **seals**	**seals** are mounted according to task and manufacturers' specifications and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
C-12.01.06P	mount plain (friction) bearings	plain (friction) bearings are mounted using **plain (friction) bearing equipment** to fit according to manufacturers' specifications
C-12.01.07P	mount anti-friction (rolling element-type) bearings	anti-friction (rolling element-type) bearings are mounted using **anti-friction (rolling element-type) bearings equipment** to fit according to manufacturers' specifications
C-12.01.08P	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-12.01.09P	secure, level and align **shafts**, **bearings** and **seals**	**shafts**, **bearings** and **seals** are secured, levelled and aligned according to site and manufacturers' specifications, and engineered drawings
C-12.01.10P	apply lubricants	lubricants are applied according to site and manufacturers' specifications, and engineered drawings
C-12.01.11P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

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

bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt

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

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

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

anti-friction (rolling element-type) bearings equipment: induction heaters, oil baths, arbour presses, bearing ovens, refrigerator, freezer, dry ice, liquid nitrogen

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

Knowledge

Reference Code	Learning Outcomes and Objectives
C-12.01.01L	demonstrate knowledge of **shafts**, **bearings**, **seals**, and their components, accessories, characteristics, applications and operation
a.	identify types of **shafts**, **bearings** and **seals**, and describe their components, accessories, characteristics and applications
b.	describe operating principles of **shafts**, **bearings** and **seals**
c.	interpret information about **shafts**, **bearings** and **seals** found in drawings and **specifications**
C-12.01.02L	demonstrate knowledge of procedures to install **shafts**, **bearings** and **seals**
a.	identify tools and equipment to install **shafts**, **bearings** and **seals**, and describe their procedures for use
b.	identify hazards and describe safe work practices to install **shafts**, **bearings** and **seals**
c.	describe procedures to inspect **shafts**, **bearings** and **seals**
d.	describe procedures to install **shafts**, **bearings** and **seals**
e.	describe procedures to test **shafts**, **bearings** and **seals**

Range of Variables (include, but not limited to)

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

bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt

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

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

C-12.02 Diagnoses shafts, bearings and seals

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-12.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
C-12.02.02P	perform **sensory inspection** of **shafts**, **bearings** and **seals** for defects	**sensory inspection** of **shafts**, **bearings** and **seals** is performed to determine **next steps**
C-12.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-12.02.04P	test and evaluate **shafts**, **bearings** and **seals**	**shafts**, **bearings** and **seals** are tested and evaluated using specialized equipment according to manufacturers' specifications
C-12.02.05P	perform monitoring and analysis	monitoring and analysis are performed to detect defects not identified through **sensory inspection**
C-12.02.06P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
C-12.02.07P	document findings	findings are documented according to site specifications

Range of Variables (include, but not limited to)

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

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

bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt

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

next steps: repair, replace, overhaul, adjust

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-12.02.01L	demonstrate knowledge of **shafts**, **bearings**, **seals**, and their components, accessories, characteristics, applications and operation
a.	identify types of **shafts**, **bearings** and **seals**, and describe their components, accessories, characteristics and applications
b.	describe operating principles of **shafts**, **bearings** and **seals**
c.	interpret information about **shafts**, **bearings** and **seals** found in drawings and specifications
C-12.02.02L	demonstrate knowledge of procedures to diagnose **shafts**, **bearings** and **seals**
a.	identify tools and equipment to diagnose **shafts**, **bearings** and **seals**, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **shafts**, **bearings** and **seals**
c.	identify factors to consider when determining if **shafts**, **bearings** and **seals** need to be repaired or replaced
d.	describe procedures to inspect **shafts**, **bearings** and **seals**
e.	describe procedures to diagnose **shafts**, **bearings** and **seals**
f.	describe procedures to test **shafts**, **bearings** and **seals**
C-12.02.03L	demonstrate knowledge of regulatory requirements to diagnose **shafts**, **bearings** and **seals**
a.	identify codes, standards and regulations to diagnose **shafts**, **bearings** and **seals**

Range of Variables (include, but not limited to)

shafts: drive, counter, jack, hollow, shaft accessories (keys, pins, taper bushings, retaining rings)
bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt
seals: static, dynamic, mechanical, non-contacting (labyrinth/annulus), contact, compression

C-12.03 Maintains shafts, bearings and seals

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-12.03.01P	inspect, modify and adjust **shafts**, **bearings** and **seals**	**shafts**, **bearings** and **seals** are inspected according to specifications and operating conditions
C-12.03.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-12.03.03P	align **components**	**components** are aligned according to site and manufacturers' specifications, and engineered drawings
C-12.03.04P	check coolant and lubricant levels, **seals** and **equipment protection devices**	coolant and lubricant levels, **seals** and **equipment protection devices** are checked according to site and manufacturers' specifications
C-12.03.05P	monitor temperature, vibration and pressure	temperature, vibration and pressure are monitored according to site and manufacturers' specifications, and engineered drawings
C-12.03.06P	check automatic bearing and seal lubrication systems	automatic bearing and seal lubrication systems are checked according to site and manufacturers' specifications, and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
C-12.03.07P	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-12.03.08P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
C-12.03.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation
C-12.03.10P	identify faulty or damaged equipment	faulty or damaged equipment is identified to determine repair or replacement
C-12.03.11P	document actions and findings	actions and findings are documented according to site specifications

Range of Variables (include, but not limited to)

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

bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt

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

components: couplings, keys, gears, pulleys, sprockets

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-12.03.01L	demonstrate knowledge of **shafts**, **bearings**, **seals**, and their components, accessories, characteristics, applications and operation
a.	identify types of **shafts**, **bearings** and **seals**, and describe their components, accessories, characteristics and applications
b.	describe operating principles of **shafts**, **bearings** and **seals**

c.	interpret information about **shafts**, **bearings** and **seals** found in drawings and specifications
C-12.03.02L	demonstrate knowledge of procedures to maintain **shafts**, **bearings** and **seals**
a.	identify tools and equipment to maintain **shafts**, **bearings** and **seals**, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain **shafts**, **bearings** and **seals**
c.	identify factors to consider when determining if **shafts**, **bearings** and **seals** need to be repaired or replaced
d.	describe procedures to inspect **shafts**, **bearings** and **seals**
e.	describe procedures to maintain **shafts**, **bearings** and **seals**
f.	describe procedures to test **shafts**, **bearings** and **seals**
C-12.03.03L	demonstrate knowledge of regulatory requirements to maintain **shafts**, **bearings** and **seals**
a.	identify codes, standards and regulations to maintain **shafts**, **bearings** and **seals**
C-12.03.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **shafts**, **bearings** and **seals**

Range of Variables (include, but not limited to)

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

bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt

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

C-12.04 Repairs shafts, bearings and seals

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-12.04.01P	repair and replace faulty **shafts**, **bearings** and **seals**	faulty **shafts**, **bearings** and **seals** are repaired and replaced according to manufacturers' specifications
C-12.04.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-12.04.03P	dismantle, remove and reassemble **shafts**, **bearings** and **seals**	**shafts**, **bearings** and **seals** are dismantled, removed and reassembled according to manufacturers' specifications and engineered drawings
C-12.04.04P	pour and scrape friction bearings	friction bearings are poured and scraped according to manufacturers' specifications and engineered drawings
C-12.04.05P	prepare and repair shaft	shaft is prepared and repaired using various **methods**
C-12.04.06P	align **components**	**components** are aligned according to manufacturers' specifications
C-12.04.07P	access **shafts**, **bearings** and **seals**	**shafts**, **bearings** and **seals** are accessed by removing **components**
C-12.04.08P	size and replace **shafts**, **bearings** and **seals**	**shafts**, **bearings** and **seals** are sized and replaced according to manufacturers' specifications
C-12.04.09P	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-12.04.10P	machine keys, keyways and keysets	keys, keyways and keysets are machined according to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
C-12.04.11P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
C-12.04.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
C-12.04.13P	document actions	actions are documented according to site specifications

Range of Variables (include, but not limited to)

shafts: drive, counter, jack, hollow, shaft accessories (e.g., keys, pins, taper bushings, retaining rings)

bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt

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

methods: sleeving, welding, filing, polishing, machining

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-12.04.01L	demonstrate knowledge of **shafts**, **bearings**, **seals**, and their **components**, **accessories**, characteristics, applications and operation
a.	identify types of **shafts**, **bearings** and **seals**, and describe their **components**, **accessories**, characteristics and applications
b.	describe operating principles of **shafts**, **bearings** and **seals**
c.	interpret information about **shafts**, **bearings** and **seals** found in drawings and specifications
C-12.04.02L	demonstrate knowledge of procedures to repair **shafts**, **bearings** and **seals**
a.	identify tools and equipment to repair **shafts**, **bearings** and **seals**, and describe their procedures for use

Reference Code	Learning Outcomes and Objectives
b.	identify hazards and describe safe work practices to repair **shafts**, **bearings** and **seals**
c.	identify factors to consider when determining if **shafts**, **bearings** and **seals** need to be repaired or replaced
d.	describe procedures to inspect **shafts**, **bearings** and **seals**
e.	describe procedures to repair **shafts**, **bearings** and **seals**
f.	describe procedures to test **shafts**, **bearings** and **seals**
C-12.04.03L	demonstrate knowledge of regulatory requirements to repair **shafts**, **bearings** and **seals**
a.	identify codes, standards and regulations to repair **shafts**, **bearings** and **seals**
C-12.04.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **shafts**, **bearings** and **seals**

Range of Variables (include, but not limited to)

shafts: drive, counter, jack, hollow, shaft accessories (e.g., keys, pins, taper bushings, retaining rings)

bearings: plain (friction), anti-friction (rolling element), adapter and withdrawal sleeves, housings, babbitt

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

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

accessories (shaft): keys, pins, taper bushings, retaining rings, sleeves

Task C-13 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-13.01 Installs couplings, clutches and brakes

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-13.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-13.01.02P	select **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are selected according to **specifications**
C-13.01.03P	position **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are positioned manually or by using rigging, hoisting/lifting and moving equipment according to site and manufacturers' specifications, and engineered drawings
C-13.01.04P	mount **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are mounted using tools and equipment, and by heating or cooling components
C-13.01.05P	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

Reference Code	Performance Criteria	Evidence of Attainment
C-13.01.06P	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-13.01.07P	align **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are aligned according to manufacturers' specifications
C-13.01.08P	lubricate **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are lubricated according to manufacturers' specifications
C-13.01.09P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
C-13.01.10P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation
C-13.01.11P	document actions and findings	actions and findings are documented according to site specifications

Range of Variables (include, but not limited to)

couplings: rigid, elastomeric, grid, mechanical, fluid

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

brakes: friction, fluid/wet disc, electromagnetic

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-13.01.01L	demonstrate knowledge of **couplings**, **clutches** and **brakes**, their components, accessories, characteristics, applications and operation
a.	identify types of **couplings**, **clutches** and **brakes**, and their components and accessories, and describe their characteristics and applications
b.	describe operating principles of **couplings**, **clutches** and **brakes**, and their components and accessories
c.	interpret information about **couplings**, **clutches** and **brakes**, and their components and accessories found in drawings and **specifications**
C-13.01.02L	demonstrate knowledge of procedures to remove and install **couplings**, **clutches** and **brakes,** and their components and accessories
a.	identify tools and equipment to remove and install **couplings**, **clutches** and **brakes**, and their components and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to remove and install **couplings**, **clutches** and **brakes**, and their components and accessories
c.	describe procedures to inspect **couplings**, **clutches** and **brakes**, and their components and accessories
d.	describe procedures to install **couplings**, **clutches** and **brakes**, and their components and accessories
e.	describe procedures to test **couplings**, **clutches** and **brakes**, and their components and accessories
f.	identify basic electrical principles and describe their associated procedures
C-13.01.03L	demonstrate knowledge of regulatory requirements to install **couplings**, **clutches** and **brakes**, and their components and accessories
a.	identify codes, standards and regulations to install **couplings**, **clutches** and **brakes**, and their components and accessories

Range of Variables (include, but not limited to)

couplings: rigid, elastomeric, grid, mechanical, fluid

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

brakes: friction, fluid/wet disc, electromagnetic

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

C-13.02 Diagnoses couplings, clutches and brakes

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-13.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
C-13.02.02P	perform **sensory inspection** of **couplings**, **clutches** and **brakes** for defects	**sensory inspection** of **couplings**, **clutches** and **brakes** is performed to determine next steps
C-13.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-13.02.04P	perform **monitoring and analysis**	**monitoring and analysis** are performed to detect defects not identified through **sensory inspection**
C-13.02.05P	verify lubrication levels and condition	lubrication levels and condition are verified by **physical inspection**
C-13.02.06P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
C-13.02.07P	measure clearances of **couplings**, **clutches** and **brakes**	clearances of **couplings**, **clutches** and **brakes** are measured according to manufacturers' specifications
C-13.02.08P	assess and detect faulty or damaged components	faulty or damaged components are assessed and detected to determine repair or replacement
C-13.02.09P	document findings	findings are documented according to site specifications

Range of Variables (include, but not limited to)

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

couplings: rigid, elastomeric, grid, mechanical, fluid

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

brakes: friction, fluid/wet disc, electromagnetic

monitoring and analysis: monitoring temperature and vibration levels with specialized equipment

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-13.02.01L	demonstrate knowledge of **couplings**, **clutches** and **brakes**, their components, accessories, characteristics, applications and operation
a.	identify types of **couplings**, **clutches** and **brakes**, and their components and accessories, and describe their characteristics and applications
b.	describe operating principles of **couplings**, **clutches** and **brakes**, and their components and accessories
c.	interpret information about **couplings**, **clutches** and **brakes**, and their components and accessories found in drawings and specifications
C-13.02.02L	demonstrate knowledge of procedures to repair **couplings**, **clutches** and **brakes,** and their components and accessories
a.	identify tools and equipment to repair **couplings**, **clutches** and **brakes**, and their components and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to repair **couplings**, **clutches** and **brakes**, and their components and accessories
c.	identify factors to consider when determining if **couplings**, **clutches** and **brakes** or their components need to be repaired or replaced
d.	describe procedures to inspect **couplings**, **clutches** and **brakes**, and their components and accessories
e.	describe procedures to repair **couplings**, **clutches** and **brakes**, and their components and accessories
f.	describe procedures to test **couplings**, **clutches** and **brakes**, and their components and accessories
g.	identify basic electrical principles and describe their associated procedures

Reference Code	Learning Outcomes and Objectives
C-13.02.03L	demonstrate knowledge of regulatory requirements to repair **couplings**, **clutches** and **brakes**, and their components and accessories
a.	identify codes, standards and regulations to repair **couplings**, **clutches** and **brakes**, and their components and accessories

Range of Variables (include, but not limited to)

couplings: rigid, elastomeric, grid, mechanical, fluid
clutches: overrunning, friction, positive contact, fluid, electromagnetic
brakes: friction, fluid/wet disc, electromagnetic

C-13.03 Maintains couplings, clutches and brakes

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-13.03.01P	access **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are accessed by removing guards, safety devices and components
C-13.03.02P	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
C-13.03.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-13.03.04P	assess machine keys and keyways	keys and keyways are assessed according to manufacturers' specifications and engineered drawings
C-13.03.05P	assess **condition** of **couplings**, **clutches** and **brakes**, and their **components**	**condition** of **couplings**, **clutches** and **brakes**, and their **components** is assessed

Reference Code	Performance Criteria	Evidence of Attainment
C-13.03.06P	replace faulty **components**	faulty **components** are replaced according to site and manufacturers' specifications, and engineered drawings
C-13.03.07P	reinstall machine guarding and **safety devices**	machine guarding and **safety devices** are reinstalled according to site and manufacturers' specifications, and regulations
C-13.03.08P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
C-13.03.09P	document actions and findings	actions and findings are documented according to site specifications

Range of Variables (include, but not limited to)

couplings: rigid, elastomeric, grid, fluid

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

brakes: friction, fluid/wet disc, electromagnetic

components: springs, grids, elastomeric elements, friction pads, diaphragms

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-13.03.01L	demonstrate knowledge of **couplings**, **clutches** and **brakes**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **couplings**, **clutches** and **brakes**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **couplings**, **clutches** and **brakes**, and their **components** and accessories
c.	interpret information about **couplings**, **clutches** and **brakes**, and their **components** and accessories found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
C-13.03.02L	demonstrate knowledge of procedures to maintain **couplings**, **clutches** and **brakes,** and their **components** and accessories
a.	identify tools and equipment to maintain **couplings**, **clutches** and **brakes**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain **couplings**, **clutches** and **brakes**, and their **components** and accessories
c.	identify factors to consider when determining if **couplings**, **clutches** and **brakes** or their **components** need to be maintained or replaced
d.	describe procedures to inspect **couplings**, **clutches** and **brakes**, and their **components** and accessories
e.	describe procedures to maintain **couplings**, **clutches** and **brakes**, and their **components** and accessories
f.	describe procedures to test **couplings**, **clutches** and **brakes**, and their **components** and accessories
C-13.03.03L	demonstrate knowledge of regulatory requirements to maintain **couplings**, **clutches** and **brakes**, and their **components** and accessories
a.	identify codes, standards and regulations to maintain **couplings**, **clutches** and **brakes**, and their **components** and accessories
C-13.03.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **couplings**, **clutches** and **brakes**, and their **components** and accessories

Range of Variables (include, but not limited to)

couplings: rigid, elastomeric, grid, fluid
clutches: overrunning, friction, positive contact, fluid, electromagnetic
brakes: friction, fluid/wet disc, electromagnetic
components: springs, grids, elastomeric elements, friction pads, diaphragms

C-13.04 Repairs couplings, clutches and brakes

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-13.04.01P	access **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are accessed by removing safety guards and **safety devices**
C-13.04.02P	repair or replace faulty **couplings**, **clutches** and **brakes**	faulty **couplings**, **clutches** and **brakes** are repaired or replaced according to site and manufacturers' specifications, and engineered drawings
C-13.04.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-13.04.04P	dismantle, remove and reassemble **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are dismantled, removed and reassembled according to manufacturers' specifications and engineered drawings
C-13.04.05P	recondition **couplings**, **clutches** and **brakes** and their **components**	**couplings**, **clutches** and **brakes** and their **components** are reconditioned according to manufacturers' specifications and engineered drawings
C-13.04.06P	replace **coupling**, **clutch** and **brake components**	**coupling**, **clutch** and **brake components** are replaced according to manufacturers' specifications and engineered drawings
C-13.04.07P	adjust **couplings**, **clutches** and **brakes**	**couplings**, **clutches** and **brakes** are adjusted according to manufacturers' specifications and engineered drawings

C-13.04.08P	align **coupling**, **clutch** and **brake components**	**coupling**, **clutch** and **brake components** are aligned according to manufacturers' specifications and engineered drawings
C-13.04.09P	reinstall guards and **safety devices**	guards and **safety devices** are reinstalled according to site and manufacturers' specifications and regulations
C-13.04.10P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation
C-13.04.11P	document actions	actions are documented according to site specifications

Range of Variables (include, but not limited to)

couplings: rigid, elastomeric, grid, mechanical, fluid

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

brakes: friction, fluid/wet disc, electromagnetic

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

components: springs, grids, elastomeric elements, friction pads, diaphragms

Knowledge

Reference Code	Learning Outcomes and Objectives
C-13.04.01L	demonstrate knowledge of **couplings**, **clutches** and **brakes**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **couplings**, **clutches** and **brakes**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **couplings**, **clutches** and **brakes**, and their **components** and accessories
c.	interpret information about **couplings**, **clutches** and **brakes**, and their **components** and accessories found in drawings and specifications
C-13.04.02L	demonstrate knowledge of procedures to repair **couplings**, **clutches** and **brakes,** and their **components** and accessories
a.	identify tools and equipment to repair **couplings**, **clutches** and **brakes**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to repair **couplings**, **clutches** and **brakes**, and their **components** and accessories

Reference Code	Learning Outcomes and Objectives
c.	identify factors to consider when determining if **couplings**, **clutches** and **brakes** or their **components** need to be repaired or replaced
d.	describe procedures to inspect **couplings**, **clutches** and **brakes**, and their **components** and accessories
e.	describe procedures to repair **couplings**, **clutches** and **brakes**, and their **components** and accessories
f.	describe procedures to test **couplings**, **clutches** and **brakes**, and their **components** and accessories
C-13.04.03L	demonstrate knowledge of regulatory requirements to repair **couplings**, **clutches** and **brakes**, and their **components** and accessories
a.	identify codes, standards and regulations to repair **couplings**, **clutches** and **brakes**, and their **components** and accessories
C-13.04.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **couplings**, **clutches** and **brakes**, and their **components** and accessories

Range of Variables (include, but not limited to)

couplings: rigid, elastomeric, grid, mechanical, fluid
clutches: overrunning, friction, positive contact, fluid, electromagnetic
brakes: friction, fluid/wet disc, electromagnetic
components: springs, grids, elastomeric elements, friction pads, diaphragms

Task C-14 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 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-14.01 Installs chain and belt drive systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-14.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-14.01.02P	select **chain** and **belt drive systems**	**chain** and **belt drive systems** are selected according to engineered drawings and equipment application
C-14.01.03P	position **chain** and **belt drive systems**	**chain** and **belt drive systems** are positioned manually or with rigging, hoisting/lifting and moving equipment according to site and manufacturers' specifications, and engineered drawings
C-14.01.04P	assemble **chain** and **belt drive systems**	**chain** and **belt drive systems** are assembled according to site and manufacturers' specifications and engineered drawings
C-14.01.05P	align **chain** and **belt drive systems**	**chain** and **belt drive systems** are aligned according to site and manufacturers' specifications, and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
C-14.01.06P	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 site and manufacturers' specifications and engineered drawings
C-14.01.07P	lubricate chains	chains are lubricated according to site and manufacturers' specifications, and engineered drawings
C-14.01.08P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
C-14.01.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications and returned to operation

Range of Variables (include, but not limited to)

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

belt drive systems: v-belt, cog belt, synchronous, flat belt, poly-V belts, round belts

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-14.01.01L	demonstrate knowledge of **chain** and **belt drive systems**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **chain** and **belt drive systems**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **chain** and **belt drive systems**, and their **components** and accessories
c.	interpret information about **chain** and **belt drive systems**, and their **components** and accessories found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
C-14.01.02L	demonstrate knowledge of procedures to install **chain** and **belt drive systems**, and their **components** and accessories
a.	identify tools and equipment to install **chain** and **belt drive systems**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to install **chain** and **belt drive systems**, and their **components** and accessories
c.	describe procedures to inspect **chain** and **belt drive systems**, and their **components** and accessories
d.	describe procedures to install **chain** and **belt drive systems**, and their **components** and accessories
e.	describe procedures to test **chain** and **belt drive systems**, and their **components** and accessories
C-14.01.03L	demonstrate knowledge of **formulas** and calculations for **chain** and **belt drive systems**
a.	identify factors and **conditions** to consider and required calculations to determine **chain** and **belt drive systems** requirements
b.	identify **formulas** and perform calculations

Range of Variables (include, but not limited to)

chain drive systems: roller, silent, composite, lube free
belt drive systems: v-belt, cog belt, synchronous, flat belt, poly-V belts, round belts
components: sprockets and sheaves, taper bushing, link (half link, offset), master link
formulas: belt/chain lengths, speed and torque ratios, belt tension, chain slack
conditions: torque, horsepower, loads, temperatures, rpm, shaft angles (incline or flat)

C-14.02 Diagnoses chain and belt drive systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-14.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained

Reference Code	Performance Criteria	Evidence of Attainment
C-14.02.02P	perform **sensory inspection** of **chain** and **belt drive systems**	**sensory inspection** of **chain** and **belt drive systems** is performed to determine next steps
C-14.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-14.02.04P	test and evaluate **chain** and **belt drive systems**	**chain** and **belt drive systems** are tested and evaluated according to site and manufacturers' specifications, and engineered drawings
C-14.02.05P	perform monitoring and analysis	monitoring and analysis are performed to detect defects not identified through **sensory inspection**
C-14.02.06P	verify chain lubrication and condition	chain lubrication and condition are verified according to site and manufacturers' specifications, and engineered drawings
C-14.02.07P	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-14.02.08P	assess and detect faulty or damaged **components**	faulty or damaged **components** are assessed and detected to determine **next steps**
C-14.02.09P	document findings	findings are documented according to site specifications

Range of Variables (include, but not limited to)

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

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

belt drive systems: v-belt, cog belt, synchronous, flat belt, poly-V belts, round belts

components: sprockets and sheaves, taper bushing, link (half-link, offset)

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

Knowledge

Reference Code	Learning Outcomes and Objectives
C-14.02.01L	demonstrate knowledge of **chain** and **belt drive systems**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **chain** and **belt drive systems**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **chain** and **belt drive systems**, and their **components** and accessories
c.	interpret information about **chain** and **belt drive systems**, and their **components** and accessories found in drawings and specifications
C-14.02.02L	demonstrate knowledge of procedures to diagnose **chain** and **belt drive systems,** and their **components** and accessories
a.	identify tools and equipment to diagnose **chain** and **belt drive systems**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **chain** and **belt drive systems**, and their **components** and accessories
c.	identify factors to consider when determining if **chain** and **belt drive systems** need to be repaired or replaced
d.	describe procedures to inspect **chain** and **belt drive systems**, and their **components** and accessories
e.	describe procedures to diagnose **chain** and **belt drive systems**, and their **components** and accessories
f.	describe procedures to test **chain** and **belt drive systems**, and their **components** and accessories
C-14.02.03L	demonstrate knowledge of regulatory requirements to diagnose **chain** and **belt drive systems**, and their **components** and accessories
a.	identify codes, standards and regulations to diagnose **chain** and **belt drive systems**, and their **components** and accessories
C-14.02.04L	demonstrate knowledge of **formulas** and calculations for **chain** and **belt drive systems**
a.	identify factors to consider and required calculations to determine **chain** and **belt drive systems** requirements
b.	identify **formulas** and perform calculations

