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RED SEAL · SCEAU ROUGE

National Occupational Analysis

Industrial Mechanic (Millwright)

2013

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Industrial Mechanic (Millwright)

2013

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FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this National Occupational Analysis (NOA) as the national standard for the occupation of Industrial Mechanic (Millwright).

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. To this end, Employment and Social Development Canada (ESDC) sponsors a program, under the guidance of the CCDA, to develop a series of NOAs.

The NOAs 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 curricula for training leading to the certification of skilled workers;
- to facilitate the mobility of apprentices and skilled workers in Canada; and,
- to supply employers, employees, associations, industries, training institutions and governments with analyses of occupations.

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This analysis was prepared by the Labour Market Integration Directorate of ESDC. The coordinating, facilitating and processing of this analysis were undertaken by employees of the NOA development team of the Trades and Apprenticeship Division. The host jurisdiction of Manitoba also participated in the development of this NOA.

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APPENDICES

STRUCTURE OF ANALYSIS

To facilitate understanding of the occupation, the work performed by tradespersons is divided into the following categories:

Blocks	the largest division within the analysis that is comprised of a distinct set of trade activities
Tasks	distinct actions that describe the activities within a block
Sub-Tasks	distinct actions that describe the activities within a task
Key Competencies	activities that a person should be able to do in order to be called 'competent' in the trade

The analysis also provides the following information:

Trends	changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment
Related Components	a list of products, items, materials and other elements relevant to the block
Tools and Equipment	categories of tools and equipment used to perform all tasks in the block; these tools and equipment are listed in Appendix A
Context	information to clarify the intent and meaning of tasks
Required Knowledge	the elements of knowledge that an individual must acquire to adequately perform a task

The appendices located at the end of the analysis are described as follows:

Appendix A — Tools and Equipment	a non-exhaustive list of tools and equipment used in this trade
Appendix B — Glossary	definitions or explanations of selected technical terms used in the analysis
Appendix C — Acronyms	a list of acronyms used in the analysis with their full name
Appendix D — Block and Task Weighting	the block and task percentages submitted by each jurisdiction, and the national averages of these percentages; these national averages determine the number of questions for each block and task in the Interprovincial exam
Appendix E — Pie Chart	a graph which depicts the national percentages of exam questions assigned to blocks
Appendix F — Task Profile Chart	a chart which outlines graphically the blocks, tasks and sub-tasks of this analysis

DEVELOPMENT AND VALIDATION OF ANALYSIS

Development of Analysis

A draft analysis is developed by a committee of industry experts in the field led by a team of facilitators from ESDC. This draft analysis breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

Draft Review

The NOA development team then forwards a copy of the analysis and its translation to provincial and territorial authorities for a review of its content and structure. Their recommendations are assessed and incorporated into the analysis.

Validation and Weighting

The analysis is sent to all provinces and territories for validation and weighting. Participating jurisdictions consult with industry to validate and weight the document, examining the blocks, tasks and sub-tasks of the analysis as follows:

BLOCKS	Each jurisdiction assigns a percentage of questions to each block for an examination that would cover the entire trade.
TASKS	Each jurisdiction assigns a percentage of exam questions to each task within a block.
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 NOA development team who then analyzes the data and incorporates it into the document. The NOA provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for block and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

This method for the validation of the NOA also identifies common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions perform a sub-task, it shall be considered common core. Interprovincial Red Seal Examinations are based on 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 a specific jurisdiction
NO	sub-task not performed by qualified workers in the occupation in a specific jurisdiction
NV	analysis Not Validated by a province/territory
ND	trade Not Designated in a province/territory
NOT COMMON CORE (NCC)	sub-task, task or block performed by 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 block 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

ANALYSIS

Safe working procedures and conditions, accident prevention, and the preservation of health are of primary importance to industry in Canada. These responsibilities are shared and require the joint efforts of government, employers and employees. It is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and work environments can be created by controlling the variables and behaviours that may contribute to accidents or injury.

It is generally recognized that safety-conscious attitudes and work practices contribute to a healthy, safe and accident-free work environment.

It is imperative to apply and be familiar with the Occupational Health and Safety (OH&S) Acts and Workplace Hazardous Materials Information System (WHMIS) regulations. As well, it is essential to determine workplace hazards and take measures to protect oneself, co-workers, the public and the environment.

Safety education is an integral part of training in all jurisdictions. As safety is an imperative part of all trades, it is assumed and therefore it is not included as a qualifier of any activities. However, the technical safety tasks and sub-tasks specific to the trade are included in this analysis.

SCOPE OF THE INDUSTRIAL MECHANIC (MILLWRIGHT) TRADE

"Industrial Mechanic (Millwright)" is this trade's official Red Seal occupational title approved by the CCDA. This analysis covers tasks performed by industrial mechanics (millwrights) whose occupational title has been identified by some provinces and territories of Canada under the following names:

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
Industrial Mechanic (Millwright)	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Millwright									✓				

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

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

Other tasks that may be performed in this trade include welding, cutting, rigging and machining as required. Industrial mechanics (millwrights) ~~may~~ prepare bases for equipment.

Prints, diagrams, schematic drawings and manuals assist industrial mechanics (millwrights) in determining work procedures.

Industrial mechanics (millwrights) work with a wide variety of tools. They may use hand and power tools in installation and repair work. Larger machine tools such as lathes, drill presses and grinders may be used in fabrication of machine parts. Hoisting and lifting equipment such as cranes, jacks and forklifts is 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, service and food processing among others. Millwrights are involved with the installation, maintenance and repair of machinery, equipment and components.

The work environment for industrial mechanics (millwrights) is varied and may involve working in extreme or adverse conditions. They often work shift work. They may work in confined spaces, at heights, with heavy equipment and around moving machinery. 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 technical tests. Other important attributes include good coordination, manual dexterity and the ability to visualize a layout in three dimensions.

Industrial mechanics (millwrights) often possess overlapping skills with other tradespeople such as steamfitter/pipefitter, industrial instrument mechanic, power engineer, welder, machinist or industrial electrician. They may be certified in these other trades as well. Industrial mechanics (millwrights) may work in specialized areas of the trade such as fluid analysis, vibration analysis and laser alignment. With experience, they may advance to other positions such as mentor, supervisor, planner, superintendent or trainer.

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

Advances in predictive maintenance have led to more advanced diagnostic equipment such as alignment equipment and vibration monitoring equipment. Acoustic monitoring technology is advancing rapidly. Borescopes are increasingly used to view and troubleshoot internal components. There is advanced diagnostic equipment for fluid power inspection such as handheld analyzers and clamp-on flowmeters.

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

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

The evolution of technology and the complexity of systems such as hydraulics, robotics, green power panels and mechatronics are expanding the scope of work for industrial mechanics (millwrights).

There is a wider variety of materials available for use in the construction of machinery and components, such as new composite alloys and advanced plastics. More types of sealant and epoxy materials are available to the industrial mechanic (millwright).

Preventive and predictive maintenance planning is seen as more important and scheduled shutdowns are more prevalent. Reliability Centered Maintenance (RCM) methodology is becoming more common because of its cost effectiveness.

Some hand and power tools are ergonomically designed to prevent repetitive strain injuries. Many power tools are now cordless with improved battery life and light weight in design, making them more ergonomically friendly, resulting in fewer injuries. There is an increased use of mobile equipment such as forklifts, scissor lifts, aerial lifts and lift trucks in the trade. This equipment is incorporating more safety features. Certification of the equipment and employees is becoming mandatory.