Range of Variables (include, but not limited to)

chain drive systems: roller, silent, composite, lube free
belt drive systems: v-belt, cog belt, synchronous, flat belt, poly-V belts, round belts
next steps: repair, replace, overhaul, adjust, continue operation
components: sprockets and sheaves, taper bushing, link (half-link, offset)
formulas: belt/chain lengths, speed and torque ratios, belt tension, chain slack, chain stretch

C-14.03 Maintains chain and belt drive systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-14.03.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-14.03.02P	access **chain** and **belt drive systems**	**chain** and **belt drive systems** are accessed by removing guards, safety devices and components
C-14.03.03P	clean, inspect, modify and adjust **chain** and **belt drive systems**	**chain** and **belt drive systems** are cleaned, inspected, modified and adjusted according to site and manufacturers' specifications, and operating conditions
C-14.03.04P	check and replace lubricants on **chain drive systems**	lubricants on **chain drive systems** are checked and replaced according to site and manufacturers' specifications, and engineered drawings
C-14.03.05P	check **lubrication systems**	**lubrication systems** are checked according to site and manufacturers' specifications, and engineered drawings
C-14.03.06P	check condition of **components**	condition of **components** is checked according to site and manufacturers' specifications, and engineered drawings

C-14.03.07P	check alignment of sprockets and sheaves	alignment of sprockets and sheaves is checked according to site and manufacturers' specifications, and engineered drawings
C-14.03.08P	adjust **chain** and **belt drive systems**	**chain** and **belt drive system** slack/tension is adjusted according to site and manufacturers' specifications, and engineered drawings
C-14.03.09P	reinstall machine guarding and **safety devices**	machine guarding and **safety devices** are reinstalled according to site and manufacturers' specifications, and regulations
C-14.03.10P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation
C-14.03.11P	document actions and findings	actions and findings are documented according to site specifications

Range of Variables (include, but not limited to)

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

belt drive systems: v-belt, cog belt, banded synchronous, flat belt, poly-V belts, round belts

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

components: sprockets and sheaves, taper bushing, connecting link, offset link

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-14.03.01L	demonstrate knowledge of **chain** and **belt drive systems**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **chain** and **belt drive systems**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **chain** and **belt drive systems**, and their **components** and accessories
c.	interpret information about **chain** and **belt drive systems**, and their **components** and accessories found in drawings and specifications

C-14.03.02L	demonstrate knowledge of procedures to maintain **chain** and **belt drive systems**, and their **components** and accessories
a.	identify tools and equipment to maintain **chain** and **belt drive systems**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain **chain** and **belt drive systems**, and their **components** and accessories
c.	identify factors to consider when determining if **chain** and **belt drive systems** need to be repaired, replaced or realigned
d.	describe procedures to inspect **chain** and **belt drive systems**, and their **components** and accessories
e.	describe procedures to maintain **chain** and **belt drive systems**, and their **components** and accessories
f.	describe procedures to test **chain** and **belt drive systems**, and their **components** and accessories
C-14.03.03L	demonstrate knowledge of regulatory requirements to maintain **chain** and **belt drive systems**, and their **components** and accessories
a.	identify codes, standards and regulations to maintain **chain** and **belt drive systems**, and their **components** and accessories
C-14.03.04L	demonstrate knowledge of **formulas** and calculations for **chain** and **belt drive systems**
a.	identify factors to consider and required calculations to determine **chain** and **belt drive systems** requirements
b.	identify **formulas** and perform calculations
C-14.03.06L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **chain** and **belt drive systems**, and their **components** and accessories

Range of Variables (include, but not limited to)

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

belt drive systems: v-belt, cog belt, banded synchronous, flat belt, poly-V belts, round belts

components: sprockets and sheaves, taper bushing, connecting link, offset link

formulas: belt/chain lengths, speed and torque ratios, belt tension, chain slack

C-14.04 Repairs chain and belt drive systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-14.04.01P	select and use **tools and equipment**	**tools and equipment** are selected and used according to task, specifications and regulations
C-14.04.02P	repair and replace faulty **chain** and **belt drive systems**	faulty **chain** and **belt drive systems** are repaired and replaced according to site and manufacturers' specifications, and engineered drawings
C-14.04.03P	dismantle, remove and reassemble **chain** and **belt drive systems**	**chain** and **belt drive systems** are dismantled, removed and reassembled according to manufacturers' specifications and engineered drawings
C-14.04.04P	access **chain** and **belt drive systems**	**chain** and **belt drive systems** are accessed by removing safety guards and **safety devices**
C-14.04.05P	align **components**	**components** are aligned according to site and manufacturers' specifications, and engineered drawings
C-14.04.06P	lubricate **chain drive system**	**chain drive system** is lubricated according to site and manufacturers' specifications, and engineered drawings
C-14.04.07P	reinstall guards and **safety devices**	guards and **safety devices** are reinstalled according to site and manufacturers' specifications, engineered drawings and regulations
C-14.04.08P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation

Reference Code	Performance Criteria	Evidence of Attainment
C-14.04.09P	document actions	actions are documented according to site specifications

Range of Variables (include, but not limited to)

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

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

belt drive systems: v-belt, cog belt, synchronous, flat belt, high torque drive (HTD), poly-V belts, round belts

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

components: sprockets and sheaves, taper bushing, connecting link, offset link

Knowledge

Reference Code	Learning Outcomes and Objectives
C-14.04.01L	demonstrate knowledge of **chain** and **belt drive systems**, their **components**, accessories, characteristics, applications and operation
a.	identify types of **chain** and **belt drive systems**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **chain** and **belt drive systems**, and their **components** and accessories
c.	interpret information about **chain** and **belt drive systems**, and their **components** and accessories found in drawings and specifications
C-14.04.02L	demonstrate knowledge of procedures to repair **chain** and **belt drive systems**, and their **components** and accessories
a.	identify **tools and equipment** to repair **chain** and **belt drive systems**, and their **components** and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to repair **chain** and **belt drive systems**, and their **components** and accessories
c.	identify factors to consider when determining if **chain** and **belt drive systems** need to be repaired or replaced
d.	describe procedures to inspect **chain** and **belt drive systems**, and their **components** and accessories
e.	describe procedures to repair **chain** and **belt drive systems**, and their **components** and accessories
f.	describe procedures to test **chain** and **belt drive systems**, and their **components** and accessories

Reference Code	Learning Outcomes and Objectives
C-14.04.03L	demonstrate knowledge of regulatory requirements to repair **chain** and **belt drive systems**, and their **components** and accessories
a.	identify codes, standards and regulations to repair **chain** and **belt drive systems**, and their **components** and accessories
C-14.04.04L	demonstrate knowledge of **formulas** and calculations for **chain** and **belt drive systems**
a.	identify factors to consider and required calculations to determine **chain** and **belt drive systems** requirements
b.	identify **formulas** and perform calculations
C-14.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **chain** and **belt drive systems**, and their **components** and accessories

Range of Variables (include, but not limited to)

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

belt drive systems: v-belt, cog belt, synchronous, flat belt, high torque drive (HTD), poly-V belts, round belts

components: sprockets and sheaves, taper bushing, connecting link, offset link

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

formulas: belt/chain lengths, speed and torque ratios, belt tension

Task C-15 Services gear systems

Task Descriptor

Gear systems transmit torque, power, and rotary and linear movement from one component to another and may 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-15.01 Installs gear systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-15.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-15.01.02P	select gear systems	gear systems are selected according to site and manufacturers' specifications, engineered drawings and equipment application
C-15.01.03P	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-15.01.04P	assemble gear systems	gear systems are assembled according to site and manufacturers' specifications, and engineered drawings
C-15.01.05P	align gear systems	gear systems are aligned according to site and manufacturers' specifications, and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
C-15.01.06P	check and adjust backlash and tooth contact	backlash and tooth contact is checked and adjusted according to manufacturers' specifications and engineered drawings
C-15.01.07P	lubricate gear systems	gear systems are lubricated according to site and manufacturers' specifications, and engineered drawings
C-15.01.08P	install safety guards and **safety devices**	safety guards and **safety devices** are installed according to site and manufacturers' specifications, engineered drawings and regulations
C-15.01.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation

Range of Variables (include, but not limited to)

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-15.01.01L	demonstrate knowledge of **gears** and **gear drives**, their components, accessories, characteristics, applications and operation
a.	identify types of **gears** and **gear drives**, and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **gears** and **gear drives**, and their components and accessories
c.	interpret information about **gears** and **gear drives**, and their components and accessories found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
C-15.01.02L	demonstrate knowledge of procedures to install and align **gears** and **gear drives**, and their components and accessories
a.	identify tools and equipment to install and align **gears** and **gear drives**, and their components and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to install **gears** and **gear drives**, and their components and accessories
c.	describe procedures to inspect **gears** and **gear drives**, and their components and accessories
d.	describe procedures to install and align **gears** and **gear drives**, and their components and accessories
e.	describe procedures to test **gears** and **gear drives**, and their components and accessories
C-15.01.03L	demonstrate knowledge of gear engagement procedures
a.	identify tools and equipment to set backlash and tooth contact, and describe their procedures for use
b.	describe procedures to set backlash and tooth contact
C-15.01.04L	demonstrate knowledge of regulatory requirements to install **gears** and **gear drives**, and their components and accessories
a.	identify codes, standards and regulations to install **gears** and **gear drives**, and their components and accessories
C-15.01.05L	demonstrate knowledge of **formulas** and calculations for **gears** and **gear drives**
a.	identify factors to consider and required calculations to determine **gears** and **gear drives** requirements
b.	identify **formulas** and perform calculations

Range of Variables (include, but not limited to)

gears: spur, straight bevel, spiral bevel, herringbone, helical, worm, hypoid, internal, mitre
gear drives: planetary, worm, parallel shaft, crown and pinion, rack and pinion
formulas: diametral pitch, pitch diameter, gear ratios, module

C-15.02 Diagnoses gear systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-15.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
C-15.02.02P	perform **sensory inspection** of gear systems	**sensory inspection** of gear systems is performed to determine **next steps**
C-15.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-15.02.04P	test and evaluate gear systems	gear systems are tested and evaluated according to site and manufacturers' specifications, and engineered drawings
C-15.02.05P	perform monitoring and analysis	monitoring and analysis are performed to detect defects not identified through **sensory inspection**
C-15.02.06P	verify lubrication level and condition	lubrication level and condition are verified according to site and manufacturers' specifications, and engineered drawings
C-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, engineered drawings, and regulations
C-15.02.08P	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-15.02.09P	assess and detect faulty or damaged components	faulty or damaged components are assessed and detected to determine **next steps**

Reference Code	Performance Criteria	Evidence of Attainment
C-15.02.10P	document findings	findings are documented according to site specifications

Range of Variables (include, but not limited to)

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

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
C-15.02.01L	demonstrate knowledge of **gears** and **gear drives**, their components, accessories, characteristics, applications and operation
a.	identify types of **gears** and **gear drives**, and their components and accessories, and describe their characteristics and applications
b.	describe operating principles of **gears** and **gear drives**, and their components and accessories
c.	interpret information about **gears** and **gear drives**, and their components and accessories found in drawings and specifications
C-15.02.02L	demonstrate knowledge of procedures to diagnose **gears** and **gear drives**, and their components and accessories
a.	identify tools and equipment to diagnose **gears** and **gear drives**, and their components and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **gears** and **gear drives**, and their components and accessories
c.	identify factors to consider when determining if **gears**, **gear drives**, or their components need to be repaired or replaced
d.	describe procedures to inspect **gears** and **gear drives**, and their components and accessories
e.	describe procedures to diagnose **gears** and **gear drives**, and their components and accessories
f.	describe procedures to test **gears** and **gear drives**, and their components and accessories

Reference Code	Learning Outcomes and Objectives
C-15.02.03L	demonstrate knowledge of gear engagement procedures
a.	identify tools and equipment to set backlash and tooth contact, and describe their procedures for use
b.	describe procedures to set backlash and tooth contact
C-15.02.04L	demonstrate knowledge of regulatory requirements to install **gears** and **gear drives**, and their components and accessories
a.	identify codes, standards and regulations to install **gears** and **gear drives**, and their components and accessories
C-15.02.05L	demonstrate knowledge of **formulas** and calculations for **gears** and **gear drives**
a.	identify factors to consider and required calculations to determine **gears** and **gear drives** requirements
b.	identify **formulas** and perform calculations

Range of Variables (include, but not limited to)

gears: spur, straight bevel, spiral bevel, herringbone, helical, worm, hypoid, internal, mitre
gear drives: planetary, worm, parallel shaft, crown and pinion
formulas: diametral pitch, pitch diameter, gear ratios, module

C-15.03 Maintains gear systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-15.03.01P	select and use **tools and equipment**	**tools and equipment** are selected and used according to task, specifications and regulations
C-15.03.02P	access gear systems	gear systems are accessed by removing guards, inspection ports, covers and **safety devices**

Reference Code	Performance Criteria	Evidence of Attainment
C-15.03.03P	clean, inspect, modify and adjust gear systems	gear systems are cleaned, inspected, modified and adjusted according to site and manufacturers' specifications
C-15.03.04P	check vents, lubricants and seals	vents, lubricants and seals are checked according to site and manufacturers' specifications, and engineered drawings
C-15.03.05P	check **condition** of gear systems	**condition** of gear systems and components are checked according to site and manufacturers' specifications, and engineered drawings
C-15.03.06P	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 regulations
C-15.03.07P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation
C-15.03.08P	document actions and findings	actions and findings are documented according to site specifications

Range of Variables (include, but not limited to)

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

condition: alignment, backlash, clearance, tooth contact

Knowledge

Reference Code	Learning Outcomes and Objectives
C-15.03.01L	demonstrate knowledge of **gears** and **gear drives**, their components, accessories, characteristics, applications and operation
a.	identify types of **gears** and **gear drives**, and their components and accessories, and describe their characteristics and applications
b.	describe operating principles of **gears** and **gear drives**, and their components and accessories
c.	interpret information about **gears** and **gear drives**, and their components and accessories found in drawings and specifications
C-15.03.02L	demonstrate knowledge of procedures to diagnose **gears** and **gear drives**, and their components and accessories
a.	identify **tools and equipment** to diagnose **gears** and **gear drives**, and their components and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **gears** and **gear drives**, and their components and accessories
c.	identify **factors** to consider when determining if **gears**, **gear drives**, or their components need to be repaired or replaced
d.	describe procedures to inspect **gears** and **gear drives**, and their components and accessories
e.	describe procedures to maintain **gears** and **gear drives**, and their components and accessories
f.	describe procedures to test **gears** and **gear drives**, and their components and accessories
C-15.03.03L	demonstrate knowledge of gear engagement procedures
a.	identify tools and equipment to set backlash and tooth contact, and describe their procedures for use
b.	describe procedures to set backlash and tooth contact
C-15.03.04L	demonstrate knowledge of regulatory requirements to install **gears** and **gear drives**, and their components and accessories
a.	identify codes, standards and regulations to install **gears** and **gear drives**, and their components and accessories
C-15.03.05L	demonstrate knowledge of **formulas** and calculations for **gears** and **gear drives**
a.	identify factors to consider and required calculations to determine **gears** and **gear drives** requirements
b.	identify **formulas** and perform calculations

Reference Code	Learning Outcomes and Objectives
C-15.03.06L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **gears** and **gear drives**, and their components and accessories

Range of Variables (include, but not limited to)

gears: spur, straight bevel, spiral bevel, herringbone, helical, worm, hypoid, internal, mitre

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

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

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

formulas: diametral pitch, pitch diameter, gear ratios, module

C-15.04 Repairs gear systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-15.04.01P	repair and replace faulty gear systems	faulty gear systems are repaired and replaced according to site and manufacturers' specifications, and engineered drawings
C-15.04.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
C-15.04.03P	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

Reference Code	Performance Criteria	Evidence of Attainment
C-15.04.04P	dismantle, remove and reassemble gear systems	gear systems are dismantled, removed and reassembled according to manufacturers' specifications and engineered drawings
C-15.04.05P	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-15.04.06P	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-15.04.07P	lubricate **gears**	**gears** are lubricated according to site and manufacturers' specifications, and engineered drawings
C-15.04.08P	reinstall guards, **safety devices**, ports and covers	guards, **safety devices**, ports and covers are reinstalled according to site and manufacturers' specifications, engineered drawings and regulations
C-15.04.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications, and returned to operation
C-15.04.10P	document actions	actions are documented according to site specifications

Range of Variables (include, but not limited to)

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

gears: spur, straight bevel, spiral bevel, herringbone, helical, worm, hypoid, internal, mitre

Knowledge

Reference Code	Learning Outcomes and Objectives
C-15.04.01L	demonstrate knowledge of **gears** and **gear drives**, their components, accessories, characteristics, applications and operation
a.	identify types of **gears** and **gear drives**, and their components and accessories, and describe their characteristics and applications
b.	describe operating principles of **gears** and **gear drives**, and their components and accessories
c.	interpret information about **gears** and **gear drives**, and their components and accessories found in drawings and specifications
C-15.04.02L	demonstrate knowledge of procedures to diagnose **gears** and **gear drives**, and their components and accessories
a.	identify tools and equipment to diagnose **gears** and **gear drives**, and their components and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **gears** and **gear drives**, and their components and accessories
c.	identify factors to consider when determining if **gears**, **gear drives**, or their components need to be repaired or replaced
d.	describe procedures to inspect **gears** and **gear drives**, and their components and accessories
e.	describe procedures to repair **gears** and **gear drives**, and their components and accessories
f.	describe procedures to test **gears** and **gear drives**, and their components and accessories
C-15.04.03L	demonstrate knowledge of regulatory requirements to install **gears** and **gear drives**, and their components and accessories
a.	identify codes, standards and regulations to install **gears** and **gear drives**, and their components and accessories
C-15.04.04L	demonstrate knowledge of **formulas** and calculations for **gears** and **gear drives**
a.	identify factors to consider and required calculations to determine **gears** and **gear drives** requirements
b.	identify **formulas** and perform calculations

Reference Code	Learning Outcomes and Objectives
C-15.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **gears** and **gear drives**, and their components and accessories

Range of Variables (include, but not limited to)

gears: spur, straight bevel, spiral bevel, herringbone, helical, worm, hypoid, internal, mitre
gear drives: planetary, worm, parallel shaft, crown and pinion, rack and pinion
formulas: diametral pitch, pitch diameter, gear ratios, module

Task C-16 Performs shaft alignment procedures

Task Descriptor

Alignment procedures are performed to ensure colinear shaft alignment in the horizontal and vertical planes, and to increase the operating lifespan of rotating equipment. For this standard, this task only addresses collinear shaft alignment.

C-16.01 Performs rough alignment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-16.01.01P	inspect equipment	equipment is inspected for **defects**
C-16.01.02P	select and use **rough shaft alignment tools**	**rough shaft alignment tools** are selected to determine degree of misalignment
C-16.01.03P	identify cause of misalignment in equipment	cause of misalignment in equipment is identified to determine **corrective action**

Reference Code	Performance Criteria	Evidence of Attainment
C-16.01.04P	correct vertical, horizontal and angular misalignment	vertical, horizontal and angular misalignment is corrected by shimming and by adjusting position of driver/driven equipment
C-16.01.05P	record alignment data	alignment data are recorded to demonstrate compliance according to task

Range of Variables (include, but not limited to)

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

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

corrective action: replacement, repair, adjustment

Knowledge

Reference Code	Learning Outcomes and Objectives
C-16.01.01L	demonstrate knowledge of shafts, their components, accessories, characteristics, applications and operation
a.	identify types of shafts, and their components and accessories, and describe their characteristics and applications
b.	describe operating principles of shafts, and their components and accessories
c.	interpret information about shafts, and their components and accessories found in drawings and specifications
C-16.01.02L	demonstrate knowledge of rough alignment procedures
a.	identify **rough shaft alignment tools** to align shafts, and their components and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices for rough alignment
c.	describe **rough alignment procedures**
d.	describe procedures to determine shaft misalignment
e.	describe procedures to calculate shims

Range of Variables (include, but not limited to)

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

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

C-16.02 Performs dial alignment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-16.02.01P	inspect equipment	equipment is inspected for **defects**
C-16.02.02P	select and use **dial alignment tools**	**dial alignment tools** are selected and used to determine degree of misalignment
C-16.02.03P	identify cause of misalignment in equipment	cause of misalignment in equipment is identified to determine **corrective action**
C-16.02.04P	correct offset and angular misalignment in horizontal and vertical planes	offset and angular misalignment in horizontal and vertical planes are corrected by shimming and by adjusting position of driver/driven equipment
C-16.02.05P	record alignment data	alignment data are recorded according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

defects: loose fasteners, cracked foundations, pipe strain, damaged housings, soft foot, excessive run-out, defective bearings

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

corrective action: replacement, repair, adjustment

Knowledge

Reference Code	Learning Outcomes and Objectives
C-16.02.01L	demonstrate knowledge of shafts, their components, accessories, characteristics, applications and operation
a.	identify types of shafts, and their components and accessories, and describe their characteristics and applications
b.	describe operating principles of shafts, and their components and accessories
c.	interpret information about shafts, and their components and accessories found in drawings and specifications
C-16.02.02L	demonstrate knowledge of **dial alignment procedures**
a.	identify **dial alignment tools** to align shafts, and describe their procedures for use
b.	identify hazards and describe safe work practices for dial alignment
c.	identify types of **dial alignment methods**, and describe their associated **procedures**
d.	describe procedures to determine shaft misalignment
e.	describe procedures to calculate shims for hot or cold alignment

Range of Variables (include, but not limited to)

dial alignment procedures: doing pre-alignment checks, selecting tools and equipment, performing calculations, accounting for dial bar sag, making adjustments

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

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

C-16.03 Performs laser alignment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
C-16.03.01P	inspect equipment	equipment is inspected for **defects**
C-16.03.02P	select and use **laser alignment tools**	**laser alignment tools** are selected to determine degree of misalignment

Reference Code	Performance Criteria	Evidence of Attainment
C-16.03.03P	identify cause of misalignment in equipment	cause of misalignment in equipment is identified to determine **corrective action**
C-16.03.04P	correct offset and angular misalignment in horizontal and vertical planes	offset and angular misalignment in horizontal and vertical planes is corrected by shimming and by adjusting position of driver/driven equipment
C-16.03.05P	record alignment data	alignment data are recorded according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

defects: loose fasteners, cracked foundations, pipe strain, damaged housings, soft foot, excessive run-out, defective bearings

laser alignment tools: laser alignment kit (e.g., tape measure, mounting clamps, laser heads, electronic tablets)

corrective action: replacement, repair, adjustment

Knowledge

Reference Code	Learning Outcomes and Objectives
C-16.03.01L	demonstrate knowledge of shafts, their components, accessories, characteristics, applications and operation
a.	identify types of shafts, and their components and accessories, and describe their characteristics and applications
b.	describe operating principles of shafts, and their components and accessories
c.	interpret information about shafts, and their components and accessories found in drawings and specifications
C-16.03.02L	demonstrate knowledge of laser alignment procedures
a.	identify **laser alignment tools** to align shafts, and their components and accessories, and describe their procedures for use
b.	identify hazards and describe safe work practices for laser alignment
c.	describe **laser alignment procedures**
d.	describe procedures to determine shaft misalignment
e.	describe procedures to calculate shims for hot or cold alignment

Range of Variables (include, but not limited to)

laser alignment tools: laser alignment kit (e.g., tape measure, mounting clamps, laser heads, electronic tablets)

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

Major Work Activity D—Services material handling/process systems

Task D-17 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-17.01 Installs robotics and automated equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-17.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-17.01.02P	determine location and elevation for installation	location and elevation for installation are determined according to site and manufacturers' specifications, and engineered drawings
D-17.01.03P	prepare foundation	foundation is prepared according to site and manufacturers' specifications, and engineered drawings
D-17.01.04P	prepare base, base plates and structure	base, base plates and structure are prepared using **methods** according to site and manufacturers' specifications, and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
D-17.01.05P	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-17.01.06P	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 regulations
D-17.01.07P	secure, level and align **robotics** and **automated equipment**	**robotics** and **automated equipment** are secured, levelled and aligned according to site and manufacturers' specifications, engineered drawings and regulations
D-17.01.08P	install **auxiliary systems**	**auxiliary systems** are installed according to site and manufacturers' specifications, engineered drawings, regulations and procedures
D-17.01.09P	install and calibrate **electromechanical components**	electromechanical components are installed and calibrated according to manufacturers' specifications, company policies, and jurisdictional regulations and limitations
D-17.01.10P	test range of movement	range of movement is tested
D-17.01.11P	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-17.01.12P	install **safety guards** and **safety devices**	**safety guards** and **safety devices** are installed according to site and manufacturers' specifications, engineered drawings and regulations
D-17.01.13P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-17.01.14P	verify functionality of **safety devices**	**safety device** functionality is verified according to site and manufacturers' specifications, engineered drawings and regulations