Personal protective equipment (PPE) is becoming more user-friendly and protective, resulting in increased usage among tradespersons. Improved identification of hazardous materials through increased use of Material Safety Data Sheets (MSDS) contributes to a safer work environment.

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

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

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

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

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

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

The essential skills profile for the industrial mechanic (millwright) trade indicates that the most important essential skills are **document use, numeracy** and **critical thinking**.

The application of these skills may be described throughout this document within the competency statements which support each subtask of the trade. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at www.red-seal.ca.

Reading

Industrial mechanics (millwrights) read texts such as short descriptions and directions on labels for products. They read bulletins, manuals and procedures when installing, operating, troubleshooting 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 schematic drawings of systems (pneumatic, mechanical, structural and hydraulic) to identify malfunction. Industrial mechanics (millwrights) may also retrieve and study data from scale drawings to identify location of machinery to be installed and verify location of machinery. They also complete forms such as purchase orders, maintenance forms, logbooks and work orders.

Writing

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

Numeracy

Industrial mechanics (millwrights) measure various physical properties of equipment. They calculate distances, totals, maximums, minimums, tolerances, fits and quantities required. They also calculate loads, capacities and dimensions for mechanical components and systems. Industrial mechanics (millwrights) estimate weights and distances appropriate for equipment and procedures. They perform calculations in order to adjust and align machinery and equipment according to specifications.

Oral Communication

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

Thinking Skills

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

Working with Others

Industrial mechanics (millwrights) perform many of their tasks independently. They work with others when necessary to install and overhaul larger pieces of equipment and complete industrial systems.

Computer Use

Industrial mechanics (millwrights) may use databases to perform queries on maintenance history. They may also enter data from completed work orders in a computerized maintenance management system (CMMS). They may use programs to create and adjust drawings with computer-assisted design software and to control and monitor operation of manufacturing and machining equipment. Industrial mechanics (millwrights) use hand-held computerized alignment, leveling and vibration measurement tools. They may use word processing software to write, edit and format texts such as incident reports and maintenance procedures.

Continuous Learning

Industrial mechanics (millwrights) may read manuals and bulletins to stay abreast of developments in their trade. They also learn informally by exchanging information with co-workers and suppliers. They may also attend training sessions on new technologies, equipment, machinery and safety procedures.

Trends

The importance of safety and environmental compliance continues to be the number one priority on the worksite.

With advancements in material composition and laser measuring devices, industrial mechanics (millwrights) are able to achieve efficiencies and high degrees of accuracy in their work.

Computerized maintenance tracking systems are more common in the workplace.

Automatic lubricators are becoming more popular because of their cost effectiveness.

Related Components

All components apply.

Tools and Equipment

See Appendix A.

Task 1 Performs safety-related functions.

Context

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

Required Knowledge

K 1	types of PPE such as safety glasses, gloves, face shields, hearing protection, respiratory equipment, safety footwear and hard hats
K 2	types of safety equipment such as fall arrest devices, first aid kits and eye wash stations
K 3	limitations of use of PPE and safety equipment
K 4	PPE and safety equipment operations
K 5	company safety policies and standard operating procedures (SOP)
K 6	disposal and recycling procedures
K 7	emergency procedures and location of on-site first aid stations and equipment

K 8	jurisdictional health and safety acts and regulations
K 9	training requirements such as fall protection and confined space entry
K 10	clear path for access and egress into and out of confined spaces
K 11	workers' rights and responsibilities
K 12	fire safety and hot work permit procedures
K 13	housekeeping practices
K 14	WHMIS
K 15	locations of WHMIS manuals and MSDS
K 16	lock-out, tag-out and zero energy procedures (individual or group)
K 17	environmental protection procedures
K 18	spill kits
K 19	due diligence
K 20	stored energy potential (thermal, electric, kinetic, radiation)
K 21	job safety analysis
K 22	hazards associated with performing condition-based monitoring using tools with attached cables and straps while performing the activity on operating equipment

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Sub-task

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	yes	yes	NV	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.01.01	organize PPE and safety equipment according to company policies and OH&S regulations
A-1.01.02	select PPE and safety equipment specific to job task
A-1.01.03	recognize worn, damaged or defective PPE and safety equipment, and remove from service
A-1.01.04	ensure proper fit of PPE and safety equipment
A-1.01.05	clean and store PPE and safety equipment according to manufacturers' recommendations

Sub-task

A-1.02 Maintains safe work environment.

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

Key Competencies

A-1.02.01	recognize and address hazards such as poor housekeeping that could cause personal injury, or equipment or environmental damage
A-1.02.02	handle and store hazardous materials according to WHMIS
A-1.02.03	install safety protection such as signage, barrier tape and barricades
A-1.02.04	identify and implement adequate ventilation in workspace
A-1.02.05	ensure clear path of access to and egress from confined spaces
A-1.02.06	test air quality of confined spaces on a continuous basis using hand held devices
A-1.02.07	follow confined space procedures and regulations
A-1.02.08	ensure cables and straps do not get caught in rotating equipment when performing condition-based monitoring

Sub-task

A-1.03 Protects the environment.

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

Key Competencies

A-1.03.01	recognize hazards that could cause personal injury and harm the environment, and report potential hazards
A-1.03.02	follow due diligence procedures to avoid contamination of water, air and soil based on jurisdictional regulations and company policies
A-1.03.03	follow disposal procedures of hazardous material

Sub-task

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

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

Key Competencies

A-1.04.01	recognize and de-energize stored energy potential in machines, process systems and components such as accumulators, suspended loads, and pneumatic and hydraulic cylinders
A-1.04.02	follow recognized SOP for shutdown, lock-out and tag-out

Task 2 Maintains and uses tools and equipment.

Context Industrial mechanics (millwrights) maintain various tools and equipment to ensure optimal efficiency and safe operation of tools.

Required Knowledge

K 1	hand tools such as files, hacksaws, chisels and hammers
K 2	portable power tools and accessories such as die grinders, impact wrenches, hydraulic wrenches, portable drills and power threaders
K 3	precision measuring tools and accessories such as laser measuring devices, micrometers, vernier calipers, feeler gauges, telescoping gauges, protractors and dial indicators
K 4	layout tools such as straightedges, height gauges, solid square, combination square, combination set, protractors, optical equipment and tape measures
K 5	rigging equipment such as block and tackles, chains, wire ropes, nylon slings, eye-bolts, hoist rings, hooks, softeners, turnbuckles, tag lines, dunnage, snatch blocks, spreader bars, lifting beams and shackles
K 6	hoisting/lifting and moving equipment such as overhead crane, mobile crane, forklift truck, hydraulic hoist, gantries, jacks, tuggers, rolling devices, hand winches, come-alongs, and chainfalls.
K 7	welding equipment such as arc, plasma, wire and oxy-acetylene welders
K 8	shop machines such as drill presses, stationary grinders, chop saws, lathes, milling machines and band saws
K 9	access equipment such as ladders, scaffolds, aerial lifts, scissor lifts, engineered personnel carriers and mobile cranes

K 10	operation, application and limitations of tools and equipment
K 11	hazards associated with shop machines
K 12	regulations and procedures governing the use of rigging, hoisting/lifting and moving equipment
K 13	safety policies and procedures
K 14	shop machine components
K 15	speeds and feeds
K 16	welding techniques such as gas metal arc welding (GMAW [MIG]), gas tungsten arc welding (GTAW [TIG]), shielded metal arc welding (SMAW), metal-cored arc welding (MCAW), flux-cored arc welding (FCAW), plasma and plastic
K 17	manufacturers' recommendations
K 18	jurisdictional and employer safety regulations
K 19	methods and recommended environmental conditions for storing tools and equipment
K 20	cleaning and handling of tools and equipment

Sub-task

A-2.01 Maintains hand and portable power tools.