Range of Variables (include, but not limited to)

methods: installation techniques, alignment

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

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

auxiliary systems: wire feeders, articulating fingers, filtering systems, tip dressers, tip changers

electromechanical components: linear variable differential transformers, servo motor, stepper motors, sensors, solenoids (coils), limit switches, electronic measuring devices, relays, contactors

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

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

safety guards: covers, screens, inspection doors, portals

safety devices: light curtain, overtravel, overload, heat detectors, emergency stops (E-stops), laser grids, lockouts, physical guards, safety mat, safety interlock

Knowledge

Reference Code	Learning Outcomes and Objectives
D-17.01.01L	demonstrate knowledge of **robotics** and **automated equipment**, their **components** and operation
a.	identify **classifications for robotics and automated equipment** and their **components**, and **auxiliary equipment**, and describe their purpose, applications and operation
b.	interpret information about **robotics** and **automated equipment** found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
D-17.01.02L	demonstrate knowledge of **electromechanical components** found in **robotics** and **automated equipment**, their characteristics, applications and operation
a.	identify **electromechanical components** found in **robotics** and **automated equipment**
b.	describe purpose and operating principles of **electromechanical components** found in **robotics** and **automated equipment**
c.	describe testing and troubleshooting procedures for **electromechanical components** found in **robotics** and **automated equipment**
D-17.01.03L	demonstrate knowledge of procedures to install **robotics** and **automated equipment**
a.	identify tools and equipment to install **robotics** and **automated equipment**, and describe their applications and procedures
b.	identify hazards and describe safe work practices associated with **robotics** and **automated equipment**
c.	describe procedures to install **robotics** and **automated equipment** and their **components**
D-17.01.04L	demonstrate knowledge of additional training and certification to install **robotics** and **automated equipment**
a.	identify additional training to install **robotics** and **automated equipment**
D-17.01.05L	demonstrate knowledge of regulatory requirements to install **robotics** and **automated equipment**
a.	identify codes, standards and regulations to install **robotics** and **automated equipment**
D-17.01.06L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **robotics** and **automated equipment**

Range of Variables (include, but not limited to)

robotics: multi-axis, EOAT, grippers and end effectors, SCARA, side entry
automated equipment: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)
components: servo motors, fluid power hoses and pistons, sensors, encoders
classifications for robotics and automated equipment: type of movement (degrees of freedom after application), application (manufacturing process), architecture (serial or parallel), brand
auxiliary equipment: wire feeders, articulating fingers, filtering systems
electromechanical components: linear variable differential transformers, servo motor, stepper motors, sensors, solenoids (coils), limit switches, electronic measuring devices, relays, contactors

D-17.02 Diagnoses robotics and automated equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-17.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
D-17.02.02P	perform **sensory inspection** of **robotics** and **automated equipment** for defects	**sensory inspection** is performed to determine next steps
D-17.02.03P	perform **condition-based monitoring methods** and analysis	**condition-based monitoring methods** and analysis are performed to detect defects not identified through **sensory inspection**
D-17.02.04P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-17.02.05P	test and evaluate **robotics** and **automated equipment**	**robotics** and **automated equipment** are tested and evaluated using specialized equipment and referring to site and manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-17.02.06P	remove, reinstall or replace **safety guards** and **safety devices**	**safety guards** and **safety devices** are removed, reinstalled or replaced according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, looking for excessive wear, stress indications, corrosion and looseness

robotics: multi-axis, EOAT, grippers and end effectors, SCARA, side entry

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

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

safety guards: covers, screens, inspection doors and portals

safety devices: light curtain, overtravel, overload, heat detectors, emergency stops (E-stops), vibration sensors, lockouts, physical guards, safety mat, safety interlock

Knowledge

Reference Code	Learning Outcomes and Objectives
D-17.02.01L	demonstrate knowledge of **robotics** and **automated equipment**, their **components** and operation
a.	identify **classifications for robotics and automated equipment** and their **components**, and **auxiliary equipment**, and describe their purpose, applications and operation
b.	interpret information about **robotics** and **automated equipment** found in drawings and specifications
D-17.02.02L	demonstrate knowledge of procedures to diagnose **robotics** and **automated equipment**
a.	identify tools and equipment to diagnose **robotics** and **automated equipment** and describe their applications and procedures
b.	identify hazards and describe safe work practices associated with **robotics** and **automated equipment**
c.	describe procedures to inspect **robotics** and **automated equipment** and their **components**
d.	describe procedures to diagnose **robotics** and **automated equipment** and their **components**

Reference Code	Learning Outcomes and Objectives
e.	identify factors to consider when determining if **robotics** and **automated equipment** need to be repaired or replaced
f.	identify basic electrical principles and describe their associated procedures
D-17.02.03L	demonstrate knowledge of additional training and certification to diagnose **robotics** and **automated equipment**
a.	identify additional training and certification to diagnose **robotics** and **automated equipment**
D-17.02.04L	demonstrate knowledge of regulatory requirements to diagnose **robotics** and **automated equipment**
a.	identify codes, standards and regulations to diagnose **robotics** and **automated equipment**
D-17.02.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection

Range of Variables (include, but not limited to)

robotics: multi-axis, EOAT, grippers and end effectors, SCARA, side entry

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

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

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

auxiliary equipment: wire feeders, articulating fingers, filtering systems

D-17.03 Maintains robotics and automated equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-17.03.01P	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 maintenance schedule using **condition-based monitoring methods**
D-17.03.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-17.03.03P	align **components**	**components** are aligned according to manufacturers' specifications
D-17.03.04P	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-17.03.05P	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-17.03.06P	check automatic lubrication systems	automatic lubrication systems are checked according to site and manufacturers' specifications, and maintenance schedule
D-17.03.07P	adjust flow and pressure controls	flow and pressure controls for **robotics** and **automated equipment** are adjusted according to manufacturers' specifications and regulations

Reference Code	Performance Criteria	Evidence of Attainment
D-17.03.08P	remove and replace **safety guards** and **safety devices**	**safety guards** and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
D-17.03.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications
D-17.03.10P	identify faulty or damaged equipment	faulty or damaged equipment is identified to determine repair or replacement according to site specifications
D-17.03.11P	tag and report faulty or damaged equipment	faulty or damaged equipment is tagged and reported according to site specifications and regulations

Range of Variables (include, but not limited to)

robotics: multi-axis, EOAT, grippers and end effectors, SCARA, side entry

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

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

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

safety devices: light curtain, overtravel, overload, heat detectors, emergency stops (E-stops), pressure mats, lockouts, physical guards, safety mat, safety interlock

safety guards: covers, screens, inspection doors and portals

Knowledge

Reference Code	Learning Outcomes and Objectives
D-17.03.01L	demonstrate knowledge of **robotics** and **automated equipment**, their **components** and operation
a.	identify **classifications for robotics and automated equipment** and their **components**, and **auxiliary equipment**, and describe their purpose, applications and operation
b.	interpret information about **robotics** and **automated equipment** found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
D-17.03.02L	demonstrate knowledge of procedures to maintain **robotics** and **automated equipment**
a.	identify tools and equipment to maintain **robotics** and **automated equipment** and describe their applications and procedures
b.	identify hazards and describe safe work practices associated with **robotics** and **automated equipment**
c.	describe procedures to maintain **robotics** and **automated equipment** and their **components**
d.	identify factors to consider when determining if **robotics** and **automated equipment** need to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures
D-17.03.03L	demonstrate knowledge of additional training and certification to maintain **robotics** and **automated equipment**
a.	identify additional training and certification to maintain **robotics** and **automated equipment**
D-17.03.04L	demonstrate knowledge of regulatory requirements to maintain **robotics** and **automated equipment**
a.	identify codes, standards and regulations to maintain **robotics** and **automated equipment**
D-17.03.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **robotics** and **automated equipment**

Range of Variables (include, but not limited to)

robotics: multi-axis, EOAT, grippers and end effectors, SCARA, side entry

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

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

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

auxiliary equipment: wire feeders, articulating fingers, filtering systems

D-17.04 Repairs robotics and automated equipment

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-17.04.01P	access **robotics** and **automated equipment**	**robotics** and **automated equipment** are accessed by removing components
D-17.04.02P	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-17.04.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-17.04.04P	prepare **robotics** and **automated equipment** for repair	**robotics** and **automated equipment** are prepared according to repair required using approved **methods**
D-17.04.05P	size and replace seals, bearings and power transmission devices	seals, bearings and power transmission devices are sized and replaced according to manufacturers' specifications
D-17.04.06P	replace faulty **components** and **auxiliary equipment**	faulty **components** and **auxiliary equipment** are replaced according to site and manufacturers' specifications and match (witness) marks
D-17.04.07P	verify complete range of movement	range of movement is checked by performing various tests
D-17.04.08P	align **components**	**components** are aligned according to manufacturers' specifications
D-17.04.09P	reinstall machine guarding and **safety devices**	machine guarding and **safety devices** are reinstalled according to site and manufacturers' specifications, and regulations

Reference Code	Performance Criteria	Evidence of Attainment
D-17.04.10P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications
D-17.04.11P	tag and report faulty or damaged equipment	faulty or damaged equipment is tagged and reported according to site specifications and regulations

Range of Variables (include, but not limited to)

robotics: multi-axis, EOAT, grippers and end effectors, SCARA, side entry
automated equipment: equipment for various processes (pick and place, welding, material handling, palletizing, painting, measuring, assembly, packing, warehousing)
components: servo motors, fluid power hoses and pistons, sensors, encoders
methods: manufacturers' or engineer's recommendations and procedures, SOP
auxiliary equipment: wire feeders, articulating fingers, filtering systems
safety devices: light curtain, overtravel, overload, heat detectors, emergency stops (E-stops), pressure mats, lockouts, physical guards, safety mat, safety interlock

Knowledge

Reference Code	Learning Outcomes and Objectives
D-17.04.01L	demonstrate knowledge of **robotics** and **automated equipment**, their **components** and operation
a.	identify **classifications for robotics and automated equipment** and their **components**, and **auxiliary equipment**, and describe their purpose, applications and operation
b.	interpret information about **robotics** and **automated equipment** found in drawings and specifications
D-17.04.02L	demonstrate knowledge of procedures to repair **robotics** and **automated equipment**
a.	identify tools and equipment to repair **robotics** and **automated equipment** and describe their applications and procedures
b.	identify hazards and describe safe work practices associated with **robotics** and **automated equipment**
c.	describe procedures to repair **robotics** and **automated equipment** and their **components**
d.	identify factors to consider when determining if **robotics** and **automated equipment** need to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures

D-17.04.03L	demonstrate knowledge of additional training and certification to repair **robotics** and **automated equipment**
a.	identify additional training and certification to repair **robotics** and **automated equipment**
D-17.04.04L	demonstrate knowledge of regulatory requirements to repair **robotics** and **automated equipment**
a.	identify codes, standards and regulations to repair **robotics** and **automated equipment**
D-17.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **robotics** and **automated equipment**

Range of Variables (include, but not limited to)

robotics: multi-axis, EOAT, grippers and end effectors, SCARA, side entry

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

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

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

auxiliary equipment: wire feeders, articulating fingers, filtering systems

Task D-18 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-18.01 Installs fans and blowers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-18.01.01P	use safe work practices related to installation of fans and blowers	safe work practices related to installation of fans and blowers are used
D-18.01.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-18.01.03P	determine location and elevation for installation	location and elevation for installation are determined according to site specifications and engineered drawings
D-18.01.04P	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-18.01.05P	prepare foundation	foundation is prepared according to site and manufacturers' specifications, and engineered drawings
D-18.01.06P	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

Reference Code	Performance Criteria	Evidence of Attainment
D-18.01.07P	level, align and secure fans and blowers	fans and blowers are levelled, aligned and secured according to site and manufacturers' specifications, and engineered drawings
D-18.01.08P	grout to distribute load and minimize vibration	load is distributed and vibration is minimized by grouting
D-18.01.09P	check rotation, static and dynamic balance, and vibration	rotation, static and dynamic balance, and vibration are checked and compared to manufacturers' specifications and plant requirements
D-18.01.10P	connect inlet/outlet	inlet/outlet is connected according to manufacturers' specifications, engineered drawings, plant requirements and regulations
D-18.01.11P	connect and align fans and blowers to driver	fans and blowers are connected and aligned to driver according to manufacturers' specifications and engineered drawings using **processes**
D-18.01.12P	install safety guards and **safety devices**	safety guards and **safety devices** are installed according to site and manufacturers' specifications, and regulations
D-18.01.13P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

methods: filing, sandblasting, buffing, scarifying

processes: co-linear shaft alignment, parallel shaft alignment

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

Knowledge

Reference Code	Learning Outcomes and Objectives
D-18.01.01L	demonstrate knowledge of fans and blowers, their components, characteristics, applications and operation
a.	identify types of fans and blower systems, and describe their characteristics and applications
b.	identify types of fan blades and describe their applications
c.	describe operating principles of fans and blowers
d.	interpret information about fans and blowers found in drawings and specifications
D-18.01.02L	demonstrate knowledge of procedures to remove and install fans and blowers
a.	identify tools and equipment to remove and install fans and blowers, and describe their procedures for use
b.	identify hazards and describe safe work practices to remove and install fans and blowers
c.	describe procedures to remove and install fans and blowers
d.	describe procedures to regulate output for fans and blowers
e.	describe procedures to balance fans and blowers
f.	identify basic electrical principles and describe their associated procedures
D-18.01.03L	demonstrate knowledge of regulatory requirements to install fans and blowers
a.	identify codes, standards and regulations to install fans and blowers
D-18.01.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle fans and blowers

D-18.02 Diagnoses fans and blowers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-18.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained by **sensory inspection** or verbal communication
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 results of **sensory inspection,** task, specifications and regulations
D-18.02.04P	use **test/evaluation procedures**	**test/evaluation procedures** are used according to results of sensory inspection
D-18.02.05P	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-18.02.06P	verify lubrication levels and condition	lubrication levels and condition are verified by **physical inspection**
D-18.02.07P	remove, reinstall or replace safety guards and **safety devices**	safety guards and **safety devices** are removed, reinstalled or replaced according to site and manufacturers' specifications, and regulations
D-18.02.08P	measure clearances of fans and blowers	clearances of fans and blowers are measured according to manufacturers' specifications
D-18.02.09P	assess and detect faulty or damaged **components**	faulty or damaged **components** are assessed and detected to determine repair or replacement according to site and manufacturers' specifications

D-18.02.10P	determine type of **repair** required	type of **repair** required is determined according to inspection and vibration analysis results
D-18.02.11P	determine root cause of failure	root cause of failure of fans and blowers are determined

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

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

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

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

physical inspection: lock out machine, visually inspect lubrication levels of blower housing, couplings, clutches and brakes

safety devices: interlocking devices, heat shields, guards, access covers, screens, inspection doors, portals, sensors (e.g., heat, motion, vibration), barriers, electronic eyes, amperage meters, electronic overloads, lockouts, physical guards

repair: bearing, coupling and drive component replacement; re-balancing

Knowledge

Reference Code	Learning Outcomes and Objectives
D-18.02.01L	demonstrate knowledge of fans and blowers, their **components**, characteristics, applications and operation
a.	identify types of fans and blower systems, and describe their characteristics and applications
b.	identify types of fan blades and describe their applications
c.	describe operating principles of fans and blowers
d.	interpret information about fans and blowers found in drawings and specifications
D-18.02.02L	demonstrate knowledge of procedures to diagnose fans and blowers
a.	identify tools and equipment to diagnose fans and blowers, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose fans and blowers
c.	describe procedures to diagnose fans and blowers
d.	describe procedures to inspect fans and blowers

Reference Code	Learning Outcomes and Objectives
e.	identify factors to consider when determining if fans and blowers need to be repaired or replaced
f.	identify basic electrical principles and describe their associated procedures
D-18.02.03L	demonstrate knowledge of regulatory requirements to diagnose fans and blowers
a.	identify codes, standards and regulations to diagnose fans and blowers

Range of Variables (include, but not limited to)

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

D-18.03 Maintains fans and blowers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-18.03.01P	use safe work practices related to fans and blowers	safe work practices related to fans and blowers are used
D-18.03.02P	perform **sensory inspection** of fans and blower components	**sensory inspection** of fan and blower components is performed using tools and equipment to locate **defects**
D-18.03.03P	select and use tools and equipment	tools and equipment are selected and used according to inspection, task, specifications and regulations
D-18.03.04P	access fans and blowers	fans and blowers are accessed by removing **auxiliary equipment**
D-18.03.05P	verify maintenance requirements	maintenance requirements are verified according to inspection, equipment history, and site and manufacturers' specifications
D-18.03.06P	clean fan blades	fan blades are cleaned according to site and manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-18.03.07P	lubricate bearings and couplings	bearings and couplings are lubricated according to site and manufacturers' specifications
D-18.03.08P	reinstall, re-align, replace and adjust fan blades and blower components	fan blades and blower components are reinstalled, realigned, replaced and adjusted according to site and manufacturers' specifications
D-18.03.09P	document and replace faulty components	faulty components are documented and replaced according to site and manufacturers' specifications, and engineered drawings
D-18.03.10P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to site and manufacturers' specifications, and regulations
D-18.03.11P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

defects: wear, misalignment, debris build-up

auxiliary equipment: guards, shrouding, scrolls, casings

Knowledge

Reference Code	Learning Outcomes and Objectives
D-18.03.01L	demonstrate knowledge of fans and blowers, their components, characteristics, applications and operation
a.	identify types of fans and blower systems, and describe their characteristics and applications
b.	identify types of fan blades and describe their applications
c.	describe operating principles of fans and blowers
d.	interpret information about fans and blowers found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
D-18.03.02L	demonstrate knowledge of procedures to maintain fans and blowers
a.	identify tools and equipment to maintain fans and blowers, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain fans and blowers
c.	describe procedures to maintain fans and blowers
d.	describe procedures to regulate output/input for fans and blowers
e.	describe procedures to balance fans and blowers
f.	identify factors to consider when determining if fans and blowers need to be repaired or replaced
g.	identify basic electrical principles and describe their associated procedures
D-18.03.03L	demonstrate knowledge of regulatory requirements to maintain fans and blowers
a.	identify codes, standards and regulations to maintain fans and blowers
D-18.03.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle fans and blowers

D-18.04 Repairs fans and blowers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-18.04.01P	use safe work practices related to fans and blowers	safe work practices related to fans and blowers are used
D-18.04.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-18.04.03P	prepare fans and blowers for repair	fans and blowers are prepared according to repair required and SOP

Reference Code	Performance Criteria	Evidence of Attainment
D-18.04.04P	correct unbalances	unbalances are corrected using **methods**
D-18.04.05P	access fans and blowers	fans and blowers are accessed by removing **auxiliary equipment**
D-18.04.06P	dismantle, remove and reassemble fans and blowers, and their components	fans and blowers, and their components are dismantled, removed and reassembled according to manufacturers' specifications
D-18.04.07P	recondition, repair or replace fans and blowers, and their components	fans and blowers, and their components are reconditioned, repaired or replaced according to site and manufacturers' specifications, and engineered drawings
D-18.04.08P	adjust clearances of fans and blowers, and their components	clearances of fans and blowers, and their components are adjusted according to manufacturers' specifications
D-18.04.09P	lubricate bearings and couplings	bearings and couplings are lubricated according to manufacturers' specifications
D-18.04.10P	level and align drive components	drive components are levelled and aligned according to manufacturers' specifications
D-18.04.11P	reinstall safety guards and safety devices	safety guards and safety devices are reinstalled according to manufacturers' specifications and regulations
D-18.04.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

methods: cleaning, static and dynamic balancing
auxiliary equipment: guards, shrouding, scrolls, casings

Knowledge

Reference Code	Learning Outcomes and Objectives
D-18.04.01L	demonstrate knowledge of fans and blowers, their components, characteristics, applications and operation
a.	identify types of fans and blower systems, and describe their characteristics and applications
b.	identify types of fan blades and describe their applications
c.	describe operating principles of fans and blowers
d.	interpret information about fans and blowers found in drawings and specifications
D-18.04.02L	demonstrate knowledge of procedures to repair fans and blowers
a.	identify tools and equipment to repair fans and blowers, and describe their procedures for use
b.	identify hazards and describe safe work practices to repair fans and blowers
c.	describe procedures to repair fans and blowers
d.	describe procedures to regulate output for fans and blowers
e.	describe procedures to balance fans and blowers
f.	identify factors to consider when determining if fans and blowers need to be repaired or replaced
g.	identify basic electrical principles and describe their associated procedures
D-18.04.03L	demonstrate knowledge of regulatory requirements to repair fans and blowers
a.	identify codes, standards and regulations to repair fans and blowers
D-18.04.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle fans and blowers

Task D-19 Services pumps

Task Descriptor

Pumps are used to move liquid and other media by positive or non-positive displacement. Proper and safe servicing practices ensure machine reliability and efficiency. Servicing includes installing, diagnosing, maintaining and repairing.

D-19.01 Installs pumps

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-19.01.01P	select and use **tools and equipment**	**tools and equipment** are selected and used according to task, specifications and regulations
D-19.01.02P	determine location and elevation for installation	location and elevation for installation are determined according to site and manufacturers' specifications, and engineered drawings
D-19.01.03P	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, and engineered drawings
D-19.01.04P	prepare foundation	foundation is prepared for installation according to site and manufacturers' specifications, and engineered drawings
D-19.01.05P	position **pump**	**pump** is positioned on foundation manually or using rigging, hoisting/lifting and moving equipment according to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-19.01.06P	secure, level and align **pump** and prime mover	**pump** and prime mover are secured, levelled and aligned according to site and manufacturers' specifications, and engineered drawings
D-19.01.07P	finish foundation	foundation is finished according to manufacturers' specifications
D-19.01.08P	set **pump** clearances	**pump** clearances are set according to site and manufacturers' specifications
D-19.01.09P	install and adjust **components**	**components** are installed and adjusted according to site and manufacturers' specifications
D-19.01.10P	connect suction and discharge piping	suction and discharge piping is connected according to site and manufacturers' specifications
D-19.01.11P	eliminate stress on **pump**	stress on **pump** is eliminated by relieving pipe strain

Range of Variables (include, but not limited to)

tools and equipment: impeller lifting jig, packing pullers, packing installation tools, packing cutters, inspection mirrors, sheave alignment tools

pumps: non-positive (e.g., centrifugal, axial flow), positive displacement (e.g., vane, gear, peristaltic, piston, diaphragm, progressive cavity)

methods: filing, sandblasting, buffing, levelling, aligning, grouting, scarifying

components: filters, breathers, wear sleeves, seals (e.g., packings, O-Rings, mechanical seal, V-rings, gaskets), impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings, barrel, couplings, bleed off valves, relief valves

Knowledge

Reference Code	Learning Outcomes and Objectives
D-19.01.01L	demonstrate knowledge of **pumps**, their **components**, characteristics, applications and operation
a.	identify types of **pumps**, their **components** and accessories, describe their characteristics, applications and purpose
b.	describe operating principles of **pumps**
c.	interpret information about **pumps** found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
D-19.01.02L	demonstrate knowledge of procedures to install **pumps**
a.	identify **tools and equipment** to install **pumps**, and describe their procedures for use
b.	identify hazards and describe safe work practices to install **pumps**
c.	describe procedures to remove and install **pumps**
d.	describe method to interpret pump curves
e.	describe **methods** to install base, base plates and structure
f.	identify basic electrical principles and describe their associated procedures
D-19.01.03L	demonstrate knowledge of regulatory requirements to install **pumps**
a.	identify codes, standards and regulations to install **pumps**
D-19.01.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **pumps**

Range of Variables (include, but not limited to)

pumps: non-positive (e.g., centrifugal, axial flow), positive displacement (e.g., vane, gear, peristaltic, piston, diaphragm, progressive cavity)

components: filters, breathers, wear sleeves, seals (e.g., packings, O-Rings, mechanical seal, V-rings, gaskets), impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings, barrel, couplings, bleed off valves, relief valves

tools and equipment: impeller lifting jig, packing pullers, packing installation tools, packing cutters, inspection mirrors, sheave alignment tools

methods: filing, sandblasting, buffing, levelling, aligning, grouting, scarifying

D-19.02 Diagnoses pumps

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-19.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained

Reference Code	Performance Criteria	Evidence of Attainment
D-19.02.02P	perform **sensory inspection** of pump components for defects	**sensory inspection** is performed to determine next steps
D-19.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-19.02.04P	**test and evaluate pumps**	**pumps** are **tested and evaluated** by referring to manufacturers' specifications
D-19.02.05P	perform **condition-based monitoring methods** and analysis	**condition-based monitoring methods** and analysis are performed to detect **defects** not identified through **sensory inspection**
D-19.02.06P	inspect pump **components**	pump **components** are inspected for **defects** and to determine **next steps**
D-19.02.07P	determine type of **repair** required	type of **repair** required is determined according to inspection results
D-19.02.08P	determine root cause of failure	root cause of failure of **pumps** are determined

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

test and evaluate: monitoring temperature and vibration levels with specialized equipment, performing oil analysis, tensioning drive belt

pumps: non-positive (centrifugal, axial flow), positive displacement (vane, gear, peristaltic, piston, diaphragm, progressive cavity)

condition-based monitoring methods: vibration monitoring, fluid analysis, thermography, ultrasonic, rotational direction, speed monitoring, pressure and flow monitoring

defects: excessive leaks, wear and heat; noise; corrosion; looseness

components: filters, breathers, wear sleeves, seals (packings, O-Rings, mechanical seal, V-rings, gaskets), impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings, barrel, couplings

next steps: repair, replace, overhaul, adjust, continue operation, bleed air from system

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

Knowledge

Reference Code	Learning Outcomes and Objectives
D-19.02.01L	demonstrate knowledge of **pumps**, their **components**, characteristics, applications and operation
a.	identify types of **pumps**, their **components** and accessories, describe their characteristics, applications and purpose
b.	describe operating principles of **pumps**
c.	interpret information about **pumps** found in drawings and specifications
D-19.02.02L	demonstrate knowledge of procedures to diagnose **pumps**
a.	identify tools and equipment to diagnose **pumps**, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **pumps**
c.	describe method to interpret pump curves
d.	describe procedures to inspect **pumps** and their **components**
e.	describe procedures to diagnose **pumps** and their **components**
f.	identify factors to consider when determining if **pumps** need to be repaired or replaced
g.	identify basic electrical principles and describe their associated procedures
D-19.02.03L	demonstrate knowledge of regulatory requirements to diagnose **pumps**
a.	identify codes, standards and regulations to diagnose **pumps**
D-19.02.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection

Range of Variables (include, but not limited to)

pumps: non-positive (centrifugal, axial flow), positive displacement (vane, gear, peristaltic, piston, diaphragm, progressive cavity)

components: filters, breathers, wear sleeves, seals (packings, O-Rings, mechanical seal, V-rings, gaskets), impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings, barrel, couplings

D-19.03 Maintains pumps

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-19.03.01P	inspect, modify and adjust **pumps**	**pumps** are inspected, modified and adjusted according to maintenance schedule using **condition-based monitoring methods**
D-19.03.02P	select and use **tools and equipment**	**tools and equipment** are selected and used according to task, specifications and regulations
D-19.03.03P	align **components**	**components** are aligned according to manufacturers' specifications
D-19.03.04P	check fluid levels	fluid levels are checked according to manufacturers' specifications
D-19.03.05P	check temperatures, vacuum, pressure and flow rates	temperatures, vacuum, pressure and flow rates are checked according to manufacturers' specifications
D-19.03.06P	perform **sensory inspection** and use **condition-based monitoring methods**	**sensory inspection** is performed, and **condition-based monitoring methods** are used to locate defects
D-19.03.07P	verify maintenance requirements	maintenance requirements are verified according to inspection, equipment history, and site and manufacturers' specifications
D-19.03.08P	clean or replace oil filters, strainers and breathers	oil filters, strainers and breathers are cleaned or replaced according to site and manufacturers' specifications
D-19.03.09P	verify operation of valves	operation of valves is verified according to site and manufacturers' specifications
D-19.03.10P	adjust packing and monitor mechanical seals	packing is adjusted and mechanical seals are monitored according to site and manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-19.03.11P	check clearances against manufacturers' specifications	clearances are checked against manufacturers' specifications

Range of Variables (include, but not limited to)

pumps: non-positive (centrifugal, axial flow), positive displacement (vane, gear, peristaltic, piston, diaphragm, progressive cavity)

condition-based monitoring methods: vibration monitoring, fluid analysis, thermography, ultrasonic, rotational direction, speed monitoring, pressure and flow monitoring

tools and equipment: impeller lifting jig, packing pullers, packing installation tools, packing cutters, inspection mirrors, sheave alignment tools

components: filters, breathers, wear sleeves, seals (packings, O-Rings, mechanical seal, V-rings, gaskets), impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings, barrel, couplings

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

Knowledge

Reference Code	Learning Outcomes and Objectives
D-19.03.01L	demonstrate knowledge of **pumps**, their **components**, characteristics, applications and operation
a.	identify types of **pumps**, their **components** and accessories, describe their characteristics, applications and purpose
b.	describe operating principles of **pumps** and their **components**
c.	interpret information about **pumps** found in drawings and specifications
D-19.03.02L	demonstrate knowledge of procedures to maintain **pumps** and their **components**
a.	identify **tools and equipment** to maintain **pumps** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain **pumps** and their **components**
c.	describe method to interpret pump curves
d.	describe procedures to maintain **pumps** and their **components**
e.	identify factors to consider when determining if **pumps** need to be repaired or replaced
f.	identify basic electrical principles and describe their associated procedures

Reference Code	Learning Outcomes and Objectives
D-19.03.03L	demonstrate knowledge of regulatory requirements to maintain **pumps**
a.	identify codes, standards and regulations to maintain **pumps**
D-19.03.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **pumps** and their **components**

Range of Variables (include, but not limited to)

pumps: non-positive (centrifugal, axial flow), positive displacement (vane, gear, peristaltic, piston, diaphragm, progressive cavity)

components: filters, breathers, wear sleeves, seals (packings, O-Rings, mechanical seal, V-rings, gaskets), impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings, barrel, couplings

tools and equipment: impeller lifting jig, packing pullers, packing installation tools, packing cutters, inspection mirrors, sheave alignment tools

D-19.04 Repairs pumps

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-19.04.01P	select and use **tools and equipment**	**tools and equipment** are selected and used according to task, specifications and regulations
D-19.04.02P	perform sensory inspection and use condition-based monitoring methods	sensory inspection is performed, and condition-based monitoring methods are used to locate defects
D-19.04.03P	prepare pumps for repair	pumps are prepared according to repair required and SOP
D-19.04.04P	verify maintenance requirements	maintenance requirements are verified according to inspection, equipment history, and site and manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-19.04.05P	clean or replace oil filters, breathers and strainers	oil filters, breathers and strainers are cleaned or replaced according to site and manufacturers' specifications
D-19.04.06P	check fluid levels	fluid levels are checked according to site and manufacturers' specifications
D-19.04.07P	check temperatures, vacuum, pressures and flow rates	temperatures, vacuum, pressures and flow rates are checked according to site and manufacturers' specifications
D-19.04.08P	align **components**	**components** are aligned according to manufacturers' specifications
D-19.04.09P	verify operation of valves	operation of valves is verified according to site and manufacturers' specifications
D-19.04.10P	adjust packing and monitor mechanical seals	packing is adjusted and mechanical seals are monitored according to site and manufacturers' specifications
D-19.04.11P	verify rotation	rotation is checked prior to coupling connection by performing bump test
D-19.04.12P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to site and manufacturers' specifications, and regulations
D-19.04.13P	check clearances against manufacturers' specifications	clearances are checked against manufacturers' specifications
D-19.04.14P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

tools and equipment: impeller lifting jig, packing pullers, bearing pullers, packing installation tools, packing cutters, inspection mirrors, sheave alignment tools, induction heaters, lifting equipment

components: filters, breathers, wear sleeves, seals (e.g., packings, O-Rings, mechanical seal, V-rings, gaskets), impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings, barrel, couplings

Knowledge

Reference Code	Learning Outcomes and Objectives
D-19.04.01L	demonstrate knowledge of **pumps**, their **components**, characteristics, applications and operation
a.	identify types of **pumps**, their **components** and accessories, describe their characteristics, applications and purpose
b.	describe operating principles of **pumps** and their **components**
c.	interpret information about **pumps** found in drawings and specifications
D-19.04.02L	demonstrate knowledge of procedures to repair **pumps** and their **components**
a.	identify **tools and equipment** to repair **pumps** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to repair **pumps** and their **components**
c.	describe method to interpret pump curves
d.	describe procedures to repair **pumps** and their **components**
e.	identify factors to consider when determining if **pumps** need to be repaired or replaced
f.	identify basic electrical principles and describe their associated procedures
D-19.04.03L	demonstrate knowledge of regulatory requirements to repair **pumps**
a.	identify codes, standards and regulations to repair **pumps**
D-19.04.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **pumps** and their **components**

Range of Variables (include, but not limited to)

pumps: non-positive (e.g., centrifugal, axial flow), positive displacement (e.g., vane, gear, peristaltic, piston, diaphragm, progressive cavity)

components: filters, breathers, wear sleeves, seals (e.g., packings, O-Rings, mechanical seal, V-rings, gaskets), impeller, shafts, wear rings, stuffing box assembly, rotating assembly, bearings, barrel, couplings

tools and equipment: impeller lifting jig, packing pullers, bearing pullers, packing installation tools, packing cutters, inspection mirrors, sheave alignment tools, induction heaters, lifting equipment

Task D-20 Services compressors

Task Descriptor

Compressors are used to supply air or other gases at an increased pressure. Servicing includes installing, diagnosing, maintaining and repairing.

D-20.01 Installs compressors

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-20.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-20.01.02P	confirm flow/pressure requirement	flow/pressure requirement is confirmed according to engineered drawings and plant demand
D-20.01.03P	determine location and elevation for installation	location and elevation for installation are determined according to site and manufacturers' specifications, and engineered drawings
D-20.01.04P	clean and rough up base for **compressor**	base for **compressor** is cleaned and roughed up using **methods** according to site and manufacturers' specifications
D-20.01.05P	prepare foundation	foundation is prepared according to site and manufacturers' specifications, and engineered drawings
D-20.01.06P	prepare base, base plates and structure	base, base plates and structure are prepared using **methods** according to site and manufacturers' specifications, and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
D-20.01.07P	position **compressor** in place	**compressor** is positioned in place using rigging, hoisting/lifting and moving equipment according to manufacturers' specifications
D-20.01.08P	level, align and secure **compressor**	**compressor** is levelled, aligned and secured according to site and manufacturers' specifications, and engineered drawings
D-20.01.09P	grout to distribute load and minimize vibration	load is distributed and vibration is minimized by grouting according to manufacturers' specifications and engineered drawings
D-20.01.10P	lubricate **compressor**	**compressor** is lubricated according to site and manufacturers' specifications
D-20.01.11P	verify rotation	rotation is verified according to manufacturers' specifications and before engaging to drive unit
D-20.01.12P	connect and align **compressor** to prime mover	**compressors** is connected and aligned to prime mover through couplings, sheaves and belts according to manufacturers' specifications
D-20.01.13P	install safety guards and **safety devices**	safety guards and **safety devices** are installed according to site and manufacturers' specifications, and regulations
D-20.01.14P	check for vibration	vibration is checked according to manufacturers' specifications
D-20.01.15P	connect inlet/outlet	inlet/outlet is connected according to manufacturers' specifications and engineered drawings
D-20.01.16P	install **accessories**	**accessories** are installed according to manufacturers' specifications and engineered drawings
D-20.01.17P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

compressors: dynamic/centrifugal, positive displacement (e.g., reciprocating, radial, screw, vane)
methods: filing, sandblasting, buffing, scarifying
safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards
accessories: silencers, filters, air dryers, lubricators, scrubbers, coolers

Knowledge

Reference Code	Learning Outcomes and Objectives
D-20.01.01L	demonstrate knowledge of **compressors**, their **components**, characteristics, applications and operation
a.	identify classifications and types of **compressors** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **compressors**
c.	interpret information about **compressors** found in drawings and specifications
D-20.01.02L	demonstrate knowledge of procedures to remove, install and align **compressors** and their **components**
a.	identify tools and equipment to remove, install and align **compressors** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to remove, install and align **compressors** and their **components**
c.	describe procedures to remove, install and align **compressors** and their **components**
d.	identify basic electrical principles and describe their associated procedures
D-20.01.03L	demonstrate knowledge of additional training and certification to install **compressors** and their **components**
a.	identify additional training and certification to install **compressors** and their **components**
D-20.01.04L	demonstrate knowledge of regulatory requirements to remove, install and align **compressors** and their **components**
a.	identify codes, standards and regulations to remove, install and align **compressors** and their **components**

Reference Code	Learning Outcomes and Objectives
D-20.01.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **compressors** and their **components**

Range of Variables (include, but not limited to)

compressors: dynamic/centrifugal, positive displacement (e.g., reciprocating, radial, screw, vane)

components: temperature gauges, pressure gauges, sheaves, piping, valves, bearings, belts, filters, pressure relief valves, temperature controllers, regulators, unloading valves, couplings, seals, receivers, intercoolers, aftercoolers

D-20.02 Diagnoses compressors

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-20.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
D-20.02.02P	perform **sensory inspection** of components for defects	**sensory inspection** of components is performed to determine next steps
D-20.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-20.02.04P	test and evaluate **compressors**	**compressors** are tested and evaluated using specialized equipment and referring to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-20.02.05P	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-20.02.06P	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-20.02.07P	assess and detect faulty or damaged **components**	faulty or damaged **components** are assessed and detected to determine **repair or replacement**
D-20.02.08P	determine root cause of failure	root cause of failure of **compressors** is determined

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

compressors: dynamic/centrifugal, positive displacement (e.g., reciprocating, radial, screw, vane)

condition-based monitoring methods: vibration monitoring, fluid analysis, thermography, ultrasonic, rotational direction, speed monitoring, system pressure monitoring

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

components: temperature gauges, pressure gauges, sheaves, piping, valves, bearings, belts, filters, pressure relief valves, temperature controllers, regulators, unloading valves, couplings, seals, receivers, intercoolers, aftercoolers

repair or replacement: replacing bearings and couplings, replacing or refurbishing valves

Knowledge

Reference Code	Learning Outcomes and Objectives
D-20.02.01L	demonstrate knowledge of **compressors**, their **components**, characteristics, applications and operation
a.	identify **compressors** and their **components** and **accessories**, and describe their characteristics and applications
b.	describe operating principles of **compressors** and their **components** and **accessories**
c.	interpret information about **compressors** and their **components** and **accessories** found in drawings and specifications
D-20.02.02L	demonstrate knowledge of procedures to diagnose **compressors** and **components**
a.	identify tools and equipment to diagnose **compressors** and **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to inspect and diagnose **compressors** and **components**
c.	describe procedures to inspect **compressors** and **components**
d.	describe procedures to diagnose **compressors** and **components**
e.	identify **factors** to consider when determining if **compressors** and their **components** need to be repaired or replaced
f.	identify basic electrical principles and describe their associated procedures
D-20.02.03L	demonstrate knowledge of additional training and certification to diagnose **compressors** and **components**
a.	identify additional training and certification to diagnose **compressors** and **components**
D-20.02.04L	demonstrate knowledge of regulatory requirements to diagnose **compressors** and **components**
a.	identify codes, standards and regulations to diagnose **compressors** and **components**
D-20.02.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **compressors** and **components**

Range of Variables (include, but not limited to)

compressors: dynamic/centrifugal, positive displacement (e.g., reciprocating, radial, screw, vane)

components: temperature gauges, pressure gauges, sheaves, piping, valves, bearings, belts, filters, pressure relief valves, temperature controllers, regulators, unloading valves, couplings, seals, receivers, intercoolers, aftercoolers

accessories: silencers, filters, air dryers, lubricators, scrubbers, coolers

factors: condition-based monitoring reports (e.g., worn bearings, oil analysis, vibration analysis, thermography), Reliability Centered Maintenance (RCM)

D-20.03 Maintains compressors

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-20.03.01P	perform **sensory inspection** of compressor and components	**sensory inspection** of compressor and components is performed to locate defects
D-20.03.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-20.03.03P	verify maintenance requirements	maintenance requirements are identified according to **condition-based monitoring methods**, equipment history, and site and manufacturers' specifications
D-20.03.04P	clean or replace oil filters and air filters	oil filters and air filters are cleaned or replaced according to site and manufacturers' specifications
D-20.03.05P	check **fluid** levels	**fluid** levels are checked according to manufacturers' specifications
D-20.03.06P	check temperatures and pressures	temperatures and pressures are checked according to site and manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-20.03.07P	remove and replace safety guards and **safety devices**	safety guards and **safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations
D-20.03.08P	align shafts	shafts are aligned or realigned according to site and manufacturers' specifications
D-20.03.09P	adjust loading and unloading set points	loading and unloading set points are adjusted according to engineered drawings, and site and manufacturers' specifications
D-20.03.10P	drain moisture from **compressors**, coolers and receivers	moisture from **compressors**, coolers and receivers is drained according to site and manufacturers' specifications
D-20.03.11P	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 regulations
D-20.03.12P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications
D-20.03.13P	identify faulty or damaged equipment	faulty or damaged equipment is identified to determine repair or replacement

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

condition-based monitoring methods: vibration monitoring, fluid analysis, thermography, ultrasonic, rotational direction, speed monitoring

fluids: coolant (water, glycol, additives), oil, grease

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

compressors: dynamic/centrifugal, positive displacement (e.g., reciprocating, radial, screw, vane)

Knowledge

Reference Code	Learning Outcomes and Objectives
D-20.03.01L	demonstrate knowledge of **compressors**, their **components**, characteristics, applications and operation
a.	identify **compressors** and their **components** and accessories, and describe their characteristics and applications
b.	describe operating principles of **compressors** and their **components** and accessories
c.	interpret information about **compressors** and their **components** and accessories found in drawings and specifications
D-20.03.02L	demonstrate knowledge of procedures to maintain **compressors** and **components**
a.	identify tools and equipment to maintain **compressors** and **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain **compressors** and **components**
c.	describe procedures to maintain **compressors** and **components**
d.	identify **factors** to consider when determining if **compressors** or their **components** need to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures
D-20.03.03L	demonstrate knowledge of additional training and certification to maintain **compressors** and **components**
a.	identify additional training and certification to maintain **compressors** and **components**
D-20.03.04L	demonstrate knowledge of regulatory requirements to maintain **compressors** and **components**
a.	identify codes, standards and regulations to maintain **compressors** and **components**
D-20.03.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **compressors** and **components**

Range of Variables (include, but not limited to)

compressors: dynamic/centrifugal, positive displacement (e.g., reciprocating, radial, screw, vane)

components: temperature gauges, pressure gauges, sheaves, piping, valves, bearings, belts, filters, pressure relief valves, temperature controllers, regulators, unloading valves, couplings, seals, receivers, intercoolers, aftercoolers

factors: condition-based monitoring reports (worn bearings, oil analysis, vibration analysis, thermography), RCM

D-20.04 Repairs compressors

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-20.04.01P	repair and replace faulty compressor **components** or **accessories**	faulty compressor **components** or **accessories** are repaired or replaced according to manufacturers' specifications
D-20.04.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-20.04.03P	prepare **compressor** and **components** for repair	**compressors** and **components** are prepared according to repair required and SOP
D-20.04.04P	identify faulty or damaged **components** and **accessories**	faulty or damaged **components** and **accessories** are identified to determine repair or replacement
D-20.04.05P	replace faulty **components** and **accessories**	faulty **components** and **accessories** are replaced according to site and manufacturers' specifications
D-20.04.06P	set/adjust clearances	clearances of **compressors** and **components** are set/adjusted according to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-20.04.07P	re-align drive components	drive components are realigned according to manufacturers' specifications
D-20.04.08P	adjust loading and unloading set points	loading and unloading set points are adjusted according to site and manufacturers' specifications
D-20.04.09P	ensure operation of relief, check and auto drain valves	operation of relief, check and auto drain valves is confirmed according to site and manufacturers' specifications, and regulations
D-20.04.10P	install safety guards and **safety devices**	safety guards and **safety devices** are installed according to site and manufacturers' specifications, and regulations
D-20.04.11P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

components: temperature gauges, pressure gauges, sheaves, piping, valves, bearings, belts, filters, pressure relief valves, temperature controllers, regulators, unloading valves, couplings, seals, receivers, intercoolers, aftercoolers

accessories: silencers, filters, air dryers, lubricators, scrubbers, coolers

compressors: dynamic/centrifugal, positive displacement (e.g., reciprocating, radial, screw, vane)

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards

Knowledge

Reference Code	Learning Outcomes and Objectives
D-20.04.01L	demonstrate knowledge of **compressors**, their **components**, characteristics, applications and operation
a.	identify **compressors** and their **components** and **accessories**, and describe their characteristics and applications
b.	describe operating principles of **compressors** and their **components** and **accessories**
c.	interpret information about **compressors** and their **components** and **accessories** found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
D-20.04.02L	demonstrate knowledge of procedures to repair **compressors** and **components**
a.	identify tools and equipment to repair **compressors** and **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to repair **compressors** and **components**
c.	describe procedures to repair **compressors** and **components**
d.	identify **factors** to consider when determining if **compressors** or their **components** need to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures
D-20.04.03L	demonstrate knowledge of additional training and certification to repair **compressors** and **components**
a.	identify additional training and certification to repair **compressors** and **components**
D-20.04.04L	demonstrate knowledge of regulatory requirements to repair **compressors** and **components**
a.	identify codes, standards and regulations to repair **compressors** and **components**
D-20.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **compressors** and **components**

Range of Variables (include, but not limited to)

compressors: dynamic/centrifugal, positive displacement (e.g., reciprocating, radial, screw, vane)

components: temperature gauges, pressure gauges, sheaves, piping, valves, bearings, belts, filters, pressure relief valves, temperature controllers, regulators, unloading valves, couplings, seals, receivers, intercoolers, aftercoolers

accessories: silencers, filters, air dryers, lubricators, scrubbers, coolers

factors: condition-based monitoring reports (worn bearings, oil analysis, vibration analysis, temperature analysis)

Task D-21 Services process piping, tanks and containers

Task Descriptor

Process piping, tanks and containers are 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, hoppers and process piping. Servicing includes installing, diagnosing, maintaining and repairing.

D-21.01 Installs process tanks and containers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-21.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-21.01.02P	determine location and elevation for installation	location and elevation for installation are determined according to site and manufacturers' specifications, and engineered drawings
D-21.01.03P	prepare and rough up foundation	foundation is prepared and roughed up according to engineered drawings and site specifications
D-21.01.04P	clean and prepare base	base is prepared using **methods** according to site and manufacturers' specifications, and engineered drawings
D-21.01.05P	position **process tanks and containers**	**process tanks and containers** are positioned in place using rigging, hoisting/lifting and moving equipment according to site and manufacturers' specifications, and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
D-21.01.06P	level, align and secure **process tanks and containers**	**process tanks and containers** are levelled, aligned and secured according to site and manufacturers' specifications, and engineered drawings
D-21.01.07P	check orientation of **process tank and container**	orientation of **process tank and container** is checked according to site specifications and engineered drawings
D-21.01.08P	grout **process tanks and containers**	grout is applied to **process tanks and containers** to distribute load and minimize vibration
D-21.01.09P	connect inlet/outlet	inlet/outlet is connected according to engineered drawings
D-21.01.10P	install **components**	**components** are installed according to manufacturers' specifications and engineered drawings
D-21.01.11P	install safety guards and **safety devices**	safety guards and **safety devices** are installed according to site and manufacturers' specifications, and regulations
D-21.01.12P	perform **final inspection and testing**	**process tanks and containers and components** are inspected, tested and results documented according to manufacturers' specifications, engineered drawings and regulations

Range of Variables (include, but not limited to)

methods: filing, sandblasting, buffing, grinding, scarifying

process tanks and containers: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

components: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, walkways, ladders, steps/staircases, access panels/doors, header tanks

safety devices: keyed switches, lockouts, physical guards, pressure sensing, overflow sensors, proximity sensors, pressure relief valves

final inspection and testing: final cleaning; flow, pressure and leak tests; final visual inspection

Knowledge

Reference Code	Learning Outcomes and Objectives
D-21.01.01L	demonstrate knowledge of **process tanks and containers**, and their **components**, characteristics, applications and operation
a.	identify types of **process tanks and containers** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **process tanks and containers** and their **components**
c.	interpret information about **process tanks and containers** and their **components** found in drawings and specifications
D-21.01.02L	demonstrate knowledge of procedures to install **process tanks and containers** and their **components**
a.	identify tools and equipment to install **process tanks and containers** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to install **process tanks and containers** and their **components**
c.	describe procedures to install **process tanks and containers** and their **components**
d.	describe procedures to inspect **process tanks and containers** and their **components**
e.	describe procedures to test **process tanks and containers** and their **components**
f.	identify basic electrical principles and describe their associated procedures
D-21.01.03L	demonstrate knowledge of additional training and certification to install **process tanks and containers** and their **components**
a.	identify additional training and certification to install **process tanks and containers** and their **components**
D-21.01.04L	demonstrate knowledge of regulatory requirements to install **process tanks and containers** and their **components**
a.	identify codes, standards and regulations to install **process tanks and containers** and their **components**
D-21.01.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **process tanks and containers** and their **components**

Range of Variables (include, but not limited to)

process tanks and containers: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

components: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, walkways, ladders, steps/staircases, access panels/doors, header tanks

D-21.02 Installs process piping

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-21.02.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-21.02.02P	select process piping **components**	process piping **components** are selected according to site specifications, engineered drawings and regulations
D-21.02.03P	determine location and elevation for installation	location and elevation for installation are determined according to site and manufacturers' specifications, and engineered drawings
D-21.02.04P	position **process piping**	**process piping** is positioned in place using rigging, hoisting/lifting and moving equipment according to engineered drawings and regulations
D-21.02.05P	place and secure **process piping**	**process piping** is placed and secured using **supports** and considering slope according to engineered drawings and regulations
D-21.02.06P	check orientation of process piping **components**	orientation of process piping **components** is checked according to engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
D-21.02.07P	connect **process piping** and **components**	**process piping** and **components** are connected according to engineered drawings and regulations
D-21.02.08P	perform **final inspection and testing**	**process piping** is inspected and tested, and results documented according to manufacturers' specifications, engineered drawings and regulations

Range of Variables (include, but not limited to)

components: fittings, valves, strainers, gaskets, connectors, fasteners, flanges, expansion joints, backflow preventer, electrical

process piping: acrylonitrile butadiene styrene (ABS), high-density polyethylene (HDPE), polyvinyl chloride (PVC), stainless, composite, carbon steel, copper

supports: stands, hangers, brackets

final inspection and testing: final cleaning; flow, pressure and leak tests; final visual inspection