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

Key Competencies

A-2.01.01	clean and lubricate hand and portable power tools according to manufacturers' recommendations
A-2.01.02	recognize worn, damaged or defective hand and portable power tools, and remove from service
A-2.01.03	store hand and portable power tools according to manufacturers' recommendations

Sub-task

A-2.02 Maintains precision measuring and layout tools.

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

Key Competencies

A-2.02.01	clean and lubricate precision measuring and layout tools according to manufacturers' recommendations
A-2.02.02	verify and set calibration of precision measuring tools before every use
A-2.02.03	recognize worn, damaged or defective precision measuring tools, and remove from service for recalibration, repair or disposal
A-2.02.04	store precision measuring and layout tools according to manufacturers' recommendations

Sub-task

A-2.03 Maintains rigging, hoisting/lifting and moving equipment.

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

Key Competencies

A-2.03.01	perform scheduled maintenance on equipment such as lubricating and cleaning
A-2.03.02	perform visual inspection of rigging, hoisting/lifting and moving equipment
A-2.03.03	identify and replace damaged hardware such as eye-bolts, slings, shackles and hooks, and remove from service
A-2.03.04	identify non-destructive testing (NDT) techniques used on hoisting/lifting equipment to detect underlying defects such as cracks
A-2.03.05	store rigging, hoisting/lifting and moving equipment according to manufacturers' recommendations and/or OH&S regulations

Sub-task

A-2.04 Maintains welding equipment.

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

Key Competencies

A-2.04.01	perform scheduled maintenance on oxy-acetylene units such as inspecting and replacing hoses, gauges, valves and mixing chamber
A-2.04.02	perform scheduled maintenance on electrically powered units such as inspecting and replacing plugs, cables, clamps, bottles, gauges and hoses
A-2.04.03	perform scheduled maintenance on mobile welding units such as inspecting plugs, cables, clamps, bottles, gauges, hoses and vehicle/trailer
A-2.04.04	store equipment according to manufacturers' recommendations, OH&S and WHMIS regulations

Sub-task

A-2.05 Uses shop machines.

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

Key Competencies

A-2.05.01	set up shop machines according to task at hand
A-2.05.02	identify fit and assembly requirements
A-2.05.03	apply coolants and cutting fluids
A-2.05.04	clean and lubricate shop machines
A-2.05.05	cut, drill, machine and grind workpiece as required

Sub-task

A-2.06 Uses access equipment.

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

Key Competencies

A-2.06.01	select access equipment according to task at hand and taking into consideration unstable conditions such as soft ground and ramps
A-2.06.02	set-up and use access equipment according to OH&S regulations and company recommendations
A-2.06.03	identify unsafe, worn, damaged or defective access equipment, and remove from service for repair or disposal
A-2.06.04	clean and lubricate access equipment according to manufacturers' recommendations
A-2.06.05	store access equipment according to manufacturers' recommendations

Task 3 Performs routine trade tasks.

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

Required Knowledge

K 1	basic metallurgy
K 2	properties and characteristics of common types of metals and materials used in the trade
K 3	compatibility of metals and of other materials
K 4	torque values, tensile strength and metal capability
K 5	established job requirements such as personnel and schedule of operations
K 6	fabricating techniques
K 7	heat treatment procedures such as annealing, hardening, tempering and normalizing of metals
K 8	personal and environment hazards of lubricants
K 9	lubricant qualities such as viscosity and drop points
K 10	lubricating systems and components
K 11	metric and imperial systems

K 12	alignment and leveling practices
K 13	safe practices for handling hot metals
K 14	safe practices for isolating equipment and achieving a zero energy state
K 15	symbols and conventions used in drawings and schematics
K 16	types of fastening devices such as nuts, bolts, rivets, screws and adhesives, and their characteristics and specifications
K 17	types of retaining devices such as keys, retaining rings, springs, dowels and pins

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Sub-task

A-3.01 Plans work.

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

Key Competencies

A-3.01.01	determine scope of job
A-3.01.02	develop safety plan according to job requirements
A-3.01.03	determine the types of tools and equipment needed
A-3.01.04	identify required materials
A-3.01.05	schedule work with other tradespersons and personnel
A-3.01.06	estimate time to complete job

Sub-task

A-3.02 Fabricates workpiece.

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

Key Competencies

A-3.02.01	select and use shop tools such as milling machines, surface grinders and lathes
A-3.02.02	identify fabrication requirements such as size, strength and materials required according to specifications
A-3.02.03	identify fit and assembly requirements according to specifications
A-3.02.04	select fabrication materials such as ferrous and non-ferrous metal

A-3.02.05	lay out workpiece
A-3.02.06	cut, drill, grind and weld workpiece as required
A-3.02.07	inspect fabricated workpiece is in accordance with specifications

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Sub-task

A-3.03 Lubricates systems and components.

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

Key Competencies

A-3.03.01	select and use tools and equipment such as hand tools, PPE, grease guns and oil cans
A-3.03.02	determine lubricants/fluid requirements according to site and manufacturers' specifications and technical manuals
A-3.03.03	identify points requiring lubricants according to manufacturers' specifications
A-3.03.04	maintain lubricant levels
A-3.03.05	remove and replace lubricants
A-3.03.06	clean systems and components

Sub-task

A-3.04 Performs leveling of components and systems.

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

Key Competencies

A-3.04.01	select and use levelling tools such as optical, laser and spirit levels
A-3.04.02	level and shim machinery and components according to site and manufacturers' specifications
A-3.04.03	record leveling data to demonstrate compliance
A-3.04.04	perform site evaluation

Sub-task

A-3.05 Uses fastening and retaining devices.

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

Key Competencies

A-3.05.01	select and use tools and equipment such as torque wrenches, impact wrenches and hydraulic tensioning devices, to install or remove fastening and retaining devices
A-3.05.02	select fastening and retaining devices according to application
A-3.05.03	select and apply chemical fasteners for anchoring purposes
A-3.05.04	achieve predetermined torque or tensioning by stretching fasteners using heat or hydraulics
A-3.05.05	select and verify thread pitch (imperial or metric) on fastener using thread pitch gauges
A-3.05.06	select fluids and compounds associated with threaded fasteners such as lubrication and thread lockers
A-3.05.07	clean, chase, plug, drill and tap threads
A-3.05.08	restore threads using a thread restoration kit

Sub-task

A-3.06 Tests metal and other materials using standardized procedures.

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

Key Competencies

A-3.06.01	select and use tools and equipment such as hammers, chisels, grinders and magnets
A-3.06.02	select ferrous and non-ferrous metals and materials according to manufacturers' specifications
A-3.06.03	identify common types of metals by filing, chiselling and examining the chips (chisel test)
A-3.06.04	identify common types of metal by grinding and examining the colour, shape and length of the sparks (spark test)
A-3.06.05	identify common types of metals using the magnet test

Sub-task

A-3.07 Performs heat treatment of metal.

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

Key Competencies

A-3.07.01	select and use tools and equipment such as ovens, forges and oxy-fuel torches
A-3.07.02	clean component for heat treatment to remove contaminants
A-3.07.03	heat metal to reach predetermined colour according to heat treatment colour charts

Sub-task

A-3.08 Uses mechanical drawings and schematics.

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

Key Competencies

A-3.08.01	determine and recognize locations of equipment, components and parts from mechanical drawings
A-3.08.02	interpret and cross-reference engineering assembly and installation drawings, process and instrumentation (P & ID) drawings, schematics and sketches, specifications and technical manuals to visualize the outcome
A-3.08.03	perform trade-related calculations
A-3.08.04	produce field drawings and freehand schematic drawings
A-3.08.05	identify symbols such as hydraulic, welding and pneumatic
A-3.08.06	update mechanical drawings to reflect the as-built (red line) drawings

Task 4 Performs measuring and layout.

Context Industrial mechanics (millwrights) ensure precise installation of equipment by utilizing measuring tools and measuring practices to lay out components and systems, and for assembly of components.

Required Knowledge

K 1	types, purposes and applications of precision, measuring, layout and leveling tools
K 2	acclimatizing requirements of precision, measuring, layout and leveling tools
K 3	interpretation of benchmarks and datum points
K 4	conversion between imperial and metric systems
K 5	how to accurately use precision, measuring, layout and leveling tools

Sub-task

A-4.01 Prepares work area, tools and materials.

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

Key Competencies

A-4.01.01	acclimatize optical precision, measuring, layout and leveling tools according to environmental conditions
A-4.01.02	verify optical precision, measuring, layout and leveling tools for calibration
A-4.01.03	prepare material to be measured by cleaning or filing
A-4.01.04	clean and prepare work area such as table, floor and wall by removing obstructions

Sub-task

A-4.02 Measures material and components.

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

Key Competencies

A-4.02.01	select and use measuring tools and equipment such as tape measures, vernier calipers, micrometers and total station (jig and transit) according to accuracy required
A-4.02.02	read and interpret measurements according to tolerances
A-4.02.03	transfer measurements to components, work area and material, according to tolerances
A-4.02.04	take inside and outside dimensions such as diameters, bores, lengths and thicknesses
A-4.02.05	level and align components such as sole plates and bases according to drawings and specifications

Sub-task

A-4.03 Lays out components.

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

Key Competencies

A-4.03.01	select and use layout tools and equipment such as plumb bobs, optical levels and transits, protractors, lasers, straightedges, combination set and total station (jig and transit) according to task and accuracy required
A-4.03.02	transfer measurements from benchmark and datum points to work area
A-4.03.03	transfer measurements from drawings to work material

Task 5 Performs cutting and welding operations.

Context Industrial mechanics (millwrights) utilize welding and cutting equipment to heat, repair and fabricate components on machinery.

Required Knowledge

K 1	gas cutting and welding safety procedures such as ventilation requirements and fire prevention
K 2	pre and post heat
K 3	recognition of unsafe welding and cutting equipment
K 4	metallurgy
K 5	alternating current (AC) and direct current (DC) welding polarity
K 6	basic cutting techniques using gas and plasma arc cutting equipment
K 7	basic welding, brazing and soldering techniques using gas welding equipment and procedures
K 8	grounding requirements
K 9	SMAW, GTAW (TIG), GMAW (MIG) procedures and equipment
K 10	plasma arc cutting procedures and equipment
K 11	proper care and handling of arc welding equipment and electrodes
K 12	safe storage and handling of compressed gases
K 13	regulations of certification requirements for structural and pressure welding
K 14	types of gas

Sub-task

A-5.01 Cuts material with gas and plasma arc cutting equipment.

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

Key Competencies

A-5.01.01	identify and prepare material to be cut according to job requirements
A-5.01.02	select and use tools and equipment such as oxy-acetylene torches, plasma arc and gougers
A-5.02.03	select gas for cutting

A-5.01.04	perform cutting procedures according to tools and equipment used and materials to be cut
A-5.01.05	perform plasma arc cutting procedures according to materials to be cut

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Sub-task

A-5.02 Joins material using gas welding equipment.

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

Key Competencies

A-5.02.01	select and prepare material to be welded/brazed and soldered according to job requirements and material compatibility
A-5.02.02	select and use tools such as tips according to job requirements
A-5.02.03	match filler rods and flux to materials to be welded, brazed or soldered
A-5.02.04	perform welding, brazing and soldering procedures according to materials being welded/brazed and soldered
A-5.02.05	prepare the workpiece according to procedural requirements such as cleaning, pre-heating and post-heating

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Sub-task

A-5.03 Welds material using shielded arc welding equipment (SMAW).

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

Key Competencies

A-5.03.01	select and prepare material to be welded according to job requirements and material compatibility
A-5.03.02	select and use electrodes according to site and job requirements
A-5.03.03	perform welding procedures according to materials being welded
A-5.03.04	adjust amperage and polarity to achieve proper fusion and penetration
A-5.03.05	visually inspect welds to ensure proper fusion and penetration
A-5.03.06	prepare the workpiece according to procedural requirements such as cleaning, pre-heating and post-heating

Sub-task

A-5.04 **Welds material with gas metal arc welding (GMAW [MIG]) equipment.**

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

Key Competencies

A-5.04.01	select and prepare material to be welded according to job requirements and material compatibility
A-5.04.02	select types of gas used for welding
A-5.04.03	select and use wire according to site and job requirements
A-5.04.04	perform welding procedures according to materials being welded
A-5.04.05	adjust amperage, shielding gas flow and feed rate to achieve proper fusion and penetration
A-5.04.06	visually inspect welds to ensure proper fusion and penetration
A-5.04.07	prepare the workpiece according to procedural requirements such as cleaning, pre-heating and post-heating

Sub-task

A-5.05 **Welds material with gas tungsten arc welding (GTAW [TIG]) equipment.**

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

Key Competencies

A-5.05.01	select and prepare material to be welded according to job requirements and material compatibility
A-5.05.02	select types of gas used for welding
A-5.05.03	select and use filler rods and tungsten according to site and job requirements
A-5.05.04	perform welding procedures according to materials being welded
A-5.05.05	adjust amperage, shielding gas flow, frequency, polarity and tungsten to achieve proper fusion and penetration
A-5.05.06	visually inspect welds to ensure proper fusion and penetration
A-5.05.07	prepare the workpiece according to procedural requirements such as cleaning, pre-heating and post-heating

BLOCK B RIGGING, HOISTING/LIFTING AND MOVING

Trends	To ensure safety during placement and removal of components, there is a need for increased planning and engineered lifts, taking into account size, shape and weight of loads.
Related Components (including, but not limited to)	Chain falls, tirfors, block and tackles, shackles, slings, come-alongs, chains, rope (nylon, fibre, wire), spreader bars, lifting beams, eye-bolts, hoist rings, hooks, overhead crane, mobile crane, forklift truck, hydraulic hoist, hydraulic jacks, gantries, jacks, snatch blocks, tuggers, hand winches
Tools and Equipment	See Appendix A.

Task 6 Plans rigging, hoisting/lifting and moving.