Knowledge

Reference Code	Learning Outcomes and Objectives
D-21.02.01L	demonstrate knowledge of **process piping**, and their **components**, characteristics, applications and operation
a.	identify **process piping** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **process piping** and their **components**
c.	interpret information about **process piping** and their **components** found in drawings and specifications
D-21.02.02L	demonstrate knowledge of procedures to install **process piping** and their **components**
a.	identify tools and equipment to install **process piping** and their **components**, and describe their procedures for use
b.	identify **hazards** and describe safe work practices to install **process piping** and their components
c.	describe procedures to install **process piping** and their **components**
d.	describe procedures to inspect **process piping** and their **components**

Reference Code	Learning Outcomes and Objectives
e.	describe procedures to test **process piping** and their **components**
f.	identify basic electrical principles and describe their associated procedures
D-21.02.03L	demonstrate knowledge of additional training and certification to install **process piping** and their **components**
a.	identify additional training and certification to install **process piping** and their **components**
D-21.02.04L	demonstrate knowledge of regulatory requirements to install **process piping** and their **components**
a.	identify codes, standards and regulations to install **process piping** and their **components**
D-21.02.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **process piping** and their components

Range of Variables (include, but not limited to)

process piping: ABS, HDPE, PVC, stainless, composite, carbon steel, copper

components: fittings, valves, strainers, gaskets, connectors, fasteners, flanges, expansion joints, backflow preventer, electrical

hazards: residual materials, pressure, extreme temperature in pipes (e.g., below freezing, above boiling), weight, acidic (e.g., caustic, corrosive), poisonous substances, flammable, explosive, oxygen, incompatibility of materials, pinch points, radiation, pipe composition, pipe strain, asbestos gaskets

D-21.03 Diagnoses process tanks and containers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-21.03.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained

D-21.03.02P	determine if NDT or condition-based monitoring is required	NDT or condition-based monitoring is determined to be required according to results of inspection
D-21.03.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-21.03.04P	perform **inspection** of **process tanks, containers** and **components** for defects	**inspection** of **process tanks, containers** and **components** is performed to determine **next steps**
D-21.03.05P	determine root causes of failure	root causes of failure of **process tanks and containers** are determined
D-21.03.06P	remove, reinstall or replace safety guards and **safety devices**	safety guards and **safety devices** are removed, reinstalled or replaced according to site and manufacturers' specifications, and regulations
D-21.03.07P	detect and assess faulty or damaged equipment	faulty or damaged equipment is detected and assessed to determine **repair** or replacement
D-21.03.08P	determine type of **repair** required	type of **repair** required is determined according to site inspection and analysis results

Range of Variables (include, but not limited to)

inspection: sensory inspection, gauge monitoring, gas detection monitoring, verifying limit controls, verifying for leaks

process tanks and containers: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

components: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, walkways, ladders, steps/staircases, access panels/doors

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

safety devices: keyed switches, lockouts, physical guards, pressure sensing, overflow sensors, proximity sensors, pressure relief valves

repair: patching, overlay, re-coating piping, welding/soldering, cleaning, threading

Knowledge

Reference Code	Learning Outcomes and Objectives
D-21.03.01L	demonstrate knowledge of **process tanks and containers**, and their **components**, characteristics, applications and operation
a.	identify **process tanks and containers** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **process tanks and containers** and their **components**
c.	interpret information about **process tanks and containers** and their **components** found in drawings and specifications
D-21.03.02L	demonstrate knowledge of procedures to diagnose **process tanks and containers** and their **components**
a.	identify tools and equipment to diagnose **process tanks and containers** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **process tanks and containers** and their **components**
c.	describe procedures to diagnose **process tanks and containers** and their **components**
d.	identify factors to consider when determining if **process tanks and containers** and their **components** need to be repaired or replaced
e	identify basic electrical principles and describe their associated procedures
D-21.03.03L	demonstrate knowledge of additional training and certification to install **process tanks and containers** and their **components**
a.	identify additional training and certification to install **process tanks and containers** and their **components**
D-21.03.04L	demonstrate knowledge of regulatory requirements to diagnose **process tanks and containers** and their **components**
a.	identify codes, standards and regulations to diagnose **process tanks and containers** and their **components**
D-21.03.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection

Range of Variables (include, but not limited to)

process tanks and containers: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

components: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, walkways, ladders, steps/staircases, access panels/doors

D-21.04 Diagnoses process piping

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-21.04.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
D-21.04.02P	determine if NDT or **condition-based monitoring method** is required	NDT or **condition-based monitoring method** is determined to be required according to results of **inspection**
D-21.04.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-21.04.04P	perform inspection of **process piping** and components for defects	inspection of **process piping** and components is performed to determine next steps
D-21.04.05P	determine root cause of failure	root cause of failure of **process piping** is determined
D-21.04.06P	assess and detect faulty or damaged equipment	faulty or damaged equipment is assessed and detected to determine **next steps**
D-21.04.07P	determine type of **repair** required	type of **repair** required is determined according to inspection and analysis results

Range of Variables (include, but not limited to)

condition-based monitoring methods: vibration monitoring, thermography, ultrasonic, pressure test

inspection: sensory inspection, gauge monitoring, gas detection monitoring, verifying limit controls, verifying for leaks

process piping: ABS, HDPE, PVC, stainless, composite, carbon steel, copper

components: fittings, valves, strainers, gaskets, connectors, fasteners, flanges, expansion joints, backflow preventer, electrical

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

repair: patching, overlay, re-coating piping, welding/soldering, cleaning, threading

Knowledge

Reference Code	Learning Outcomes and Objectives
D-21.04.01L	demonstrate knowledge of **process piping**, and their **components**, characteristics, applications and operation
a.	identify **process piping** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **process piping** and their **components**
c.	interpret information about **process piping** and their **components** found in drawings and specifications
D-21.04.02L	demonstrate knowledge of procedures to diagnose **process piping** and their **components**
a.	identify tools and equipment to diagnose **process piping** and their **components**, and describe their procedures for use
b.	identify **hazards** and describe safe work practices to diagnose **process piping** and their **components**
c.	describe procedures to diagnose **process piping** and their **components**
d.	identify factors to consider when determining if **process piping** needs to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures
D-21.04.03L	demonstrate knowledge of additional training and certification to diagnose **process piping** and their **components**
a.	identify additional training and certification to diagnose **process piping** and their **components**
D-21.04.04L	demonstrate knowledge of regulatory requirements to diagnose **process piping** and their **components**
a.	identify codes, standards and regulations to diagnose **process piping** and their **components**
D-21.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **process piping** and their **components**

Range of Variables (include, but not limited to)

process piping: ABS, HDPE, PVC, stainless, composite, carbon steel, copper

components: fittings, valves, strainers, gaskets, connectors, fasteners, flanges, expansion joints, backflow preventer, electrical

hazards: residual materials, pressure, extreme temperature in pipes (e.g., below freezing, above boiling), weight, acidic (caustic/corrosive), poisonous substances, flammable, explosive, oxygen, incompatibility of materials, pinch points, radiation, pipe composition

D-21.05 Maintains process tanks and containers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-21.05.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-21.05.02P	perform inspection of **process tanks and containers** and their **components**	inspection is performed to locate **defects**
D-21.05.03P	verify maintenance requirements	maintenance requirements are verified according to inspection, equipment history, and site and manufacturers' specifications
D-21.05.04P	clean and replace filters, breathers and strainers	filters, breathers and strainers are cleaned and replaced according to indicators and manufacturers' specifications
D-21.05.05P	check temperatures, pressures, vacuum and flow rates	temperatures, pressures, vacuum and flow rates are checked according to process requirements
D-21.05.06P	verify operation of valves	operation of valves is verified for proper function and position
D-21.05.07P	adjust process tank and container **components**	process tank and container **components** are adjusted according to process requirements

Reference Code	Performance Criteria	Evidence of Attainment
D-21.05.08P	change liners	liners are changed according to site and manufacturers' specifications
D-21.05.09P	clear ventilation systems	ventilation systems are cleared of blockages and restrictions

Range of Variables (include, but not limited to)

process tanks and containers: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

defects: leaks, wear, corrosion, erosion

components: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, walkways, ladders, steps/staircases, access panels/doors

Knowledge

Reference Code	Learning Outcomes and Objectives
D-21.05.01L	demonstrate knowledge of **process tanks and containers**, and their **components**, characteristics, applications and operation
a.	identify **process tanks and containers** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **process tanks and containers** and their **components**
c.	interpret information about **process tanks and containers** and their **components** found in drawings and specifications
D-21.05.02L	demonstrate knowledge of procedures to maintain **process tanks and containers** and their **components**
a.	identify tools and equipment to maintain **process tanks and containers** and their **components**, and describe their procedures for use
b.	identify **hazards** and describe safe work practices to maintain **process tanks and containers** and their **components**
c.	describe procedures to maintain **process tanks and containers** and their **components**
d.	identify factors to consider when determining if **process tanks and containers** and their **components** need to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures
D-21.05.03L	demonstrate knowledge of regulatory requirements to maintain **process tanks and containers** and their **components**
a.	identify codes, standards and regulations to maintain **process tanks and containers** and their **components**

Reference Code	Learning Outcomes and Objectives
D-21.05.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **process tanks and containers** and their **components**

Range of Variables (include, but not limited to)

process tanks and containers: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

components: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, walkways, ladders, steps/staircases, access panels/doors

hazards: residual materials, pressure, extreme temperature in pipes (e.g., below freezing, above boiling), weight, acidic (e.g., caustic, corrosive), poisonous substances, flammable, explosive, oxygen, incompatibility of materials, pinch points, radiation, pipe composition

D-21.06 Maintains process piping

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-21.06.01P	perform inspection of **process piping** and **components**	inspection is performed to locate **defects**
D-21.06.02P	verify maintenance requirements	maintenance requirements are verified according to inspection, equipment history, and site and manufacturers' specifications
D-21.06.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-21.06.04P	check **supports**	**supports** are checked to ensure pipes are supported according to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-21.06.05P	clean or replace breathers and strainers	breathers and strainers are cleaned or replaced according to process requirements, and site and manufacturers' specifications
D-21.06.06P	check temperatures, pressures, vacuum and flow rates	temperatures, pressures, vacuum and flow rates are checked according to process requirements
D-21.06.07P	verify operation of process piping **components**	operation of process piping **components** is verified according to process requirements
D-21.06.08P	lubricate process piping **components**	process piping **components** are lubricated according to site and manufactures' specifications
D-21.06.09P	adjust process piping **components**	process piping **components** are adjusted according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

process piping: ABS, HDPE, PVC, stainless, composite, carbon steel, copper

components: fittings, valves, strainers, gaskets, connectors, fasteners, flanges, expansion joints, backflow preventer, electrical

defects: leaks, wear, corrosion, erosion

supports: stands, hangers, brackets

Knowledge

Reference Code	Learning Outcomes and Objectives
D-21.06.01L	demonstrate knowledge of **process piping**, and their **components**, characteristics, applications and operation
a.	identify **process piping** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **process piping** and their **components**
c.	interpret information about **process piping** and their **components** found in drawings and specifications

Reference Code	Learning Outcomes and Objectives
D-21.06.02L	demonstrate knowledge of procedures to maintain **process piping** and their **components**
a.	identify tools and equipment to maintain **process piping** and their **components**, and describe their procedures for use
b.	identify **hazards** and describe safe work practices to maintain **process piping** and their **components**
c.	describe procedures to maintain **process piping** and their **components**
d.	identify factors to consider when determining if **process piping** or their **components** need to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures
D-21.06.03L	demonstrate knowledge additional training and certification to maintain **process piping** and their **components**
a.	identify additional training and certification to maintain **process piping** and their **components**
D-21.06.04L	demonstrate knowledge of regulatory requirements to maintain **process piping** and their **components**
a.	identify codes, standards and regulations to maintain **process piping** and their **components**
D-21.06.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **process piping** and their **components**

Range of Variables (include, but not limited to)

process piping: ABS, HDPE, PVC, stainless, composite, carbon steel, copper

components: fittings, valves, strainers, gaskets, connectors, fasteners, flanges, expansion joints, backflow preventer, electrical

hazards: residual materials, pressure, extreme temperature in pipes (e.g., below freezing, above boiling), weight, acidic (e.g., caustic, corrosive), poisonous substances, flammable, explosive, oxygen, incompatibility of materials, pinch points, radiation, pipe composition

D-21.07 Repairs process tanks and containers

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-21.07.01P	access **process tanks and containers**	**process tanks and containers** are accessed by removing components
D-21.07.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-21.07.03P	prepare **process tanks and containers**	**process tanks and containers** are prepared according to repair required using approved **methods**
D-21.07.04P	repair leaks	leaks are repaired using **methods**
D-21.07.05P	clean **process tanks and containers**	**process tanks and containers** are cleaned to prevent flow restrictions
D-21.07.06P	replace faulty **components** and auxiliary equipment	faulty **components** and auxiliary equipment are replaced according to manufacturers' specifications and inspection reports
D-21.07.07P	align **components**	**components** are aligned according to site and manufacturers' specifications
D-21.07.08P	reinstall machine guarding and safety devices	machine guarding and safety devices are reinstalled according to site and manufacturers' specifications, and regulations
D-21.07.09P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

process tanks and containers: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

methods (to prepare process tanks and containers): filing, sandblasting, buffing, grinding, cleaning, SOP

methods (to repair leaks): replacing gaskets, tightening threads, torquing fasteners, adjusting packing glands, patching tanks and containers, welding

components: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, walkways, ladders, steps/staircases, access panels/doors

Knowledge

Reference Code	Learning Outcomes and Objectives
D-21.07.01L	demonstrate knowledge of **process tanks and containers**, and their **components**, characteristics, applications and operation
a.	identify **process tanks and containers** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **process tanks and containers** and their **components**
c.	interpret information about **process tanks and containers** and their **components** found in drawings and specifications
D-21.07.02L	demonstrate knowledge of procedures to repair **process tanks and containers** and their **components**
a.	identify tools and equipment to repair **process tanks and containers** and their **components**, and describe their procedures for use
b.	identify **hazards** and describe safe work practices to repair **process tanks and containers** and their **components**
c.	describe procedures to repair **process tanks and containers** and their **components**
d.	identify factors to consider when determining if **process tanks and containers** and their **components** need to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures
D-21.07.03L	demonstrate knowledge of additional training and certification to repair **process tanks and containers** and their **components**
a.	identify additional training and certification to repair **process tanks and containers** and their **components**
D-21.07.04L	demonstrate knowledge of regulatory requirements to repair **process tanks and containers** and their **components**
a.	identify codes, standards and regulations to repair **process tanks and containers** and their **components**

D-21.07.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **process tanks and containers** and their **components**

Range of Variables (include, but not limited to)

process tanks and containers: bins, hoppers, receivers, thickeners, reservoirs, storage tanks

components: agitators, impellers, scrapers, mixers, spargers, level indicators, skimmers, valves, walkways, ladders, steps/staircases, access panels/doors

hazards: residual materials, pressure, extreme temperature in pipes (e.g., below freezing, above boiling), weight, acidic (e.g., caustic, corrosive), poisonous substances, flammable, explosive, oxygen, incompatibility of materials, pinch points, radiation, pipe composition

D-21.08 Repairs process piping

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-21.08.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-21.08.02P	prepare **process piping**	**process piping** is prepared according to repair or replacement required using approved **methods**
D-21.08.03P	repair or replace **supports**	**supports** are repaired or replaced according to manufacturers' specifications and inspection reports
D-21.08.04P	repair leaks	leaks are repaired using **methods**
D-21.08.05P	clean **process piping**	**process piping** is cleaned to prevent flow restrictions
D-21.08.06P	replace faulty **components** and auxiliary equipment	faulty **components** and auxiliary equipment are replaced according to manufacturers' specifications and inspection reports

Reference Code	Performance Criteria	Evidence of Attainment
D-21.08.07P	align **components**	**components** are aligned according to manufacturers' specifications

Range of Variables (include, but not limited to)

process piping: ABS, HDPE, PVC, stainless, composite, carbon steel, copper

methods (to prepare process piping): cleaning, grinding, sandblasting and buffing, steaming, SOP

supports: stands, hangers, brackets

methods (to repair leaks): replacing gaskets, tightening threads, torquing fasteners, adjusting packing glands, patching process piping and components, welding

components: fittings, valves, strainers, gaskets, connectors, fasteners, flanges, expansion joints, electrical

Knowledge

Reference Code	Learning Outcomes and Objectives
D-21.08.01L	demonstrate knowledge of **process piping**, and their **components**, characteristics, applications and operation
a.	identify **process piping** and their **components**, and describe their characteristics and applications
b.	describe operating principles of **process piping** and their **components**
c.	interpret information about **process piping** and their **components** found in drawings and specifications
D-21.08.02L	demonstrate knowledge of procedures to repair **process piping** and their **components**
a.	identify tools and equipment to repair **process piping** and their **components**, and describe their procedures for use
b.	identify **hazards** and describe safe work practices to repair **process piping** and their **components**
c.	describe procedures to repair **process piping** and their **components**
d.	identify factors to consider when determining if **process piping** and their **components** need to be repaired or replaced
e.	identify basic electrical principles and describe their associated procedures
D-21.08.03L	demonstrate knowledge of additional training and certification to repair **process piping** and their **components**
a.	identify additional training and certification to repair **process piping** and their **components**

Reference Code	Learning Outcomes and Objectives
D-21.08.04L	demonstrate knowledge of regulatory requirements to repair **process piping** and their **components**
a.	identify codes, standards and regulations to repair **process piping** and their **components**
D-21.08.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **process piping** and their **components**

Range of Variables (include, but not limited to)

process piping: ABS, HDPE, PVC, stainless, composite, carbon steel, copper

components: fittings, valves, strainers, gaskets, connectors, fasteners, flanges, expansion joints, electrical

hazards: residual materials, pressure, extreme temperature in pipes (e.g., below freezing, above boiling), weight, acidic (e.g., caustic, corrosive), poisonous substances, flammable, explosive, oxygen, incompatibility of materials, pinch points, radiation, pipe composition

Task D-22 Services conveying systems

Task Descriptor

Conveying systems are to transfer products safely and efficiently. Servicing includes installing, diagnosing, maintaining and repairing of conveying systems.

D-22.01 Installs conveying systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-22.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations

Reference Code	Performance Criteria	Evidence of Attainment
D-22.01.02P	determine location and elevation for installation	location and elevation for installation are determined according to site and manufacturers' specifications, and engineered drawings
D-22.01.03P	prepare foundation	foundation is prepared according to site and manufacturers' specifications, and engineered drawings
D-22.01.04P	prepare base or mounting brackets	base or mounting brackets are prepared according to site and manufacturers' specifications, and engineered drawings
D-22.01.05P	assemble **conveying system**	**conveying system** is assembled according to site and manufacturers' specifications, and engineered drawings
D-22.01.06P	install conveying system **components**	conveying system **components** are installed according to site and manufacturers' specifications, and engineered drawings
D-22.01.07P	position **conveying system** in place	**conveying system** is positioned in place using rigging, hoisting/lifting and moving equipment according to site and manufacturers' specifications, and engineered drawings
D-22.01.08P	align, level and secure **conveying system**	**conveying system** is aligned, levelled and secured according to site and manufacturers' specifications, and engineered drawings
D-22.01.09P	grout **conveying system**	**conveying system** is grouted to distribute load and minimize vibration
D-22.01.10P	set clearances	clearances are set according to site and manufacturers' specifications, and engineered drawings
D-22.01.11P	check direction of rotation	direction of rotation is checked according to conveying requirements

Reference Code	Performance Criteria	Evidence of Attainment
D-22.01.12P	connect in-feed and discharge assemblies	in-feed and discharge assemblies are connected according to site and manufacturers' specifications, and engineered drawings
D-22.01.13P	connect belt and chain conveyors	belt and chain conveyors are connected using **splicing techniques**
D-22.01.14P	track belts	belts are tracked and operate according to site and manufacturers' specifications, engineered drawings and in-field requirements
D-22.01.15P	connect and align prime mover	prime mover is connected and aligned
D-22.01.16P	install **sensory devices**	**sensory devices** are installed according to according to site and manufacturers' specifications, and engineered drawings
D-22.01.17P	install **safety devices**	**safety devices** are installed according to site and manufacturers' specifications, engineered drawings and regulations
D-22.01.18P	energize equipment	equipment is energized and started up according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

conveying systems: pneumatic, belt, rollers, chain, screw, bucket, flume/water

components: bearings, couplings, pulleys, rollers, gear reduction units, take-ups, scrapers, chutes, bins, grizzly bars, rotary feeders, screens, tube feeders, anti-runaway device, connecting links, rivets, locking clips, pins and wires, air cannon, limit switches, magnets, sheaves, sprockets, chains, belts, belting, filters, skirting

splicing techniques: vulcanizing; cold splicing; mechanical; plastic welding; installing connecting links, rivets, locking clips, pins and wires

sensory devices: motion detectors, depth sensors, metal detectors, belt tear alarms, x-ray devices, air cannon alarms, weight scales

safety devices: physical guards, emergency stops (E-stops), electronic eyes, handrails, lockouts, start and stop alarms, backstops

Knowledge

Reference Code	Learning Outcomes and Objectives
D-22.01.01L	demonstrate knowledge of **conveying systems**, their **components**, characteristics, applications and operation
a.	identify **conveying systems** and their **components** and **accessories**, and describe their characteristics and applications
b.	describe operating principles of **conveying systems** and their **components** and **accessories**
c.	interpret information about **conveying systems** and their **components** and **accessories** found in drawings and specifications
D-22.01.02L	demonstrate knowledge of procedures to install **conveying systems** and their **components**
a.	identify tools and equipment to install **conveying systems** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to install **conveying systems** and their **components**
c.	describe procedures to install **conveying systems** and their **components**
d.	identify factors to consider and required calculations to determine **conveying system** requirements
e.	describe splicing procedures on **conveying systems**
f.	identify basic electrical principles and describe their associated procedures
D-22.01.03L	demonstrate knowledge of additional training and certification to install **conveying systems** and their **components**
a.	identify additional training and certification to install **conveying systems** and their **components**
D-22.01.04L	demonstrate knowledge of regulatory requirements to install **conveying systems** and their **components**
a.	identify codes, standards and regulations to install **conveying systems** and their **components**
D-22.01.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **conveying systems** and their **components**

Range of Variables (include, but not limited to)

conveying systems: pneumatic, belt, rollers, chain, screw, bucket, flume/water

components: bearings, couplings, pulleys, rollers, gear reduction units, take-ups, scrapers, chutes, bins, grizzly bars, rotary feeders, screens, tube feeders, anti-runaway device, connecting links, rivets, locking clips, pins and wires, air cannon, limit switches, magnets, sheaves, sprockets, chains, belts, belting, filters, skirting

accessories: dust suppressants, magnetic belts, pulsating devices, scrapers, cleaners, spray wash systems, guides, training idlers

D-22.02 Diagnoses conveying systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-22.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
D-22.02.02P	perform **sensory inspection** of **components**	**sensory inspection** of **components** is performed to identify wear and damage
D-22.02.03P	inspect **filters**	**filters** are inspected to identify blockages, wear and damage
D-22.02.04P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
D-22.02.05P	perform condition-based monitoring routine procedures	condition-based monitoring routine procedures are performed to detect defects not identified through **sensory inspection**
D-22.02.06P	determine type of repair required on **components**	type of repair required on **components** and **next steps** are determined according to inspection, task, manufacturers' specifications and engineered drawings
D-22.02.07P	determine root cause of failure	root cause of failure of **conveying system** is determined

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

components: bearings, couplings, pulleys, rollers, gear reduction units, take-ups, scrapers, chutes, bins, grizzly bars, rotary feeders, screens, tube feeders, anti-runaway device, connecting links, rivets, locking clips, pins and wires, air cannon, limit switches, magnets, sheaves, sprockets, chains, belts, belting, filters, skirting

filters: cyclones, bag shakers, screens, precipitators

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

conveying systems: pneumatic, belt, rollers, chain, screw, bucket, flume/water

Knowledge

Reference Code	Learning Outcomes and Objectives
D-22.02.01L	demonstrate knowledge of **conveying systems**, their **components** and **accessories**, characteristics, applications and operation
a.	identify **conveying systems** and their **components** and **accessories**, and describe their characteristics and applications
b.	describe operating principles of **conveying systems** and their **components** and **accessories**
c.	interpret information about **conveying systems** and their **components** and **accessories** found in drawings and specifications
D-22.02.02L	demonstrate knowledge of procedures to diagnose **conveying systems** and their **components**
a.	identify tools and equipment to diagnose **conveying systems** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to diagnose **conveying systems** and their **components**
c.	describe procedures to inspect **conveying systems** and their **components**
d.	describe procedures to diagnose **conveying systems** and their **components**
e.	identify factors to consider when determining if **conveying systems** need to be repaired or replaced
f.	identify factors to consider and required calculations to determine **conveying system** requirements
g.	describe splicing procedures on **conveying systems**
h.	identify basic electrical principles and describe their associated procedures

Range of Variables (include, but not limited to)

conveying systems: pneumatic, belt, rollers, chain, screw, bucket, flume/water

components: bearings, couplings, pulleys, rollers, gear reduction units, take-ups, scrapers, chutes, bins, grizzly bars, rotary feeders, screens, tube feeders, anti-runaway device, connecting links, rivets, locking clips, pins and wires, air cannon, limit switches, magnets, sheaves, sprockets, chains, belts, belting, filters, skirting

accessories: dust suppressants, magnetic belts, pulsating devices, scrapers, cleaners, spray wash systems, guides, training idlers