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

Required Knowledge

K 1	rigging equipment such as block and tackles, chains, wire ropes, nylon slings, eye-bolts, hoist rings, hooks, softeners, turnbuckles, tag lines, dunnage, spreaders bars, lifting beams and shackles
K 2	hoisting/lifting and moving equipment such as overhead crane, mobile crane, forklift truck, hydraulic hoist, gantries, jacks, tuggers, engineered bases/rolling devices, hand winches, come-alongs, chain falls and snatch blocks
K 3	fibre ropes, knots and hitches
K 4	applications and limitations of equipment
K 5	requirements for engineered lifts
K 6	safe rigging, hoisting/lifting and moving practices
K 7	safety factors and working load limits (WLL)
K 8	safety regulations when rigging, hoisting/lifting and moving

K 9	weight, size/dimensions of working load and centre of gravity principles
K 10	ground and environmental conditions, and possible changes
K 11	load charts
K 12	characteristics (size, shape, wet/dry) of load being lifted
K 13	shipping information
K 14	nameplate (ID plate) and manuals

Sub-task

B-6.01 Determines load.

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

Key Competencies

B-6.01.01	scale the load using weighing devices such as hanging scales and dynamometers
B-6.01.02	calculate load weight taking into consideration size, wet/dry, centre of gravity, added components and weight of rigging
B-6.01.03	refer to nameplates, shipping information and manufacturers' manuals

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Sub-task

B-6.02 Selects rigging equipment.

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

Key Competencies

B-6.02.01	determine rigging equipment needed based on the characteristics of the lift, process (for example, lifting, dragging and pulling sideways), the number of items being lifted at one time and determined weight of load
B-6.02.02	refer to load ratings for sling arrangements such as basket vs. choker
B-6.02.03	confirm rigging capacity is appropriate for the lift taking into consideration WLL, design factor and actual weight of load being lifted
B-6.02.04	confirm certification of rigging equipment by referring to the equipment's tag or documentation

B-6.02.05	assess, inspect and document rigging equipment condition to ensure they meet company's safety policies, jurisdictional regulations and/or manufacturers' tolerances and specifications
B-6.02.06	remove and tag faulty or damaged rigging equipment from service to be repaired or discarded, and report to supervisor

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Sub-task

B-6.03 Selects hoisting/lifting and moving equipment.

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

Key Competencies:

B-6.03.01	determine hoisting/lifting and moving equipment needed based on the job scope (for example, headroom, environment, ground conditions, obstructions, weather and distance), process (for example, lifting, dragging and pulling sideways) and determined weight of load
B-6.03.02	assess, inspect and document condition of hoisting/lifting and moving equipment
B-6.03.03	confirm certification of hoisting/lifting and moving equipment by referring to operators' manuals, and the equipment's document of certification
B-6.03.04	refer to load ratings for boom angles and distance
B-6.03.05	remove and tag faulty or damaged hoisting/lifting and moving equipment from service to be repaired or discarded, and report to supervisor

Task 7 Rigs, hoists/lifts and moves load.

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

Required Knowledge

K 1	communication methods such as hand signals and two-way radios
K 2	safety practices (taping, barricading, signage, personnel, spotters)
K 3	applicable regulations regarding safe rigging, hoisting/lifting and moving practices
K 4	safe rigging, hoisting/lifting and moving procedures
K 5	requirements for engineered lifts
K 6	ground and environmental conditions, and possible changes
K 7	applications and limitations of equipment

Sub-task

B-7.01 Secures area.

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

Key Competencies

B-7.01.01	assess site, ground, environmental conditions and plan route
B-7.01.02	determine and secure lift radius using barricades and tape
B-7.01.03	confirm location of personnel

Sub-task

B-7.02 Sets up rigging, hoisting/lifting and moving equipment.

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

Key Competencies:

B-7.02.01	prepare for lift by using methods such as putting floats under outriggers, and providing cribbing and dunnage
B-7.02.02	install and/or set-up all rigging, hoisting/lifting and moving components in preparation for use
B-7.02.03	perform pre-use inspection of equipment to verify conditions such as fuel levels, tire pressure and absence of leaks
B-7.02.04	read and interpret load charts
B-7.02.05	adjust schedule to address environmental conditions such as wind, shifting ground, lightning, fog, rain and snow

Sub-task

B-7.03 Performs hoist/lift and move.

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

Key Competencies:

B-7.03.01	ensure direct line of sight between the operator and signal person
B-7.03.02	use hand signals according to OH&S regulations
B-7.03.03	use two-way radio communication when there is no direct line of sight
B-7.03.04	assess and make adjustments to stabilize load as required
B-7.03.05	adjust schedule to address environmental conditions such as wind, changing ground conditions, lightning, fog, rain and snow
B-7.03.06	perform post-lift inspection of rigging, hoisting/lifting and moving equipment

BLOCK C MECHANICAL COMPONENTS AND SYSTEMS

Trends

Machinery analysis is increasingly being performed by some industrial mechanics (millwrights) using complex monitoring systems. The maintenance of machinery has been made easier through new technology in tools and components.

Related Components (including, but not limited to)

Prime movers: internal combustion engines (gas and diesel), turbines (wind, steam, gas, hydraulic), electric motors (DC, AC).

Power transmission assemblies: belt drives, gear drives, chain drives, clutches, brakes, couplings.

Tools and Equipment

See Appendix A.

Task 8 Services prime movers.

Context

Servicing includes installing, diagnosing, repairing and maintaining. Prime movers are the heart of the mechanical system and include equipment such as electric motors, turbines 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.

Required Knowledge

K 1	lock-out, tag-out and zero energy procedures
K 2	types of prime movers such as electric motors, turbines, and internal combustion engines
K 3	types of turbines such as gas, wind, water and steam and associated equipment such as boilers
K 4	auxiliary systems such as lubrication and cooling
K 5	common faults such as loss of rpm and the failure of bearings, seals and lubrication systems
K 6	components such as bearings, shafts, seals, couplings, clutches, brakes, chains, belts and gears

K 7	condition-based monitoring technologies such as vibration analysis, ultrasonic technology (UT), fluid analysis, infrared thermography and motor current analysis
K 8	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 9	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools
K 10	equipment and their restrictions
K 11	hazards such as flammable liquids, steam and electrical shock
K 12	installation sequences and procedures
K 13	machinery specifications such as fluid levels, temperatures and pressures
K 14	manufacturers' or job site specifications
K 15	operating principles
K 16	regulations and procedures governing the use of rigging, hoisting/lifting and moving equipment
K 17	decommissioning procedures

Sub-task

C-8.01 Installs prime movers.

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

Key Competencies

C-8.01.01	select and use tools and equipment such as torque wrenches, dial indicators, precision levels and optical or laser alignment equipment according to job
C-8.01.02	determine location and elevation for installation according to engineered drawings
C-8.01.03	prepare foundation according to engineered drawings
C-8.01.04	clean and rough-up base for prime movers by methods such as filing, sandblasting and buffing
C-8.01.05	position prime movers manually or with rigging, hoisting/lifting and moving equipment
C-8.01.06	secure, level and align prime mover with driven equipment according to manufacturers' and site specifications, and engineered drawings
C-8.01.07	connect prime mover to driven equipment using components such as couplings, sheaves, sprockets and gear boxes according to engineered specifications and drawings

C-8.01.08	install auxiliary systems such as lube pumps, over-speed trip and governors according to manufacturers' specifications
C-8.01.09	bump test to check rotation prior to coupling up
C-8.01.10	install safety guards according to manufacturers' specifications and OH&S regulations
C-8.01.11	energize equipment and start-up/return to operation

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Sub-task

C-8.02 Diagnoses prime movers.

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

Key Competencies

C-8.02.01	obtain a description of the problem and symptoms
C-8.02.02	perform sensory inspection of prime movers such as listening for excessive noise, smelling burned components and feeling for excessive vibration
C-8.02.03	use test/evaluation procedures and specialized equipment according to results of sensory inspection
C-8.02.04	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
C-8.02.05	inspect prime mover components such as couplings, bearings and sheaves for defects including excessive wear, corrosion and looseness
C-8.02.06	remove and replace safety guards according to manufacturers' and site specifications
C-8.02.07	assess and detect faulty or damaged equipment to determine next steps such as repair or replace
C-8.02.08	tag and report faulty or damaged equipment

Sub-task

C-8.03 Repairs prime movers.

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

Key Competencies

C-8.03.01	rebuild and replace faulty components and auxiliary equipment according to manufacturers' specifications
C-8.03.02	use precision measuring tools such as laser alignment equipment, micrometers, torque wrenches and vernier calipers
C-8.03.03	dismantle, remove and reassemble prime movers and components to specifications using tools and procedures and match (witness) marks
C-8.03.04	align components according to manufacturers' specifications
C-8.03.05	bump test to check rotation prior to coupling up
C-8.03.06	energize equipment and start-up/return to operations

Task 9 Services shafts, bearings and seals.

Context 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 containment. Servicing includes installing, diagnosing, repairing and maintaining these components.

Required knowledge

K 1	types of bearing fits such as press, slide and interference
K 2	types of bearing housings such as pillow blocks, split and flange
K 3	style of bearings such as radial and axial
K 4	types of bearings such as anti-friction and friction
K 5	types of arrangements of bearings such as fixed and floating
K 6	anti-friction (rolling element-type) bearing installation and removal components and tools such as taper locks, cam locks and pullers
K 7	anti-friction split bearings
K 8	bearing faults such as loss of clearance, overheating, excessive lubrication and lack of lubrication

K 9	bearing fits and tolerances
K 10	bearing materials such as new alloys and advanced plastics
K 11	initial, installed and running bearing clearances according to manufacturers' specification charts
K 12	types of shafts such as drive, counter, jack and hollow
K 13	lubrication requirements
K 14	manufacturers' specifications
K 15	seal faults such as leaking, deterioration and improper installation
K 16	seal materials' compatibility with medium
K 17	types of seals such as static, dynamic, mechanical, contact and non-contact
K 18	shaft faults such as bent and worn shafts
K 19	shaft restoration applications such as shaft straightening, spray welding, peening, knurling and using sleeves
K 20	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 21	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 22	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools

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Sub-task

C-9.01 Installs shafts, bearings and seals.

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

Key Competencies

C-9.01.01	select and use tools and equipment such as torque wrenches, dial indicators, feeler gauges, micrometers and calipers according to job
C-9.01.02	select shafts, bearings and seals according to specifications such as product, operating environment, loads, temperatures, pressures and rpm
C-9.01.03	position shafts, bearings and seals manually or with rigging, hoisting/lifting and moving equipment
C-9.01.04	mount and fit friction bearings using equipment such as plastigauge, lead wires, mechanics' blue and scrapers
C-9.01.05	mount anti-friction (rolling element-type) bearings using equipment such as induction heaters, oil baths, arbor presses and bearing ovens

C-9.01.06	secure, level and align shafts, bearings and seals with driven equipment according to manufacturers' and site specifications, and engineered drawings
C-9.01.07	check, adjust and record clearances of bearings and seals according to manufacturers' specifications
C-9.01.08	apply lubricants according to manufacturers' specifications
C-9.01.09	remove and reinstall safety guards according to manufacturers' specifications and OH&S regulations

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Sub-task

C-9.02 Diagnoses shafts, bearings and seals.

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

Key Competencies

C-9.02.01	obtain a description of the problem and symptoms
C-9.02.02	perform sensory inspection of shafts, bearings and seals such as listening for excessive noise, smelling burned components and feeling for excessive vibration and heat
C-9.02.03	visually inspect for abnormalities such as leaks, missing and loose parts and damaged components
C-9.02.04	use test/evaluation procedures and specialized equipment according to results of sensory inspection
C-9.02.05	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
C-9.02.06	verify lubrication level and condition
C-9.02.07	measure clearances in friction and anti-friction (rolling element-type) bearings
C-9.02.08	assess and detect faulty or damaged equipment to determine next steps such as repair or replace
C-9.02.09	tag and report faulty or damaged equipment

Sub-task

C-9.03 Repairs shafts, bearings and seals.

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

Key Competencies

C-9.03.01	rebuild and replace faulty shafts, bearings and seals according to manufacturers' specifications
C-9.03.02	select and use precision measuring tools such as micrometers, torque wrenches, dial indicators and vernier calipers
C-9.03.03	dismantle, remove and reassemble shafts, bearings and seals to specifications using tools, procedures match (witness) marks
C-9.03.04	prepare shaft using methods such as sleeving, welding, filing and machining
C-9.03.05	align components according to manufacturers' specifications
C-9.03.06	access shafts, bearings and seals by removing components such as housings, sleeves, snap rings, collars and covers
C-9.03.07	size and replace seals according manufacturers' specifications
C-9.03.08	pour and scrape new friction bearings according manufacturers' specifications
C-9.03.09	machine keyway and key seats according manufacturers' specifications

Sub-task

C-9.04 Maintains shafts, bearings and seals.

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

Key Competencies

C-9.04.01	inspect, modify and adjust shafts, bearings and seals according to maintenance schedule using condition-based monitoring tools
C-9.04.02	check coolant and lubricants levels, packing and seals according to manufacturers' specifications and maintenance schedule
C-9.04.03	monitor temperature, vibration and pressure
C-9.04.04	check automatic bearing and seal lubrication systems
C-9.04.05	adjust flow and pressure controls for cooling and lubrication of sealing systems according to manufacturers' specifications

Task 10 Services couplings, clutches and brakes.

Context Couplings transfer rotary motion from one shaft to another. Clutches allow engagement and disengagement of power and torque. Brakes slow or stop the motion.

Required knowledge

K 1	clutch and brake faults such as wear, overheating, excessive vibration and slippage
K 2	components of couplings, clutches and brakes
K 3	coupling faults such as compromised transfer of movement, excessive vibration and worn components
K 4	indications of component failure such as clutch and brake slippage, excessive heat and vibration
K 5	required clearances and tolerances for couplings, clutches and brakes
K 6	setup and operation of couplings, clutches and brakes
K 7	types of brakes such as friction and electromagnetic
K 8	types of clutches such as overrunning, friction, positive contact and fluid
K 9	types of couplings such as rigid, flexible, fluid and electromagnetic
K 10	types of fasteners/retainers such as keys, taper locks, dowels and set screws
K 11	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 12	condition-based monitoring tools such as ultrasonic, strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 13	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools
K 14	hazards of working around hazardous friction material

Sub-task

C-10.01 Installs couplings, clutches and brakes.