D-22.03 Maintains conveying systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-22.03.01P	perform **sensory inspection**	**sensory inspection** is performed to locate damage and defects
D-22.03.02P	select and use tools and equipment	tools and equipment are used according to task, specifications and regulations
D-22.03.03P	verify maintenance requirements	maintenance requirements are verified according to inspection, equipment history, and site and manufacturers' specifications
D-22.03.04P	check **conditions**	**conditions** are checked according to manufacturers' specifications
D-22.03.05P	verify **power transmission** alignment and correct	alignment of **power transmission** is verified and corrected, if outside of specifications
D-22.03.06P	check clearances	clearances are checked against manufacturers' specifications
D-22.03.07P	maintain **components**	**components** are maintained according to manufacturers' specifications
D-22.03.08P	maintain **power transmission**	**power transmission** is maintained by **methods** according to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-22.03.09P	adjust tracking of mechanical **conveying systems**	tracking of mechanical **conveying systems** is adjusted according to manufacturers' specifications and in-field requirements
D-22.03.10P	adjust conveying system **accessories**	conveying system **accessories** are adjusted according to manufacturers' specifications
D-22.03.11P	replace filters	filters are replaced according to indicators and manufacturers' specifications
D-22.03.12P	maintain safety device components and guards	safety device components and guards are maintained according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

sensory inspection: listening for excessive noise, smelling burnt or burning components, feeling for excessive vibration and heat, visually inspecting

conditions: temperature, vibration, lubrication, pressure, flow rates, RPM, feet per minute

power transmissions: couplings, sprockets and chains, sheaves and belts, hollow shaft gear boxes, hydraulic drive motors, electric motors (internal and external), fluid couplings

components: bearings, couplings, pulleys, rollers, gear reduction units, take-ups, scrapers, chutes, bins, grizzly bars, rotary feeders, screens, tube feeders, anti-runaway device, connecting links, rivets, locking clips, pins and wires, air cannon, limit switches, magnets, sheaves, sprockets, chains, belts, belting, filters, skirting

methods: cleaning, lubricating, adjusting, checking fluid levels, tensioning, replacing

conveying systems: pneumatic, belt, rollers, chain, screw, bucket, flume/water

accessories: dust suppressants, magnetic belts, pulsating devices, scrapers, cleaners, spray wash systems, guides, training idlers

Knowledge

Reference Code	Learning Outcomes and Objectives
D-22.03.01L	demonstrate knowledge of **conveying systems**, their **components** and **accessories**, characteristics, applications and operation
a.	identify **conveying systems** and their **components** and **accessories**, and describe their characteristics and applications
b.	describe operating principles of **conveying systems** and their **components** and **accessories**

Reference Code	Learning Outcomes and Objectives
c.	interpret information about **conveying systems** and their **components** and **accessories** found in drawings and specifications
D-22.03.02L	demonstrate knowledge of procedures to maintain **conveying systems** and their **components**
a.	identify tools and equipment to maintain **conveying systems** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to maintain **conveying systems** and their **components**
c.	describe procedures to maintain **conveying systems** and their **components**
d.	identify factors to consider and required calculations to determine **conveying system** requirements
e.	describe splicing procedures on **conveying systems**
f.	describe procedures to track a conveyor belt
g.	identify basic electrical principles and describe their associated procedures
D-22.03.03L	demonstrate knowledge of additional training and certification to maintain **conveying systems** and their **components**
a.	identify additional training and certification to maintain **conveying systems** and their **components**
D-22.03.04L	demonstrate knowledge of regulatory requirements to maintain **conveying systems** and their **components**
a.	identify codes, standards and regulations to maintain **conveying systems** and their **components**
D-22.03.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **conveying systems** and their **components**

Range of Variables (include, but not limited to)

conveying systems: pneumatic, belt, rollers, chain, screw, bucket, flume/water

components: bearings, couplings, pulleys, rollers, gear reduction units, take-ups, scrapers, chutes, bins, grizzly bars, rotary feeders, screens, tube feeders, anti-runaway device, connecting links, rivets, locking clips, pins and wires, air cannon, limit switches, magnets, sheaves, sprockets, chains, belts, belting, filters, skirting

accessories: dust suppressants, magnetic belts, pulsating devices, scrapers, cleaners, spray wash systems, guides, training idlers

D-22.04 Repairs conveying systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
D-22.04.01P	access **conveying systems**	**conveying systems** are accessed by removing **components** and guards
D-22.04.02P	select and use tools and equipment	tools and equipment are used according to task, specifications and regulations
D-22.04.03P	prepare **conveying system** for repair	**conveying system** is prepared according to repair required and SOP
D-22.04.04P	dismantle **conveying system**	**conveying system** is dismantled according to type of repair required
D-22.04.05P	size, replace and align **components**	**components** are sized, replaced and aligned according to site and manufacturers' specifications, and engineered drawings
D-22.04.06P	repair **power transmission**	**power transmission** is repaired according to manufacturers' specifications
D-22.04.07P	patch, shorten or replace conveying belt	conveying belt is patched, shortened or replaced according to operating requirements, and site and manufacturers' specifications
D-22.04.08P	verify rotation	rotation is verified prior to connecting coupling by performing bump test
D-22.04.09P	adjust tracking	tracking is adjusted according to in-field requirements, and site and manufacturers' specifications
D-22.04.10P	adjust and replace conveying system **accessories**	conveying system **accessories** are adjusted and replaced according to manufacturers' specifications

Reference Code	Performance Criteria	Evidence of Attainment
D-22.04.11P	replace filters	filters are replaced according to indicators and manufacturers' specifications
D-22.04.12P	adjust, reinstall or replace safety device components and guards	safety device components and guards are adjusted, reinstalled or replaced according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

conveying systems: pneumatic, belt, rollers, chain, screw, bucket, flume/water

components: bearings, couplings, pulleys, rollers, gear reduction units, take-ups, scrapers, chutes, bins, grizzly bars, rotary feeders, screens, tube feeders, anti-runaway device, connecting links, rivets, locking clips, pins and wires, air cannon, limit switches, magnets, sheaves, sprockets, chains, belts, belting, filters, skirting

power transmissions: couplings, sprockets and chains, sheaves and belts, hollow shaft gear boxes, hydraulic drive motors, electric motors (internal and external), fluid couplings

accessories: dust suppressants, magnetic belts, pulsating devices, scrapers, cleaners, spray wash systems, guides, training idlers

Knowledge

Reference Code	Learning Outcomes and Objectives
D-22.04.01L	demonstrate knowledge of **conveying systems**, their **components** and **accessories**, characteristics, applications and operation
a.	identify **conveying systems** and their **components** and **accessories**, and describe their characteristics and applications
b.	describe operating principles of **conveying systems** and their **components** and **accessories**
c.	interpret information about **conveying systems** and their **components** and **accessories** found in drawings and specifications
D-22.04.02L	demonstrate knowledge of procedures to repair **conveying systems** and their **components**
a.	identify tools and equipment to repair **conveying systems** and their **components**, and describe their procedures for use
b.	identify hazards and describe safe work practices to repair **conveying systems** and their **components**
c.	describe procedures to repair **conveying systems** and their **components**

Reference Code	Learning Outcomes and Objectives
d.	identify factors to consider when determining if **conveying system** needs to be repaired or replaced
e.	identify factors to consider and required calculations to determine **conveying system** requirements
f.	describe splicing procedures on **conveying systems**
g.	describe procedures to track conveyor belt
h.	identify basic electrical principles and describe their associated procedures
D-22.04.03L	demonstrate knowledge of additional training and certification to repair **conveying systems** and their **components**
a.	identify additional training and certification to repair **conveying systems** and their **components**
D-22.04.04L	demonstrate knowledge of regulatory requirements to repair **conveying systems** and their **components**
a.	identify codes, standards and regulations to repair **conveying systems** and their **components**
D-22.04.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle **conveying systems** and their **components**

Range of Variables (include, but not limited to)

conveying systems: pneumatic, belt, rollers, chain, screw, bucket, flume/water

components: bearings, couplings, pulleys, rollers, gear reduction units, take-ups, scrapers, chutes, bins, grizzly bars, rotary feeders, screens, tube feeders, anti-runaway device, connecting links, rivets, locking clips, pins and wires, air cannon, limit switches, magnets, sheaves, sprockets, chains, belts, belting, filters, skirting

accessories: dust suppressants, magnetic belts, pulsating devices, scrapers, cleaners, spray wash systems, guides, training idlers

Major Work Activity E—Services fluid power systems

Task E-23 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-23.01 Installs hydraulic systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
E-23.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
E-23.01.02P	select system **components**	system **components** are selected according to site specifications and engineered drawings
E-23.01.03P	select hydraulic fluids	hydraulic fluids are selected to meet system and environmental requirements, and manufacturers' specifications
E-23.01.04P	position and secure reservoirs for hydraulic systems	reservoirs for hydraulic systems are positioned and secured according to engineered drawings and regulations
E-23.01.05P	position, align and secure hydraulic **components**	hydraulic **components** are positioned, aligned and secured according to manufacturers' specifications and engineered drawings

Reference Code	Performance Criteria	Evidence of Attainment
E-23.01.06P	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 and field requirements
E-23.01.07P	install and calibrate **electromechanical components**	**electromechanical components** are installed and calibrated according to manufacturers' specifications, company policies, and jurisdictional regulations and limitations
E-23.01.08P	test system	system is tested by fine tuning fluid, valve and component pressure and flow operation according to manufacturers' specifications and regulations

Range of Variables (include, but not limited to)

components: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors, hydraulic fluids, gauges

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

Knowledge

Reference Code	Learning Outcomes and Objectives
E-23.01.01L	demonstrate knowledge of principles and applications of **fluid power**
a.	explain **principles and theories of fluid power**
E-23.01.02L	demonstrate knowledge of hydraulic system related calculations
a.	describe units of measure used in hydraulic systems
b.	identify formulas related to hydraulic systems and describe their applications
c.	describe calculations to select and install hydraulic systems and **components**
d.	perform hydraulic related calculations

Reference Code	Learning Outcomes and Objectives
E-23.01.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation
a.	identify symbols and abbreviations related to hydraulic systems found in engineered drawings and schematics
b.	describe hydraulic system engineered drawings and schematics and their applications
c.	interpret engineered drawings and schematics to determine operation of hydraulic systems
E-23.01.04L	demonstrate knowledge of hydraulic systems, their **components**, characteristics, applications and operation
a.	identify types of hydraulic systems and describe their applications and operating principles
b.	identify hydraulic system **components** and describe their purpose and operating principles
E-23.01.05L	demonstrate knowledge of **electromechanical components** found in hydraulic systems, their characteristics, applications and operation
a.	identify **electromechanical components** found in hydraulic systems
b.	describe purpose and operating principles of **electromechanical components** found in hydraulic systems
c.	describe testing and troubleshooting procedures for **electromechanical components** found in hydraulic systems
E-23.01.06L	demonstrate knowledge of procedures to install hydraulic systems and **components**
a.	identify tools and equipment to install hydraulic systems and **components**, and describe their applications and procedures
b.	identify hazards and describe **safe work practices** for hydraulic systems and **components**
c.	describe procedures to install hydraulic systems and **components**
E-23.01.07L	demonstrate knowledge of regulatory requirements to install hydraulic systems and **components**
a.	identify codes, standards and regulations to install hydraulic systems and **components**

Reference Code	Learning Outcomes and Objectives
E-23.01.08L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle hydraulic system **components**
b.	describe procedures for spill containment and capture
c.	describe benefits of energy-efficient hydraulic systems and **components**

Range of Variables (include, but not limited to)

fluid power: hydraulic, pneumatic, vacuum

principles and theories of fluid power: Pascal's law, Bernoulli's principle, cavitation, aeration

components: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors, hydraulic fluids, gauges

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

safe work practices: lock-out/tag-out (LOTO), zero-energy state, leak detection practices

E-23.02 Diagnoses hydraulic systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
E-23.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
E-23.02.02P	perform sensory inspection of hydraulic systems	sensory inspection of hydraulic systems is performed
E-23.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
E-23.02.04P	perform **condition-based monitoring** and analysis	**condition-based monitoring** and analysis are performed to detect defects and to determine **next steps**

Reference Code	Performance Criteria	Evidence of Attainment
E-23.02.05P	interpret specifications	specifications from technical manuals, engineered drawings and manufacturers' specifications are interpreted
E-23.02.06P	remove and replace **safety devices**	**safety devices** are removed and replaced according to site and manufacturers' specifications, and jurisdictional safety regulations
E-23.02.07P	assess and detect faulty or damaged **components**	faulty or damaged **components** are assessed and detected to determine repair or replacement
E-23.02.08P	perform root cause analysis	root cause analysis is performed to determine and correct cause of failure

Range of Variables (include, but not limited to)

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

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards, emergency stops (E-stops), travel-restrict systems

components: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors, gauges

Knowledge

Reference Code	Learning Outcomes and Objectives
E-23.02.01L	demonstrate knowledge of principles and applications of **fluid power**
a.	explain **principles and theories of fluid power**
E-23.02.02L	demonstrate knowledge of hydraulic system related calculations
a.	describe units of measure used in hydraulic systems
b.	identify formulas related to hydraulic systems and describe their applications
c.	describe calculations to diagnose hydraulic systems and **components**
d.	perform hydraulic related calculations

E-23.02.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation
a.	identify symbols and abbreviations related to hydraulic systems found in engineered drawings and schematics
b.	describe hydraulic system engineered drawings and schematics and their applications
c.	interpret engineered drawings and schematics to determine operation of hydraulic systems
E-23.02.04L	demonstrate knowledge of hydraulic systems, their **components**, characteristics, applications and operation
a.	identify types of hydraulic systems and describe their applications and operating principles
b.	identify hydraulic system **components** and describe their purpose and operating principles
E-23.02.05L	demonstrate knowledge of **electromechanical components** found in hydraulic systems, their characteristics, applications and operation
a.	identify electrical components found in hydraulic systems
b.	describe purpose and operating principles of electrical components found in hydraulic systems
c.	describe testing and troubleshooting procedures for **electromechanical components** found in hydraulic systems
E-23.02.06L	demonstrate knowledge of procedures to diagnose hydraulic systems and **components**
a.	identify tools and equipment to diagnose hydraulic systems and **components**, and describe their applications and procedures
b.	identify hazards and describe **safe work practices** for diagnosing hydraulic systems and **components**
c.	describe procedures to diagnose hydraulic systems and **components**
d.	identify factors to consider when determining if hydraulic system **components** need to be repaired or replaced
E-23.02.07L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle hydraulic system **components**
b.	describe procedures for spill containment and capture

Range of Variables (include, but not limited to)

fluid power: hydraulic, pneumatic, vacuum

principles and theories of fluid power: Pascal's law, Bernoulli's principle, cavitation, aeration

components: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors, gauges

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

safe work practices: LOTO, zero-energy state, leak detection practices, practices specific to diagnosing live equipment

E-23.03 Maintains hydraulic systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
E-23.03.01P	inspect and adjust hydraulic systems	hydraulic systems are inspected and adjusted according to specifications and maintenance schedule
E-23.03.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
E-23.03.03P	verify and adjust fluid levels	fluid levels are verified and adjusted according to site and manufacturers' specifications
E-23.03.04P	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-23.03.05P	check and change filters	filters are checked and changed according to site and manufacturers' specifications
E-23.03.06P	validate overall performance of hydraulic system	overall performance of hydraulic system is validated according to performance specifications

Reference Code	Performance Criteria	Evidence of Attainment
E-23.03.07P	clean hydraulic system and **components**	hydraulic system and **components** are cleaned according to site and manufacturers' specifications
E-23.03.08P	record maintenance results	maintenance results are recorded according to site specifications and regulations

Range of Variables (include, but not limited to)

components: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors, hydraulic fluids, gauges

Knowledge

Reference Code	Learning Outcomes and Objectives
E-23.03.01L	demonstrate knowledge of principles and applications of **fluid power**
a.	explain **principles and theories of fluid power**
E-23.03.02L	demonstrate knowledge of hydraulic system related calculations
a.	describe units of measure used in hydraulic systems
b.	identify formulas related to hydraulic systems and describe their applications
c.	describe calculations to maintain hydraulic systems and **components**
d.	perform hydraulic related calculations
E-23.03.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation
a.	identify symbols and abbreviations related to hydraulic systems found in engineered drawings and schematics
b.	describe hydraulic system engineered drawings and schematics and their applications
c.	interpret engineered drawings and schematics to determine operation of hydraulic systems
E-23.03.04L	demonstrate knowledge of hydraulic systems, their **components**, characteristics, applications and operation
a.	identify types of hydraulic systems and describe their applications and operating principles
b.	identify hydraulic system **components** and describe their purpose and operating principles

Reference Code	Learning Outcomes and Objectives
E-23.03.05L	demonstrate knowledge of **electromechanical components** found in hydraulic systems, their characteristics, applications and operation
a.	identify electrical components found in hydraulic systems
b.	describe purpose and operating principles of **electromechanical components** found in hydraulic systems
E-23.03.06L	demonstrate knowledge of **procedures to inspect and maintain** hydraulic systems and **components**
a.	identify tools and equipment to maintain hydraulic systems and **components**, and describe their applications and procedures
b.	identify hazards and describe **safe work practices** for hydraulic systems and **components**
c.	describe **procedures to inspect and maintain** hydraulic systems and components
d.	identify factors to consider when determining if hydraulic system **components** need to be repaired or replaced
E-23.03.07L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle hydraulic system **components**
b.	describe procedures for spill containment and capture

Range of Variables (include, but not limited to)

fluid power: hydraulic, pneumatic, vacuum

principles and theories of fluid power: Pascal's law, Bernoulli's principle, cavitation, aeration

components: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors, hydraulic fluids, gauges

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

procedures to inspect and maintain: check hoses, piping and tubing; check fluids (condition and level); check/change filters; determine operating parameters; adjust system pressure, temperature and flow; perform visual inspection

safe work practices: LOTO, zero-energy state, leak detection practices, practices specific to maintaining live equipment

E-23.04 Repairs hydraulic systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
E-23.04.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
E-23.04.02P	release pressure	pressure is released in a controlled fashion to ensure system is at zero-energy state and to avoid injury and equipment damage
E-23.04.03P	lock out and tag out **components**	**components** are mechanically locked out and tagged out, and are left in zero-energy state
E-23.04.04P	prevent contamination	contamination is prevented during repairs by ensuring clean **components** and working environment according to manufacturers' specifications
E-23.04.05P	repair and replace **components**	**components** are repaired and replaced according to manufacturers' specifications and engineered drawings
E-23.04.06P	remove and replace **component parts**	**component parts** are removed and replaced according to manufacturers' specifications and engineered drawings
E-23.04.07P	modify systems	systems are modified according to site and manufacturers' specifications, schematics and engineered drawings
E-23.04.08P	test system	system is tested by fine tuning fluid, valve and component pressure and flow operation according to manufacturers' specifications and regulations

Reference Code	Performance Criteria	Evidence of Attainment
E-23.04.09P	reinstall **safety devices**	**safety devices** are reinstalled according to site and manufacturers' specifications and regulations
E-23.04.10P	energize equipment	equipment is energized and started according to site and manufacturers' specifications, and returned to operation

Range of Variables (include, but not limited to)

components: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors, hydraulic fluids, gauges

component parts: seals, pistons, valve spools, gaskets, springs, solenoids (coils), o-rings

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards, emergency stops (E-stops), travel-restrict systems

Knowledge

Reference Code	Learning Outcomes and Objectives
E-23.04.01L	demonstrate knowledge of principles and applications of **fluid power**
a.	explain **principles and theories of fluid power**
E-23.04.02L	demonstrate knowledge of hydraulic system related calculations
a.	describe units of measure used in hydraulic systems
b.	identify formulas related to hydraulic systems and describe their applications
c.	describe calculations to maintain hydraulic systems and **components**
d.	perform hydraulic related calculations
E-23.04.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation
a.	identify symbols and abbreviations related to hydraulic systems found in engineered drawings and schematics
b.	describe hydraulic system engineered drawings and schematics and their applications
c.	interpret engineered drawings and schematics to determine operation of hydraulic systems

Reference Code	Learning Outcomes and Objectives
E-23.04.04L	demonstrate knowledge of hydraulic systems, their **components**, characteristics, applications and operation
a.	identify types of hydraulic systems and describe their applications and operating principles
b.	identify hydraulic system **components** and describe their purpose and operating principles
E-23.04.05L	demonstrate knowledge of **electromechanical components** found in hydraulic systems, their characteristics, applications and operation
a.	identify electrical components found in hydraulic systems
b.	describe purpose and operating principles of **electromechanical components** found in hydraulic systems
E-23.04.06L	demonstrate knowledge of procedures to repair hydraulic systems and **components**
a.	identify tools and equipment to repair hydraulic systems and **components**, and describe their applications and procedures
b.	identify hazards and describe **safe work practices** for hydraulic systems and **components**
c.	describe **procedures to repair** hydraulic systems and **components**
E-23.04.07L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle hydraulic system **components**
b.	describe procedures for spill containment and capture

Range of Variables (include, but not limited to)

fluid power: hydraulic, pneumatic, vacuum

principles and theories of fluid power: Pascal's law, Bernoulli's principle, cavitation, aeration

components: pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers, filters, accumulators, motors, fluid conductors, hydraulic fluids, gauges

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

safe work practices: LOTO, zero-energy state, leak detection practices

procedures to repair: replace hoses, piping and tubing; replace and replenish fluids; check/change filters; adjust system pressure, temperature and flow

Task E-24 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.