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

Key Competencies

C-10.01.01	select and use tools and equipment such as torque wrenches, dial indicators, feeler gauges, straight edges, micrometers, laser alignment equipment and calipers according to job
C-10.01.02	select couplings, clutches and brakes according to specifications such as torque, horsepower, loads, temperatures and rpm
C-10.01.03	position couplings, clutches and brakes manually or with using rigging, hoisting/lifting and moving equipment
C-10.01.04	assemble couplings, clutches and brakes using tools and equipment such as presses and pullers, and by heating or cooling the components
C-10.01.05	assemble couplings, clutches and brakes with driven equipment according to manufacturers' and site specifications, and engineered drawings
C-10.01.06	check, adjust and record clearances of couplings, clutches and brakes according to manufacturers' specifications
C-10.01.07	align couplings, clutches and brakes according to manufacturers' specifications
C-10.01.08	lubricate couplings according to manufacturers' specifications
C-10.01.09	remove and reinstall safety guards according to manufacturers' specifications and OH&S regulations
C-10.01.10	energize equipment and start-up/return to operations

Sub-task

C-10.02 Diagnoses couplings, clutches and brakes.

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

Key Competencies

C-10.02.01	obtain a description of the problem and symptoms
C-10.02.02	perform sensory inspection of couplings, clutches and brakes such as listening for excessive noise, smelling burned components and feeling for excessive vibration and heat
C-10.02.03	visually inspect for abnormalities such as missing and loose parts, worn and damaged components
C-10.02.04	select and use tools and equipment such as vernier calipers and condition-based monitoring tools
C-10.02.05	use test/evaluation procedures such as monitoring temperature and vibration levels with specialized equipment according to results of sensory inspection
C-10.02.06	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
C-10.02.07	verify lubrication level and condition
C-10.02.08	remove and replace safety guards according to manufacturers' and site specifications
C-10.02.09	measure clearances of brakes and couplings according to manufacturers' specifications
C-10.02.10	assess and detect faulty or damaged components to determine next steps such as repair or replace
C-10.02.11	tag and report faulty or damaged components

Sub-task

C-10.03 Repairs couplings, clutches and brakes.

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

Key Competencies

C-10.03.01	rebuild and replace faulty couplings, clutches and brakes according to manufacturers' specifications
C-10.03.02	select and use tools and equipment such as micrometers, hydraulic presses, pullers, torque wrenches, dial indicators and vernier calipers
C-10.03.03	dismantle, remove and reassemble couplings, clutches and brakes to specifications using match (witness) marks, and according to procedures
C-10.03.04	recondition couplings and clutches, and broach keyway according manufacturers' specifications
C-10.03.05	access couplings, clutches and brakes by removing safety guards
C-10.03.06	replace coupling components such as springs, grids and elastomeric elements according to manufacturers' specifications
C-10.03.07	replace clutch and brake components such as friction pads, diaphragms and springs according to manufacturers' specifications
C-10.03.08	adjust clutches and brakes according to manufacturers' specifications
C-10.03.09	align components according to manufacturers' specifications
C-10.03.10	reinstall guards and safety devices according to manufacturers' specifications

Task 11 Services chain and belt drive systems.

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

Required knowledge

K 1	speed and ratio calculations
K 2	belt and chain calculation of length
K 3	belt and chain sizing
K 4	belt drive components such as sheaves, idlers and pulleys

K 5	belt faults such as slippage and excessive wear
K 6	chain and chain drive components such as sprockets, idlers and links
K 7	idler positioning to accommodate arc of contact, tension and slack
K 8	indications of chain faults such as noise, vibration and excessive heat
K 9	load capacities
K 10	manufacturers' specifications such as tension, rpm, capacity limitations and operating conditions
K 11	types of belts such as v-belts, timing belts and flat belts
K 12	types of chains such as roller, silent, pintle and detachable
K 13	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 14	condition-based monitoring tools such as belt tension frequency meter, strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 15	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools

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Sub-task

C-11.01 Installs chain and belt drive systems.

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

Key Competencies

C-11.01.01	select and use tools and equipment such as torque wrenches, straight edges and alignment tools according to job
C-11.01.02	select chain and belt drive systems according to specifications such as torque, horsepower, loads, temperatures and rpm, and equipment application
C-11.01.03	position chain and belt drive systems manually or with rigging, hoisting/lifting and moving equipment
C-11.01.04	assemble chain and belt drive systems using tools and equipment such as presses, tensioners, chain breaks, ropes and pullers
C-11.01.05	align chain and belt drive systems with driven equipment according to manufacturers' and site specifications, and engineered drawings
C-11.01.06	check and adjust tension of chain and belt drive systems according to manufacturers' specifications
C-11.01.07	lubricate chains according to manufacturers' specifications

C-11.01.08	remove and reinstall safety guards according to manufacturers' specifications and OH&S regulations
C-11.01.09	energize equipment and start -up/return to operations

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Sub-task

C-11.02 Diagnoses chain and belt drive systems.

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

Key Competencies

C-11.02.01	obtain a description of the problem and symptoms
C-11.02.02	perform sensory inspection of chain and belt drive systems such as listening for excessive noise, smelling burned components and feeling for excessive vibration and heat
C-11.02.03	visually inspect for abnormalities such as missing and loose parts, worn and damaged components
C-11.02.04	use test/evaluation procedures such as monitoring temperature and vibration levels with specialized equipment according to results of sensory inspection
C-11.02.05	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
C-11.02.06	verify chain lubrication level and condition
C-11.02.07	measure tension of chain and belt drive systems according to manufacturers' specifications
C-11.02.08	assess and detect faulty or damaged components to determine next steps such as repair or replace
C-11.02.09	tag and report faulty or damaged components

Sub-task

C-11.03 Repairs chain and belt drive systems.

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

Key Competencies

C-11.03.01	rebuild and replace faulty chains and belt drive systems according to manufacturers' specifications
C-11.03.02	select and use tools and equipment such as hydraulic presses, pullers, torque wrenches and alignment tools
C-11.03.03	dismantle, remove and reassemble chains and belt drive systems to manufacturers' specifications
C-11.03.04	access chains and belt drive systems by removing safety guards and covers
C-11.03.05	align components such as sprockets and sheaves according to manufacturers' specifications
C-11.03.06	lubricate chain according to site and manufacturers' specifications
C-11.03.07	reinstall guards and safety devices according to manufacturers' specifications
C-11.03.08	energize equipment and start-up/return to operations

Sub-task

C-11.04 Maintains chain and belt drive systems.

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

Key Competencies

C-11.04.01	clean, inspect, modify and adjust chain and belt drive systems according to maintenance schedule using condition-based monitoring tools, tension gauges and alignment tools
C-11.04.02	check lubricants according to manufacturers' specifications and maintenance schedule
C-11.04.03	check condition of sprockets, sheaves, belts and chains
C-11.04.04	check alignment of sprockets and sheaves according to manufacturers' specifications
C-11.04.05	adjust chain and belt drive systems tension

Task 12 Services gear systems.

Context Gear systems transmit rotary and linear movement from one component to another and may be used to increase or reduce speed. Gear systems are used when there is a need for greater versatility such as speed control, shaft orientation and timing requirements.

Required knowledge

K 1	installation sequence
K 2	gear faults such as overheating, vibration and excessive noise
K 3	gear system components and their installation requirements such as fits, thrust, clearances and tolerances
K 4	gear system components such as shafts, bearings and casings
K 5	gear terminology such as pitch diameter, diametral pitch, dedendum, addendum and working depth
K 6	installation methods such as pressed, keyed, sliding and pinned
K 7	lubrication methods such as splash, forced and oil rings
K 8	simple and compound gear trains
K 9	monitoring equipment such as temperature probes and thermographic equipment, oil analysis, vibration analysis and ultrasound devices
K 10	types of gear systems such as planetary, reduction, and rack and pinion
K 11	types of gears such as spur, herringbone, worm and hypoid
K 12	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 13	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 14	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools

Sub-task

C-12.01 Installs gear systems.