E-24.01 Installs pneumatic and vacuum systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
E-24.01.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
E-24.01.02P	select system **components**	system **components** are selected according to site specifications and engineered drawings
E-24.01.03P	position and secure receivers	receivers for pneumatic and vacuum systems are positioned and secured according to engineered drawings and regulations
E-24.01.04P	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
E-24.01.05P	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 and field requirements
E-24.01.06P	install and calibrate **electromechanical components**	**electromechanical components** are installed and calibrated according to manufacturers' specifications, company policies, and jurisdictional regulations and limitations

Reference Code	Performance Criteria	Evidence of Attainment
E-24.01.07P	test system	system is tested by fine tuning pressure and volumetrics according to manufacturers' specifications and regulations

Range of Variables (include, but not limited to)

components: piping, tubing, hoses, receivers, blowers, dryers, coolers, pumps, filter-regulator-lubricator (FRL), motors, actuators, valves, separators, compressors, gauges, safety valves, fittings

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

Knowledge

Reference Code	Learning Outcomes and Objectives
E-24.01.01L	demonstrate knowledge of principles and applications of **fluid power**
a.	explain **principles and theories of fluid power**
E-24.01.02L	demonstrate knowledge of pneumatic and vacuum system related calculations
a.	describe units of measure used in pneumatic and vacuum systems
b.	identify formulas related to pneumatic and vacuum systems and describe their applications
c.	describe calculations to select and install pneumatic and vacuum systems and **components**
d.	perform pneumatic and vacuum related calculations
E-24.01.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation
a.	identify symbols and abbreviations related to pneumatic and vacuum systems found in engineered drawings and schematics
b.	describe pneumatic and vacuum systems engineered drawings and schematics and their applications
c.	interpret engineered drawings and schematics to determine operation of pneumatic and vacuum systems

Reference Code	Learning Outcomes and Objectives
E-24.01.04L	demonstrate knowledge of pneumatic and vacuum systems, their **components**, characteristics, applications and operation
a.	identify types of pneumatic and vacuum systems and describe their applications and operating principles
b.	identify pneumatic and vacuum system **components** and describe their purpose and operating principles
E-24.01.05L	demonstrate knowledge of **electromechanical components** found in pneumatic and vacuum systems, their characteristics, applications and operation
a.	identify **electromechanical components** found in pneumatic and vacuum systems
b.	describe purpose and operating principles of **electromechanical components** found in pneumatic and vacuum systems
c.	describe testing and troubleshooting procedures for **electromechanical components** found in pneumatic and vacuum systems
E-24.01.06L	demonstrate knowledge of procedures to install pneumatic and vacuum systems and **components**
a.	identify tools and equipment to install pneumatic and vacuum systems and **components**, and describe their applications and procedures
b.	identify hazards and describe **safe work practices** for pneumatic and vacuum systems and **components**
c.	describe procedures to install pneumatic and vacuum systems and **components**
d.	describe **air treatment components** and methods in pneumatic systems
E-24.01.07L	demonstrate knowledge of regulatory requirements to install pneumatic and vacuum systems and **components**
a.	identify codes, standards and regulations to install pneumatic and vacuum systems and **components**
E-24.01.08L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle pneumatic and vacuum system **components**
b.	describe procedures for spill containment and capture
c.	describe benefits of energy-efficient pneumatic and vacuum systems and **components**

Range of Variables (include, but not limited to)

fluid power: pneumatic, vacuum

principles and theories of fluid power: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle, Ideal gas law

components: piping, tubing, hoses, receivers, blowers, dryers, coolers, pumps, FRL, motors, actuators, valves, separators, compressors, gauges, safety valves, fittings

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

safe work practices: LOTO, zero-energy state, leak detection practices

air treatment components: dryers, after-coolers, separators, filters, regulators

E-24.02 Diagnoses pneumatic and vacuum systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
E-24.02.01P	obtain description of problem and symptoms	description of problem and symptoms is obtained
E-24.02.02P	perform sensory inspection of pneumatic and vacuum systems	sensory inspection of pneumatic and vacuum systems is performed
E-24.02.03P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
E-24.02.04P	perform **condition-based monitoring methods** and analysis	**condition-based monitoring methods** and analysis are performed to determine **next steps**
E-24.02.05P	interpret specifications	specifications from technical manuals and drawings, and manufacturers' specifications are interpreted
E-24.02.06P	remove and replace **safety devices**	**safety devices** are removed and replaced according to site and manufacturers' specifications, and regulations

Reference Code	Performance Criteria	Evidence of Attainment
E-24.02.07P	assess and detect faulty or damaged **components**	faulty or damaged **components** are assessed and detected to determine repair or replacement
E-24.02.08P	perform root cause analysis	root cause analysis is performed to determine and correct cause of failure

Range of Variables (include, but not limited to)

condition-based monitoring methods: vibration monitoring, fluid analysis, thermography, ultrasonic, tribology, pressure differential

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

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards, emergency stops (E-stops), travel-restrict systems, explosion-proof membranes, vacuum breakers

components: piping, tubing, hoses, receivers, blowers, dryers, coolers, pumps, FRL, motors, actuators, valves, separators, compressors, solenoids (coils), gauges, safety valves

Knowledge

Reference Code	Learning Outcomes and Objectives
E-24.02.01L	demonstrate knowledge of principles and applications of **fluid power**
a.	explain **principles and theories of fluid power**
E-24.02.02L	demonstrate knowledge of pneumatic and vacuum system related calculations
a.	describe units of measure used in pneumatic and vacuum systems
b.	identify formulas related to pneumatic and vacuum systems and describe their applications
c.	describe calculations to select and install pneumatic and vacuum systems and **components**
d.	perform pneumatic and vacuum related calculations
E-24.02.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation
a.	identify symbols and abbreviations related to pneumatic and vacuum systems found in engineered drawings and schematics
b.	describe pneumatic and vacuum systems engineered drawings and schematics and their applications
c.	interpret engineered drawings and schematics to determine operation of pneumatic and vacuum systems

Reference Code	Learning Outcomes and Objectives
E-24.02.04L	demonstrate knowledge of pneumatic and vacuum systems, their **components**, characteristics, applications and operation
a.	identify types of pneumatic and vacuum systems and describe their applications and operating principles
b.	identify pneumatic and vacuum system **components** and describe their purpose and operating principles
E-24.02.05L	demonstrate knowledge of **electromechanical components** found in pneumatic and vacuum systems, their characteristics, applications and operation
a.	identify **electromechanical components** found in pneumatic and vacuum systems
b.	describe purpose and operating principles of **electromechanical components** found in pneumatic and vacuum systems
c.	describe testing and troubleshooting procedures for **electromechanical components** found in pneumatic and vacuum systems
E-24.02.06L	demonstrate knowledge of procedures to diagnose pneumatic and vacuum systems and **components**
a.	identify tools and equipment to diagnose pneumatic and vacuum systems and **components**, and describe their applications and procedures
b.	identify hazards and describe **safe work practices** for pneumatic and vacuum systems and **components**
c.	describe procedures to diagnose pneumatic and vacuum systems and **components**
d.	describe methods of **air treatment** in pneumatic systems
e.	describe procedures to inspect pneumatic and vacuum systems and components
f.	identify factors to consider when determining if pneumatic and vacuum system components need to be repaired or replaced
E-24.02.07L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle pneumatic and vacuum system **components**
b.	describe procedures for spill containment and capture

Range of Variables (include, but not limited to)

fluid power: pneumatic, vacuum
principles and theories of fluid power: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle, Ideal gas law
components: piping, tubing, hoses, receivers, blowers, dryers, coolers, pumps, FRL, motors, actuators, valves, separators, compressors, solenoids (coils), gauges, safety valves
electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors
safe work practices: LOTO, zero-energy state, leak detection practices, practices specific to diagnosing live equipment
air treatment: dryers, after-coolers, separators, filters, regulators

E-24.03 Maintains pneumatic and vacuum systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
E-24.03.01P	inspect and adjust pneumatic and vacuum systems	pneumatic and vacuum systems are inspected and adjusted according to specifications and maintenance schedule
E-24.03.02P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
E-24.03.03P	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-24.03.04P	check, calibrate and change gauges, filters, separators and dryers	gauges, filters, separators and dryers are checked, calibrated and changed according to site and manufacturers' specifications

E-24.03.05P	validate overall performance of pneumatic and vacuum system	overall performance of pneumatic and vacuum system is validated according to performance specifications
E-24.03.06P	clean pneumatic and vacuum systems and **components**	pneumatic and vacuum systems and **components** are cleaned according to site and manufacturers' specifications
E-24.03.07P	record maintenance results	maintenance results are recorded according to site specifications and regulations

Range of Variables (include, but not limited to)

components: piping, tubing, hoses, receivers, blowers, dryers, coolers, pumps, FRL, motors, actuators, valves, separators, compressors, solenoids (coils), gauges, safety valves, fittings

Knowledge

Reference Code	Learning Outcomes and Objectives
E-24.03.01L	demonstrate knowledge of principles and applications of **fluid power**
a.	explain **principles and theories of fluid power**
E-24.03.02L	demonstrate knowledge of pneumatic and vacuum system related calculations
a.	describe units of measure used in pneumatic and vacuum systems
b.	identify formulas related to pneumatic and vacuum systems and describe their applications
c.	describe calculations to select and install pneumatic and vacuum systems and **components**
d.	perform pneumatic and vacuum related calculations
E-24.03.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation
a.	identify symbols and abbreviations related to pneumatic and vacuum systems found in engineered drawings and schematics
b.	describe pneumatic and vacuum systems engineered drawings and schematics and their applications
c.	interpret engineered drawings and schematics to determine operation of pneumatic and vacuum systems

Reference Code	Learning Outcomes and Objectives
E-24.03.04L	demonstrate knowledge of pneumatic and vacuum systems, their **components**, characteristics, applications and operation
a.	identify types of pneumatic and vacuum systems and describe their applications and operating principles
b.	identify pneumatic and vacuum system **components** and describe their purpose and operating principles
E-24.03.05L	demonstrate knowledge of **electromechanical components** found in pneumatic and vacuum systems, their characteristics, applications and operation
a.	identify **electromechanical components** found in pneumatic and vacuum systems
b.	describe purpose and operating principles of **electromechanical components** found in pneumatic and vacuum systems
c.	describe testing and troubleshooting procedures for **electromechanical components** found in pneumatic and vacuum systems
E-24.03.06L	demonstrate knowledge of **procedures to inspect and maintain** pneumatic and vacuum systems and **components**
a.	identify tools and equipment to maintain pneumatic and vacuum systems and **components**, and describe their applications and procedures
b.	identify hazards and describe **safe work practices** for pneumatic and vacuum systems and **components**
c.	describe methods of **air treatment** in pneumatic systems
d.	describe **procedures to inspect and maintain** pneumatic and vacuum systems and components
e.	identify factors to consider when determining if pneumatic and vacuum system **components** need to be repaired or replaced
E-24.03.07L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle pneumatic and vacuum system **components**
b.	describe procedures for spill containment and capture

Range of Variables (include, but not limited to)

fluid power: pneumatic, vacuum

principles and theories of fluid power: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle, Ideal gas law

components: piping, tubing, hoses, receivers, blowers, dryers, coolers, pumps, FRL, motors, actuators, valves, separators, compressors, solenoids (coils), gauges, safety valves, fittings

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

safe work practices: LOTO, zero-energy state, leak detection practices, practices specific to maintaining live equipment

air treatment: dryers, after-coolers, separators, filters, regulators

procedures to inspect and maintain: check hoses, piping and tubing; check lubricating methods; check/change filters; perform air audit; determine operating parameters; adjust system pressure, temperature and flow; perform visual inspection

E-24.04 Repairs pneumatic and vacuum systems

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
E-24.04.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
E-24.04.02P	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-24.04.03P	lock out and tag out **components**	**components** are mechanically locked out and tagged out, and are left in zero-energy state
E-24.04.04P	prevent contamination	contamination is prevented during repairs by ensuring clean **components** and working environment according to manufacturers' specifications

E-24.04.05P	repair and replace **components**	**components** are repaired and replaced according to manufacturers' specifications and engineered drawings
E-24.04.06P	remove and replace **component parts**	**component parts** are removed and replaced according to manufacturers' specifications and engineered drawings
E-24.04.07P	modify systems	systems are modified according to schematics, site and manufacturers' specifications and engineered drawings
E-24.04.08P	test system	system is tested by fine tuning pressure and volumetrics according to manufacturers' specifications and regulations
E-24.04.09P	reinstall **safety devices**	**safety devices** are reinstalled according to site and manufacturers' specifications and regulations
E-24.04.10P	energize equipment	equipment is energized and started according to site and manufacturers' specifications, and returned to operation

Range of Variables (include, but not limited to)

components: piping, tubing, hoses, receivers, blowers, dryers, coolers, pumps, FRL, motors, actuators, valves, separators, compressors, solenoids (coils), gauges, safety valves, fittings

component parts: seals, pistons, fittings, strainers, filters, valves, springs, o-rings, spools, gaskets

safety devices: light curtains, pressure-sensitive matting, keyed switches, lockouts, physical guards, emergency stops (E-stops), travel-restrict systems, explosion-proof membranes, vacuum breakers

Knowledge

Reference Code	Learning Outcomes and Objectives
E-24.04.01L	demonstrate knowledge of principles and applications of **fluid power**
a.	explain **principles and theories of fluid power**
E-24.04.02L	demonstrate knowledge of pneumatic and vacuum system related calculations
a.	describe units of measure used in pneumatic and vacuum systems
b.	identify formulas related to pneumatic and vacuum systems and describe their applications
c.	describe calculations to select and install pneumatic and vacuum systems and **components**
d.	perform pneumatic and vacuum related calculations
E-24.04.03L	demonstrate knowledge of engineered drawings and schematics, their use and interpretation
a.	identify symbols and abbreviations related to pneumatic and vacuum systems found in engineered drawings and schematics
b.	describe pneumatic and vacuum systems engineered drawings and schematics and their applications
c.	interpret engineered drawings and schematics to determine operation of pneumatic and vacuum systems
E-24.04.04L	demonstrate knowledge of pneumatic and vacuum systems, their **components**, characteristics, applications and operation
a.	identify types of pneumatic and vacuum systems and describe their applications and operating principles
b.	identify pneumatic and vacuum system **components** and describe their purpose and operating principles
E-24.04.05L	demonstrate knowledge of **electromechanical components** found in pneumatic and vacuum systems, their characteristics, applications and operation
a.	identify **electromechanical components** found in pneumatic and vacuum systems
b.	describe purpose and operating principles of **electromechanical components** found in pneumatic and vacuum systems
c.	describe testing and troubleshooting procedures for **electromechanical components** found in pneumatic and vacuum systems

E-24.04.06L	demonstrate knowledge of **procedures to repair** pneumatic and vacuum systems and **components**
a.	identify tools and equipment to repair pneumatic and vacuum systems and **components**, and describe their applications and procedures
b.	identify hazards and describe **safe work practices** for pneumatic and vacuum systems and **components**
c.	describe procedures to repair pneumatic and vacuum systems and **components**
d.	describe procedures to replace **component parts**
E-24.04.07L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle pneumatic and vacuum system **components**
b.	describe procedures for spill containment and capture

Range of Variables (include, but not limited to)

fluid power: pneumatic, vacuum

principles and theories of fluid power: Pascal's law, Boyle's law, Charles' law, Gay-Lussac's law, Bernoulli's principle, Ideal gas law

components: piping, tubing, hoses, receivers, blowers, dryers, coolers, pumps, FRL, motors, actuators, valves, separators, compressors, solenoids (coils), gauges, safety valves, fittings

electromechanical components: solenoids (coils), limit switches, electronic measuring devices, relays, contactors

procedures to repair: replace hoses, piping and tubing; replace and replenish fluids; check/change filters; adjust system pressure, temperature and flow

safe work practices: LOTO procedures, zero-energy state, leak detection practices

component parts: seals, pistons, fittings, strainers, filters, valves, springs, o-rings, spools, gaskets

Major Work Activity F—Performs maintenance, testing commissioning and decommissioning methods

Task F-25 Performs maintenance and testing

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 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-25.01 Performs preventative maintenance activities

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
F-25.01.01P	perform sensory inspections of equipment and **components**	sensory inspections of equipment and **components** are performed at predetermined scheduled intervals to detect **defects**
F-25.01.02P	perform hands-on inspections	hands-on inspections of equipment and **components** are performed
F-25.01.03P	check system condition	**components** with **defects** are repaired, replaced or maintained according to site and manufacturers' specifications, and regulations

Reference Code	Performance Criteria	Evidence of Attainment
F-25.01.04P	check condition, level and temperature of fluids	condition, level and temperature of fluids are checked according to site and manufacturers' specifications, and regulations
F-25.01.05P	perform lubrication of equipment	equipment is lubricated according to site and manufacturers' specifications, and regulations
F-25.01.06P	review **historical data** for preventative maintenance	**historical data** are reviewed to inform preventative maintenance
F-25.01.07P	record information for future equipment evaluation and repair	information for future equipment evaluation and repair is recorded according to company policies and procedures, and manufacturers' requirements
F-25.01.08P	review collected data	collected data are reviewed to determine suitable maintenance scope and schedules

Range of Variables (include, but not limited to)

components: filters, sight glasses, packing, seals, bearings, gaskets, belts, chains, fasteners

defects: unusual sounds and vibration, cracks, loose fasteners, leaks

historical data: graphs, logbooks, lab reports, images, work order history, inspection reports, installation reports

Knowledge

Reference Code	Learning Outcomes and Objectives
F-25.01.01L	demonstrate knowledge of preventative maintenance
a.	identify **types of maintenance models** and describe their purpose and applications
b.	identify **strategic maintenance philosophies**
c.	identify **sources of information to develop maintenance history**
d.	identify **preventative maintenance practices**, and describe their applications
e.	interpret preventative maintenance schedule

Reference Code	Learning Outcomes and Objectives
F-25.01.02L	demonstrate knowledge of procedures to perform preventative maintenance
a.	identify tools and equipment used for preventative maintenance, and describe their applications and procedures
b.	identify hazards and describe safe work practices for preventative maintenance procedures
c.	describe procedures to perform preventative maintenance activities
d.	describe procedures to record preventative maintenance data
e.	describe procedures to schedule preventative maintenance activities
F-25.01.03L	demonstrate knowledge of regulatory requirements to perform preventative maintenance
a.	identify codes, standards and regulations to perform preventative maintenance
F-25.01.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle equipment and materials
b.	explain cost and environmental benefits of well-maintained equipment

Range of Variables (include, but not limited to)

types of maintenance models: breakdown, preventative, predictive, proactive

strategic maintenance philosophies: condition-based maintenance (CBM), RCM

sources of information to develop maintenance history: reports, checklists, manufacturers' specifications, root cause analysis, equipment history (work order)

preventative maintenance practices: non-destructive testing (e.g., ultrasonic, thermography), fluid analysis, balancing, motor current analysis, scheduled overhauls, scheduled replacement, maintaining machinery cleanliness and condition

F-25.02 Performs vibration analysis procedures

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
F-25.02.01P	select and use vibration analysis equipment	vibration analysis equipment is selected and used according to application, site specifications and regulations
F-25.02.02P	set **parameters** of vibration analysis equipment	**parameters** of vibration analysis equipment for desired data collection are set according to site and manufacturers' specifications
F-25.02.03P	collect readings	readings are collected at consistent points across rotating equipment
F-25.02.04P	identify vibration frequencies related to type of components on which data are being collected	vibration frequencies related to type of components on which data are being collected are identified
F-25.02.05P	identify **causes of vibration**	**causes of vibration** are identified based on interpretation of data collected

Range of Variables (include, but not limited to)

parameters: base, motor RPMs, tolerances, route

causes of vibration: misalignment, shaft faults, mechanical looseness, mechanical frequencies, unbalance and eccentricity, ball pass frequency, blade pass frequency, belt drive problems, gear problems

Knowledge

Reference Code	Learning Outcomes and Objectives
F-25.02.01L	demonstrate knowledge of vibration analysis
a.	identify **causes of vibration**
b.	identify **types of vibration**
c.	identify **sources of information for vibration analysis**

Reference Code	Learning Outcomes and Objectives
F-25.02.02L	demonstrate knowledge of procedures to perform vibration analysis
a.	identify **tools and equipment** for vibration analysis, and describe their applications and procedures
b.	identify hazards and describe safe work practices for vibration analysis procedures
c.	describe procedures to perform vibration analysis
d.	record and interpret data collected using vibration analysis equipment
F-25.02.03L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	explain cost and environmental benefits of well-maintained equipment

Range of Variables (include, but not limited to)

causes of vibration: misalignment, shaft faults, mechanical looseness, mechanical frequencies, unbalance and eccentricity, ball pass frequency, blade pass frequency, belt drive problems, gear problems

types of vibration: harmonics, resonance, natural vibration, critical speed

sources of information for vibration analysis: manufacturers' specifications, vibration severity charts, service records and trends

tools and equipment: data collector, probes, vibration pen, strobe, online monitor, transducers (accelerometer), vibration analyzer

F-25.03 Performs balancing procedures

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
F-25.03.01P	inspect equipment	equipment is inspected for **defects** according to site and manufacturers' specifications, and regulations
F-25.03.02P	clean equipment	equipment is cleaned to confirm if balancing is necessary
F-25.03.03P	identify type of unbalance in equipment	type of unbalance in equipment is identified to determine corrective action needed

Reference Code	Performance Criteria	Evidence of Attainment
F-25.03.04P	use balancing equipment	balancing equipment is used to determine location of unbalance
F-25.03.05P	add or remove specific weights at identified locations	specific weights at identified locations are added or removed according to site and manufacturers' specifications

Range of Variables (include, but not limited to)

defects: broken fins, bent shafts, missing weights, loose fit, worn components

Knowledge

Reference Code	Learning Outcomes and Objectives
F-25.03.01L	demonstrate knowledge of **balancing procedures**
a.	identify **sources of information** for balancing
b.	identify **conditions of unbalance** and describe their characteristics
c.	identify types of **balancing procedures** and describe their applications
d.	interpret information on **balancing procedures** found in drawings and specifications
e.	identify **tools and equipment** for balancing, and describe their applications and procedures
f.	identify hazards and describe safe work practices to perform **balancing procedures**
g.	record and interpret data collected during balancing
F-25.03.02L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	explain cost and environmental benefits of well-balanced equipment

Range of Variables (include, but not limited to)

balancing procedures: static (single-plane), dynamic (multi-plane)

sources of information about balancing: manufacturers' specifications, vibration severity charts, service records and trends

conditions of unbalance: static, couple, quasi-static, dynamic

tools and equipment: hand tools, weights, polar graphing charts, protractor, balancing equipment (e.g., hand-held devices, shop balancing machines, knife edges, strobe)

F-25.04 Performs non-destructive testing (NDT) procedures

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
F-25.04.01P	prepare component for testing	component is prepared for testing to avoid false readings
F-25.04.02P	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 regulations
F-25.04.03P	select and use tools and equipment	tools and equipment are selected and used according to **NDT methods**, task, specifications and regulations
F-25.04.04P	perform **NDT methods**	**NDT methods** are performed according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

NDT methods: dye penetrant, magnetic particle, radiography, ultrasonic, visual, thermography, air or water pressure testing, spectrometer, eddy current analysis
component characteristics: ferrous, non-ferrous, hardness, composition
defects: cracks, thin walls, inclusions, metal fatigue (e.g., stress/strain)

Knowledge

Reference Code	Learning Outcomes and Objectives
F-25.04.01L	demonstrate knowledge of **NDT methods**
a.	identify types of **NDT methods** and describe their applications
b.	interpret information on **NDT methods** found in drawings and specifications
c.	identify tools and equipment to perform **NDT methods**, and describe their applications and procedures

Reference Code	Learning Outcomes and Objectives
d.	identify hazards and describe safe work practices to perform **NDT methods**
e.	describe procedures to perform **NDT methods**
f.	record and interpret data collected using **NDT methods**
g.	identify basic electrical principles and describe their associated procedures
F-25.04.02L	demonstrate knowledge of additional training and certification to perform **NDT methods**
a.	identify additional training and certification to perform certain **NDT methods**
F-25.04.03L	demonstrate knowledge of regulatory requirements to perform **NDT methods**
a.	identify codes, standards and regulations to perform **NDT methods**
b.	identify regulatory safety considerations for certifying equipment after NDT
F-25.04.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	explain cost and environmental benefits of well-maintained equipment

Range of Variables (include, but not limited to)

NDT methods: dye penetrant, magnetic particle, radiography, ultrasonic, visual, thermography, air or water pressure testing, spectrometer, eddy current analysis

F-25.05 Performs fluid analysis procedures

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
F-25.05.01P	select and use tools and equipment	tools and equipment are selected and used according to task, specifications and regulations
F-25.05.02P	detect **defects** in fluid condition	**defects** are detected in fluid condition using sensory inspection and **testing procedures**

Reference Code	Performance Criteria	Evidence of Attainment
F-25.05.03P	determine location and frequency of sample collection	location and frequency of sample collection is determined according to site and manufacturers' specifications, and regulations
F-25.05.04P	interpret **test report information**	**test report information** is interpreted
F-25.05.05P	direct information for corrective action	information for corrective action is directed from **test report information** according to site and manufacturers' specifications, and regulations

Range of Variables (include, but not limited to)

defects: change in colour and odour; presence of sludge or impurities; undesired change in operating temperature

testing procedures: spectrographic analysis, particle count, crackle test, acidity test, cup testing, viscosity testing

test report information: contamination, abnormal viscosity, wear particles, corrective actions, total base number (TBN), total acid number (TAN)

Knowledge

Reference Code	Learning Outcomes and Objectives
F-25.05.01L	demonstrate knowledge of fluid analysis
a.	identify and describe characteristics and applications of fluid analysis
b.	identify fluid contaminants and describe their causes and remedies
c.	interpret information about fluid analysis found on graphs and specifications
F-25.05.02L	demonstrate knowledge of procedures to collect and test fluid samples from systems
a.	identify **tools and equipment** used for fluid sampling, and describe their applications and procedures
b.	identify hazards and describe safe work practices for fluid sampling
c.	describe fluid collection and **testing procedures**
d.	interpret and record fluid analysis data
F-25.05.03L	demonstrate knowledge of additional training and certification for fluid sampling
a.	identify additional training and certification for fluid sampling

Reference Code	Learning Outcomes and Objectives
F-25.05.04L	demonstrate knowledge of regulatory requirements for fluid sampling
a.	identify codes, standards and regulations for fluid sampling
F-25.05.05L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle fluids
b.	explain cost and environmental benefits of well-maintained equipment

Range of Variables (include, but not limited to)

tools and equipment: hot plate, viscometer (viscosimeter), litmus paper, thermometers, sterile sample bottles, spectrometers

testing procedures: spectrographic analysis, particle count, crackle test, acidity test, cup testing, viscosity testing

F-25.06 Performs predictive maintenance activities

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
F-25.06.01P	select and use tools and equipment for predictive maintenance	tools and equipment for predictive maintenance are selected and used according to task, specifications and regulations
F-25.06.02P	select **predictive maintenance method**	**predictive maintenance method** is selected based on characteristics of component being tested
F-25.06.03P	record information for future equipment evaluation and repair	information for future equipment evaluation and repair is recorded
F-25.06.04P	review collected data	collected data are reviewed to determine suitable maintenance scope and schedules

Range of Variables (include, but not limited to)

predictive maintenance methods: vibration analysis, fluid analysis, thermography, ultrasonic, sensory inspection, NDT

Knowledge

Reference Code	Learning Outcomes and Objectives
F-25.06.01L	demonstrate knowledge of predictive maintenance
a.	identify **predictive maintenance methods** and describe their applications
b.	identify **types of maintenance models** and describe their purpose and applications
c.	identify **strategic maintenance philosophies**
d.	identify **sources of information to develop maintenance history**
e.	interpret information to perform predictive maintenance procedures found in drawings and specifications
F-25.06.02L	demonstrate knowledge of procedures to perform predictive maintenance
a.	identify tools and equipment to perform predictive maintenance, and describe their applications and procedures
b.	identify hazards and describe safe work practices to perform predictive maintenance
c.	describe procedures to schedule predictive maintenance activities
d.	describe procedures to perform predictive maintenance
e.	describe procedures to record predictive maintenance data
F-25.06.03L	demonstrate knowledge of regulatory requirements to perform predictive maintenance procedures
a.	identify codes, standards and regulations to perform predictive maintenance procedures
F-25.06.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle equipment and materials
b.	explain cost and environmental benefits of well-maintained equipment

Range of Variables (include, but not limited to)

predictive maintenance methods: vibration analysis, fluid analysis, thermography, ultrasonic, sensory inspection, NDT

types of maintenance models: breakdown, preventative, predictive, proactive

strategic maintenance philosophies: CBM, RCM

sources of information to develop maintenance history: reports, checklists, manufacturers' specifications, root cause analysis, graphs, logbooks, lab reports, images, work order history, inspection reports, installation reports

Task F-26 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. Effective commissioning and decommissioning processes are critical to ensure quality assurance and quality control (QA/QC) points are met.

F-26.01 Commissions systems and components

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
F-26.01.01P	develop and complete checklist based on **information sources and documentation**	checklist is developed and completed according to site and manufacturers' specifications, and jurisdictional regulations
F-26.01.02P	review equipment and component checklist	equipment and component checklist is reviewed to ensure that all procedures have been performed according to site and manufacturers' specifications, and jurisdictional regulations
F-26.01.03P	check system **safety components**	system **safety components** are checked according to site and manufacturers' specifications, and jurisdictional regulations
F-26.01.04P	perform start-up and break-in on systems and equipment	start-up and break-in on systems and equipment is performed according to site and manufacturers' specifications
F-26.01.05P	perform **monitoring activities**	**monitoring activities** are performed according to site and manufacturers' specifications, and regulations

Reference Code	Performance Criteria	Evidence of Attainment
F-26.01.06P	perform and record baseline readings	baseline readings are performed and recorded according to site and manufacturers' specifications, and regulations
F-26.01.07P	perform **adjustments**	**adjustments** are performed according to monitoring activity findings, and site and manufacturers' specifications

Range of Variables (include, but not limited to)

information sources and documentation: manufacturers' specifications, operating parameters, jurisdictional codes and regulations (TDG, WHMIS, environmental assessment)

safety components: guards, emergency stops (E-stops), interlocks (light curtains, pressure switches, zero-speed switch), overspeed trips, pressure relief device, limit switches, backstops, caution tape

monitoring activities: checking seal pressures, bolt torque, shaft alignments, fluid levels, temperature, vibration

adjustments: re-torquing fasteners, re-aligning shafts, topping up fluids, adjusting leakage rate, adjusting seal conditions

Knowledge

Reference Code	Learning Outcomes and Objectives
F-26.01.01L	demonstrate knowledge of commissioning and its purpose
a.	describe commissioning applications and purpose
b.	identify types of systems and components that need to be commissioned
c.	interpret **information sources and documentation for commissioning**
F-26.01.02L	demonstrate knowledge of procedures to commission systems and components
a.	identify tools and equipment to commission systems and components, and describe their procedures for use
b.	identify hazards and describe safe work practices to commission systems
c.	describe **monitoring** and **adjustment** procedures used in commissioning
F-26.01.03L	demonstrate knowledge of regulatory requirements to commission systems and components
a.	identify codes, standards and regulations to commission systems and components

Reference Code	Learning Outcomes and Objectives
F-26.01.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	describe procedures to dispose of and recycle equipment and materials
b.	explain cost and environmental benefits of well-planned commissioning

Range of Variables (include, but not limited to)

information sources and documentation: manufacturers' specifications, operating parameters, jurisdictional codes and regulations (TDG, WHMIS, environmental assessment)

monitoring activities: checking seal pressures, bolt torque, shaft alignments, fluid levels, temperature, vibration

adjustments: re-torquing fasteners, re-aligning shafts, topping up fluids, adjusting leakage rate, adjusting seal conditions

F-26.02 Decommissions systems and components

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

Skills

Reference Code	Performance Criteria	Evidence of Attainment
F-26.02.01P	develop and complete checklist based on **information sources and documentation**	checklist is developed and completed according to site and manufacturers' specifications, and jurisdictional regulations
F-26.02.02P	perform decontamination procedures	decontamination procedures are completed according to company policies and jurisdictional regulations
F-26.02.03P	sort, recycle and dispose of **materials**	**materials** are sorted, recycled and disposed of according to site and manufacturers' specifications, and jurisdictional regulations
F-26.02.04P	perform **decommissioning procedures**	**decommissioning procedures** are performed according to site and manufacturers' specifications, and jurisdictional regulations

Reference Code	Performance Criteria	Evidence of Attainment
F-26.02.05P	record decommissioning	decommissioning is recorded according to site and manufacturers' specifications, and jurisdictional regulations

Range of Variables (include, but not limited to)

information sources and documentation: manufacturers' specifications, operating parameters, jurisdictional codes and regulations (TDG, WHMIS, environmental assessment)

materials: petrochemicals, effluents, hazardous waste, ferrous and non-ferrous metals, filters

decommissioning procedures: disassembly, removal of components, inventory components, removal of machines

Knowledge

Reference Code	Learning Outcomes and Objectives
F-26.02.01L	demonstrate knowledge of decommissioning and its purpose
a.	describe decommissioning applications and purpose
b.	identify types of systems and components that need to be decommissioned
c.	interpret **information sources and documentation** for decommissioning
F-26.02.02L	demonstrate knowledge of procedures to decommission systems and components
a.	identify tools and equipment to decommission systems and components, and describe their procedures for use
b.	identify hazards and describe safe work practices to decommission systems and parts
c.	describe **decommissioning procedures**
F-26.02.03L	demonstrate knowledge of regulatory requirements to decommission systems and components
a.	identify codes, standards and regulations to decommission systems and components
F-26.02.04L	demonstrate knowledge of sustainability and environmental stewardship practices
a.	identify practices that contribute to environmental protection
b.	describe procedures to dispose of and recycle materials
c.	identify when decommissioning requires further environmental assessments

Range of Variables (include, but not limited to)

information sources and documentation: manufacturers' specifications, operating parameters, jurisdictional codes and regulations (TDG, WHMIS, environmental assessment)

decommissioning procedures: disassembly, removal of components, inventory components, removal of machines

Appendix A—Acronyms

ABS	acrylonitrile butadiene styrene
AR	augmented reality
AC/DC	alternating current/direct current
AWP	aerial work platform
CAD	computer aided drawing/design
CBM	condition-based maintenance
CCUS	carbon capture, utilization and storage
CMMS	computerized maintenance management system
CNZEAA	Canadian Net-Zero Emissions Accountability Act
EOAT	end of arm tooling
FCAW	flux-cored arc welding
FRL	filter-regulator-lubricator
GFCI	ground fault circuit interrupter
GHS	Global Harmonization System
GMAW	gas metal arc welding (also known as metal inert gas [MIG] welding)
GTAW	gas tungsten arc welding (also known as tungsten inert gas [TIG] welding)
HDPE	high-density polyethylene
ITP	Inspection and Test Plan
LEED	Leadership in Energy and Environmental Design
LOTO	Lock Out Tag Out
MEWP	Mobile elevating work platform
MIG	metal inert gas
NDT	non-destructive testing
NECB	National Energy Code of Canada for Buildings
OHS	Occupational Health and Safety
PAPR	powered air purifying respirator
P&ID	piping and instrumentation diagram
PLC	programmable logic controller
PME	powered mobile equipment
PPE	personal protective equipment
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
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	tungsten inert gas
WHMIS	Workplace Hazardous Materials Information System
WLL	working load limit
ZCB	Zero Carbon Building

Appendix B—Tools and Equipment / Outils et équipement

Personal Protective Equipment (PPE) and Safety Equipment / Équipement de protection individuelle et de sécurité

apron	tabliers
arm bands (signalling sleeve)	brassards (couvre-bras)
automatic external defibrillator (AED)	défibrillateurs externes automatisés (DEA)
breathing protection (e.g., paper filter masks, self-contained breathing apparatus, respirator, powered air purifying respirator)	protection respiratoire (masques à filtre de papier, appareils respiratoires autonomes, etc.)
coveralls - all types (e.g., acid, chemical, fire resistant)	combinaisons - tous les types (résistantes à l'acide, aux produits chimiques, au feu, etc.)
eye protection (e.g., face shields, safety glasses, goggles)	protection des yeux (écrans faciaux, lunettes de protection, lunettes étanches, etc.)
eye wash station	douches oculaires
fall protection and devices	matériel de protection antichute
fire protection equipment (e.g., extinguisher, blanket)	matériel de protection contre l'incendie (extincteurs, couvertures anti-feu, etc.)
first aid kit (CSA approved)	trousses de premiers soins
gas detectors	détecteurs de gaz
gauntlet (forearm protector)	gants à crispin (protèges avant-bras)
gloves (e.g., impact resistant, welding, cut resistant, rubber, heat resistant)	gants (résistants aux impacts, de soudure, résistants aux coupures, isolants, résistants à la chaleur, etc.)
hard hat	casques de sécurité
hearing protection	protège-oreilles
high-visibility clothing	vêtements à haute visibilité
life jackets	gilets de sauvetage
lock out equipment (e.g., locks, tags, lock box, scissor clamp)	équipement de cadenassage (cadenas, étiquettes, boîtiers de sécurité, pinces ciseaux, etc.)
personal monitors	moniteurs personnels
safety footwear	bottes de sécurité
safety harness & fall arresting devices	harnais de sécurité et dispositifs d'arrêt de chute
safety vests	gilets de sécurité
snood	protection faciale

spats	guêtres
welding blinds	écrans de soudeur
welding goggles	lunettes de soudeur
welding helmets	casques de soudure
welding jackets	vestes de soudeur

Hand Tools / Outils à main

alignment bars	barres d’alignement
brushes (e.g., wire, cleaning)	brosses (métalliques, de nettoyage)
chisels	burins
clamps (C-Clamps)	serre-joints (serre-joints en C)
extractors (e.g., tap, bolt, screw)	extracteurs (de tarauds, de boulons, de vis, etc.)
files	limes
grease guns (e.g., ultrasonic, cordless, air)	pistolets-graisseurs (à ultrasons, sans fil, pneumatiques)
hacksaw	scies à métaux
hammers (e.g., ball peen, claw, dead blow, sledge, soft faced, rubber, chipping)	marteaux (panne ronde, panne fendue, amortisseurs, masses, massettes, caoutchouc, à buriner, etc.)
hex keys	clés hexagonales
honing stone	pierres à aiguiser
levels (e.g., machinist, torpedo, spirit, laser)	niveaux (de machiniste, torpille, à bulle, laser, etc.)
locking pliers	pinces-étaux
nibblers	grignoteuses
oil can	burettes à huile
piano wire	cordes à piano
pipe and tube cutters	coupe-tuyaux et coupe-tubes
pliers	pinces
plumb bob	fils à plomb
pop riveter	riveteuses
pry bars	barres-leviers
pullers	extracteurs
punches	poinçons
reamers	alésoirs
scrapers	grattoirs
screwdrivers	tournevis

tap and dies	tarauds et filières
thread chasers	peignes de filetage
threading accessories	accessoires de filetage
tin snip	cisailles de ferblantier
trowels	truelles
tube benders	cintreuses
wheel dresser	décrasse-meules
wrenches (e.g., adjustable, pipe, socket, torque)	clés (à molette, à tubes, à douilles, dynamométriques, etc.)

Measuring and Layout Tools / Instruments de mesure et de traçage

automated laser head	têtes laser automatisées
belt-tension gauge	tensiomètres
bore gauge	calibres d’alésage
calipers (e.g., digital, vernier, dial)	pieds à coulisse (numériques, à vernier, à cadran, etc.)
center gauge	calibres d’angle
chalk lines	cordeaux à craie
combination square set	jeu d’équerres combinées
depth gauge	jauges de profondeur
dial indicator	comparateurs à cadran
dividers	compas à pointe sèche
feeler gauge	calibres d’épaisseur
gauge blocks	blocs de précision (cale étalon)
gear pitch gauge	jauges de pas d’engrenage
height gauge (e.g., digital, vernier, dial)	calibres de hauteur (numériques, à vernier, à cadran, etc.)
laser alignment equipment	matériel d’alignement laser
layout dye	colorants de traçage
lead wire	fils de plomb
micrometers	micromètres
pi-tape	circomètres
plasti-gauge	jauges plastiques
precision level	niveaux de précision
precision optical tools (e.g., levels, theodolites, transits, total station)	outils optiques de précision (niveaux, théodolites, niveaux optiques, stations totales, etc.)
precision straightedge	règles droites

protractors	rapporteurs d’angles
radius gauge	calibres à rayon
rulers	règles
scribers	pointes à tracer
sheave gauge	réas calibrés
sine bar	barre-sinus
small hole gauge	jauges à petit diamètre
solid square	équerres
squares	équerres
string line	cordeaux
surface plates	marbres
tape measures	rubans à mesurer
taper gauge	vérificateurs coniques
telescopic gauge	jauges télescopiques
thread pitch (gauge)	jauges de filetage
three-dimensional laser scanner	lecteurs laser tridimensionnels
trammels	compas
transfer calipers (e.g., inside, outside, hermaphrodite)	compas (d’intérieur, d’extérieur, hermaphrodites, etc.)
web deflection gauge	déflectomètres

Portable Power Tools / Outils mécaniques portatifs

angle grinder	meuleuses d’angle
chainsaw	scies à chaîne
circular saw	scies circulaires
die grinder	meules à rectifier les matrices
explosive-actuated tool	outils à charge explosive
hammer drill	marteaux perforateurs
heat gun	pistolets à air chaud
hydraulic nuts	écrous hydrauliques
hydraulic ram	béliers hydrauliques
hydraulic wrenches	clés hydrauliques
impact drill	perceuses à percussion
impact gun (rivet)	pistolets cloueurs (riveteuses)
impact wrench	clés à percussion
jack hammer	marteaux perforateurs
jig saw	scies sauteuses

portable band saw	scies à ruban mécanique
portable bender	cintreuses portatives
portable drill	perceuses portatives
portable threader	fileteuses mécaniques
reciprocating saw	scies alternatives
right angle drill	perceuses d’angle
routers	toupies

Shop Tools and Equipment / Équipement et outils d’atelier

angle plates	équerres de montage
band saw	scies à ruban
bearing heater (e.g., induction, oil bath, oven)	réchauffeurs de roulements (à induction, bains d’huile, fours, etc.)
brake press	presses plieuses
chop saw	tronçonneuses
cribbing (dunnage)	caissons (fardage)
drill press (e.g., bench, radial arm, upright)	perceuses à colonne
hydraulic press (e.g., horizontal, vertical)	presses hydrauliques
iron worker	cisailles-poinçonneuses
lathe	tours
media blaster	sableuses d’abrasifs
milling machine	fraiseuses
parallel bars	barres parallèles
parts washer	machines à laver des pièces
pedestal grinder	meuleuses sur socle
shears	cisailles
surface grinder	rectifieuses planes
tube rollers	laminoirs à tubes
twist drills	forets hélicoïdaux
v-blocks	blocs en V
vises	étaux

Welding and Cutting Equipment / Équipement de soudage et de coupage

air carbon arc cutting equipment	équipement de coupage à l’arc avec électrode de carbone et jet d’air
flux core arc welding (FCAW) equipment and consumables	équipement et consommables pour le soudage à l’arc avec fil fourré (FCAW)

gas metal arc welding (GMAW) equipment and consumables	équipement et consommables pour le soudage à l’arc sous gaz avec fil plein (GMAW)
gas tungsten arc welding (GTAW) equipment and consumables	équipement et consommables pour le soudage à l’arc sous gaz avec électrode de tungstène (GTAW)
oxy-acetylene equipment and consumables	équipement et consommables pour le soudage oxyacétylénique
oxy-fuel cutting equipment	équipement de coupage oxygaz
plasma arc cutting equipment and consumables	équipement et consommables pour le coupage à l’arc plasma (procédé PAC)
shielded metal arc welding (SMAW) equipment and consumables	équipement et consommables pour le soudage à l’arc avec électrode enrobée (procédé SMAW)

Testing and measuring Equipment / Équipement d’essai et de mesure

ammeter	ampèremètres
balancing equipment	matériel d’équilibrage
borescope	endoscopes
calculators	calculatrices
computers	ordinateurs
dye penetrant test equipment	matériel d’essai par ressuage
flow meter	débitmètres
fluid analysis equipment	équipement d’analyse des fluides
hardness test equipment	matériel d’essai de dureté
laser alignment equipment	matériel de centrage laser
magnetic particle test equipment	équipement de contrôle magnétoscopique
multimeter	multimètres
non-contact voltage tester	testeurs de tension sans contact
pressure/vacuum gauge	jauges à vide ou de dépression
printers	imprimantes
radio transmitter	émetteurs radio
scales	balances
strobe light	lumières stroboscopiques
tachometer	tachymètres
thermographic test equipment	matériel d’essai thermographique
ultrasonic test equipment	matériel d’essai ultrasonique
vibration analysis equipment	matériel d’analyse des vibrations

Access, Rigging, Hoisting and Lifting Equipment / Équipement d’accès, de gréage, de hissage et de levage

aerial lifts	cages élévatrices
air bags	coussins gonflables
air jack	vérins pneumatiques
air tuggers	treuils pneumatiques
block and tackle	palans à moufles
chain fall	palans à chaîne
chains	chaînes
crane (e.g., gantry, mobile, overhead)	grues (portique, mobile roulant)
equipment handling rollers	rouleaux de manutention de l’équipement
forklift	chariots élévateurs à fourche
hydraulic blocks	palans hydrauliques
hydraulic jack	vérins hydrauliques
ladders	échelles
lever actuated chain hoist	palans à levier
lifting eyes	anneaux de levage
mobile elevated work platforms (MEWP)	plateformes de travail élévatrices mobiles
outrigger	stabilisateurs
pinch bar	barres-levier
power chain blocks	palans à chaine mécaniques
rigging hardware (turnbuckle, wire rope clips, hooks, collector rings, edge protectors)	matériel de gréage (tendeur, serre- câbles, bagues collectrices, matériel de protection des bords)
scaffolds	échafaudages
scissor lift	plateformes élévatrices à ciseaux
screw jack	vérins à vis
shackles	manilles
sheave blocks	blocs-poulie
slings	élingues
snatch block	poulies à chape ouvrante
spreader bar	barres d’écartement
synthetic rope	cordre en fibre synthétique
trolleys	chariots
winches	treuils
wire rope	câbles métalliques
wire rope hoists	câbles de levage métalliques

Appendix C—Glossary / Glossaire

agitator	a device which keeps material moving in a tank or vessel; the movement may be required to prevent settling and to mix material	**agitateur**	dispositif qui maintient les matériaux contenus dans un réservoir ou dans une chaudière en mouvement. Ce mouvement peut être nécessaire pour empêcher les matériaux de durcir et pour les mélanger
arc of contact	degrees of contact between the sheave, the pulley and the belt, or the sprocket and the chain	**arc de contact**	surface de contact entre le réa, la poulie et la courroie, ou entre la roue dentée et la chaîne
axial flow	to flow along the axis of a fan or a pump	**débit axial**	débit le long de l'axe d'un ventilateur ou d'une pompe
babbitt	material used in plain friction bearings (usually lead-based)	**métal blanc**	matériau utilisé dans les paliers lisses (habituellement à base de plomb)
backlash	amount of clearance between mating gear teeth	**jeu entre dents**	jeu disponible entre des dentures conjuguées
basic measuring tools	these types of measuring tools have a direct scale on them (e.g., rules, tapes, plate protractor)	**outil de mesure de base**	outil de mesure gradué (règle, ruban, rapporteur d'angles, etc.)
bearing	device that allows two parts to move in contact with each other	**palier**	dispositif qui permet à deux parties de tourner ou de se déplacer en contact l'une avec l'autre
blower	device that moves air at low or high pressures and volumes	**soufflante**	dispositif qui déplace l'air à un volume et à une pression basse ou élevée
centrifugal flow	to flow 90 degrees to the axis of a fan or a pump away from the centre	**débit centrifuge**	débit à 90 degrés par rapport à l'axe d'un ventilateur ou d'une pompe en direction opposée au centre

clutch	device to engage or disengage a driver to a driven unit	**embrayage**	dispositif utilisé pour enclencher ou débrayer une unité motrice et une unité entraînée
colinear shafts	shafts sharing the same axis	**arbres colinéaires**	arbres partageant le même axe
condition-based monitoring methods	methods to identify issues including data collection, data analysis, alert generation, maintenance planning and continuous improvement	**méthode de surveillance fondée sur l'état**	méthode de détermination des problèmes, y compris la collecte et l'analyse de données, la génération d'alertes, la planification de l'entretien et l'amélioration continue
conveying systems	system to move material (usually solid) from one place to another	**convoyeur**	système utilisé pour déplacer des matériaux (habituellement solides) d'un endroit à un autre
couplings	mechanical elements to connect two colinear shafts together	**accouplement**	pièce utilisée pour raccorder une unité motrice à une unité entraînée
elastomeric element	flexible element to join couplings and dampen energy and misalignment	**élément élastomérique**	élément flexible utilisé pour joindre les accouplements et atténuer l'énergie et le désalignement
engineered lift	A hoisting/lifting operation that has been planned and approved by an engineer. This type of lift is done when risks are greater due to load, shape, environmental conditions or other circumstances	**lavage exécuté sur plan d'ingénieur**	opération de levage planifiée et approuvée par un ingénieur. Ce type de levage est effectué lorsque les risques sont importants en raison de la charge, de la forme, des conditions environnementales ou d'autres circonstances
fan	device to create air movement	**ventilateur**	dispositif utilisé pour engendrer un déplacement d'air
fluid	substance (either a liquid or gas) that has the ability to flow	**fluide**	substance (liquide ou gazeuse) capable de s'écouler

gear system	a mechanical arrangement that transmits motion and torque between gears to achieve specific changes (speed, direction or force)	**engrenage**	dispositif mécanique qui transmet le mouvement et le couple entre les roues d'engrenage pour obtenir des changements spécifiques (de vitesse, de direction ou de force)
hypoid gear	set of bevel gearing with non-intersecting shaft axes	**engrenage hypoïde**	ensemble de roues d'engrenage coniques dont les axes d'arbre ne se croisent pas
maintain	keeping a machine or system running efficiently with a minimum amount of down-time; for use in this standard the term "maintain" can encompass: checking for worn parts, lubrication, adjustment, inspection and modification	**entretenir**	garder une machine ou un système en bon état de marche avec un temps d'arrêt minimal; dans la présente analyse, le terme « entretenir » peut comprendre : vérifier si des pièces sont usées, vérifier la lubrification et le réglage, inspecter et modifier
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	**spécifications des fabricants**	fait référence aux normes de performance et de construction mécanique pour une certaine machine et données par le fabricant; cette information est habituellement disponible dans les dessins, les manuels et les bulletins fournis par le fabricant
multi-plane balancing	to balance a rotating part on more than two planes; multi-plane balancing is usually performed with computer software that is provided with vibration analysis and balancing instruments	**équilibrage multiplan**	équilibrer une pièce qui tourne sur plus de deux plans; on effectue habituellement l'équilibrage multiplan à l'aide d'un logiciel qui est habituellement fourni avec les instruments d'équilibrage et d'analyse de vibrations

non-destructive testing (NDT)	evaluation procedures that do not damage the material being tested; these may include magnetic particle, x-ray, ultrasound and dye penetrant testing	**essai non destructif**	essai qui n'endommage pas le matériel à l'essai; cette procédure pourrait comprendre l'essai par particules magnétiques, radiographique, par ultrasons et par ressuage
positive displacement	moving a fluid by repeatedly enclosing a fixed volume and moving it mechanically through the system. The action can be driven by pistons, screws, gears, rollers, diaphragms or vanes	**déplacement volumétrique**	transférer un fluide en enfermant de manière répétée un volume fixe et en le déplaçant mécaniquement à travers le système. L'action peut être entraînée par des pistons, des vis, des engrenages, des galets, des diaphragmes ou des palettes
precision measuring tools	these types of measuring tools amplify the readers ability to distinguish measurements (e.g., micrometer, vernier caliper, vernier bevel protractor)	**outil de mesure de précision**	outil de mesure amplifiant la capacité des lecteurs à distinguer les mesures (micromètre, pied à coulisse, rapporteur d'angle à vernier, etc.)
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	**entretien prédictif**	activité effectuée d'après l'information provenant de registres de performances passées et actuelles afin de prédire de façon objective les problèmes mécaniques; l'entretien prédictif est une approche de surveillance proactive plutôt qu'une approche réactive ou basée sur le temps

preventative maintenance	activities based on periodic sampling and inspections; it normally involves the routine scheduling of maintenance activities; this schedule is based on past experience and manufacturers' recommendations	**entretien préventif**	activité basée sur des inspections et un échantillonnage périodiques; cela implique normalement l'établissement routinier du calendrier des activités d'entretien; ce calendrier se base sur l'expérience et sur les recommandations des fabricants
prime mover	driver of the machine; it may be wind, water, electric, steam, gas or diesel powered	**moteur principal**	dispositif d'entraînement de la machine; il peut fonctionner à l'électricité, à la vapeur, à l'essence ou au diesel
sensory inspection	inspecting through the senses (visual, hearing, feeling, smell)	**inspection sensorielle**	inspection faite en se servant de ses sens (vue, ouïe, toucher, odorat)
service	for use in this standard the term "service" refers to installing, diagnosing, repairing and maintaining	**faire la maintenance**	pour la présente analyse, le terme « maintenance » fait référence à la pose, au diagnostic, à la réparation et à l'entretien
thermographic equipment	equipment that displays the temperatures of components by measuring infrared radiation	**équipement thermographique**	matériel qui affiche la température des pièces en mesurant les rayons infrarouges
tooth contact	amount of engagement and pattern formed by mating gear teeth	**point de contact des dents**	prise et façon dont les dents entrent en contact les unes avec les autres
tribology	the study of friction, wear, lubrication and the design of bearings; the science of interacting surfaces in relative motion	**tribologie**	étude de la friction, de l'usure, de la lubrification et de la conception des paliers; la science des surfaces interactives en mouvement relatif

vibration analysis	the process of monitoring the condition of equipment and the diagnosis of faults through the measurement and analysis of vibration within that equipment	**analyse des vibrations**	procédé de contrôle de l’état d’un appareil et de l’analyse de ses défauts grâce aux mesures et à l’analyse des vibrations à l’intérieur de cet appareil