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

Key Competencies

C-12.01.01	select and use tools and equipment such as torque wrenches, jacks, alignment tools, blueing and plastigauges according to job
C-12.01.02	select gear systems according to specifications such as torque, horsepower, loads, temperatures and rpm, and equipment application
C-12.01.03	position gear systems manually or with rigging, hoisting/lifting and moving equipment
C-12.01.04	assemble gear systems using tools and equipment such as presses and hydraulic jacks, and by heating and cooling
C-12.01.05	align gear systems with driven and driver equipment according to manufacturers' and site specifications, and engineered drawings
C-12.01.06	check and adjust backlash and tooth contact according to manufacturers' specifications
C-12.01.07	lubricate gear systems according to site and manufacturers' specifications
C-12.01.08	remove and reinstall safety guards according to manufacturers' specifications and OH&S regulations
C-12.01.09	energize equipment and start-up/return to operations

Sub-task

C-12.02 Diagnoses gear systems.

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

Key Competencies

C-12.02.01	obtain a description of the problem and symptoms
C-12.02.02	perform sensory inspection of gear systems such as listening for excessive noise, smelling burned components and feeling for excessive vibration and heat
C-12.02.03	visually inspect for abnormalities such as missing and loose parts, worn and damaged components

C-12.02.04	select and use tools and equipment such as condition-based monitoring tools, dial indicators and feeler gauges
C-12.02.05	use test/evaluation procedures such as monitoring temperature and vibration levels with specialized equipment according to results of sensory inspection
C-12.02.06	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
C-12.02.07	verify lubrication level and condition
C-12.02.08	remove and replace safety guards according to site and manufacturers' specifications
C-12.02.09	measure clearance, backlash and tooth contact of gear systems according to manufacturers' specifications
C-12.02.10	assess and detect faulty or damaged components to determine next steps such as repair or replace
C-12.02.11	tag and report faulty or damaged components

Sub-task

C-12.03 Repairs gear systems.

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

Key Competencies

C-12.03.01	rebuild and replace faulty gear systems according to manufacturers' specifications
C-12.03.02	select and use tools and equipment such as torque wrenches, jacks, alignment tools, feeler gauges, mechanics' blue and plastigauge
C-12.03.03	access gear systems by removing safety guards and covers
C-12.03.04	dismantle, remove and reassemble gear systems to manufacturers' specifications
C-12.03.05	replace and align gears according to manufacturers' specifications
C-12.03.06	adjust gears, backlash, clearance and tooth contact according to manufacturers' specifications
C-12.03.07	lubricate gears according to site and manufacturers' specifications
C-12.03.08	reinstall guards and safety devices according to manufacturers' specifications
C-12.03.09	energize equipment and start-up/return to operations

Sub-task

C-12.04 Maintains gear systems.

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

Key Competencies

C-12.04.01	clean, inspect, modify and adjust gear systems according to maintenance schedule using condition-based monitoring tools and alignment tools
C-12.04.02	check lubricants and seals according to manufacturers' specifications and maintenance schedule
C-12.04.03	check condition of gear systems according to manufacturers' specifications
C-12.04.04	check alignment, backlash, clearance and tooth contact of gear systems according to manufacturers' specifications

Trends

Condition-based monitoring using a digital display and computer panel is becoming more sophisticated and portable by taking advantage of the latest technologies. Digital control systems have become more advanced because the programming of these devices is becoming simpler. Industrial mechanics (millwrights) are required to be well versed in leading edge as well as traditional practices.

There has been an increase in the use of more sophisticated diagnostic equipment such as infrared, vibration analysis and ultrasonic/acoustic equipment.

Related Components (including, but not limited to)

Fans and Blowers: impellers, rotors, lobes, sheaves, bearings, shafts, seals, bearing housings, fixing rings, gears, couplings, belts, louvers, safety guards.

Compressors: screws, check valves, pressure relief valves, pressure regulators, air dryers, sheaves, bearings, shafts, seals, gears, couplings, belts, safety guards.

Pumps: impellers, sheaves, bearings, shafts, seals, packings, shim packs, lantern rings, mechanical seals, wear rings, couplings, belts, face plates, safety guards.

Conveying Systems: couplings, pulleys, clutches, rollers, bearings, sheaves, backstops, sprockets, chains, belts, buckets, screws, piping, gear boxes, drive systems, trippers, ploughs, chutes, screens, skirt boards, filters, safety guards.

Process Tanks and Containers: agitators, filters, mechanical seals, packings, level and temperature indicators, pumps, valves, liners, venting systems.

Tools and Equipment

See Appendix A.

Task 13 Services fans and blowers.

Context Fans and blowers 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, repaired and maintained properly.

Required Knowledge

K 1	types of fan systems such as induction and forced draft
K 2	types of fans such as centrifugal and axial flow fans
K 3	types of blowers such as radial and axial
K 4	components of fans and blowers such as couplings, belts, shafts and sheaves
K 5	fan and blower faults such as imbalance, improper lubrication and bearing failure
K 6	fan and blower specifications such as cubic feet per minute (CFM), horsepower, speeds, volumes and clearances
K 7	manufacturers' specifications
K 8	product to be moved
K 9	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 10	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 11	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools

Sub-task

D-13.01 Installs fans and blowers.

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

Key Competencies

D-13.01.01	select and use tools and equipment such as combination wrenches, impact wrenches, dial indicators, precision levels, and optical or laser alignment equipment
D-13.01.02	determine location and elevation for installation according to engineered drawings
D-13.01.03	clean and rough-up base for fan or blower by methods such as filing, sandblasting and buffing
D-13.01.04	prepare foundation according to engineered drawings
D-13.01.05	position fan or blower in place using rigging, hoisting/lifting and moving equipment
D-13.01.06	level, align and secure fans and blowers
D-13.01.07	grout to distribute load and minimize vibration
D-13.01.08	check direction of rotation, static and dynamic balance, and vibration
D-13.01.09	connect inlet/outlet
D-13.01.10	connect and align fans and blowers to driver through couplings, sheaves and belts
D-13.01.11	install safety guards according to manufacturers' specifications and OH&S regulations
D-13.01.12	energize equipment and start-up/return to operations

Sub-task

D-13.02 Diagnoses fans and blowers.

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

Key Competencies

D-13.02.01	obtain a description of the problem and symptoms
D-13.02.02	perform sensory inspection of components such as sheaves, louvers, bearings, belts and fan blades
D-13.02.03	use test/evaluation procedures and specialized equipment according to results of sensory inspection
D-13.02.04	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
D-13.02.05	determine type of repair required such as bearing and coupling replacement, and re-balancing according to inspection and vibration analysis results
D-13.02.06	identify conditions that led to failure or breakdown of fans and blowers

Sub-task

D-13.03 Repairs fans and blowers.

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

Key Competencies

D-13.03.01	select and use tools and equipment such as welding machines, hand tools, and rigging equipment
D-13.03.02	correct imbalances by methods such as cleaning, rebalancing and replacing bearings
D-13.03.03	replace defective fan and blower components
D-13.03.04	lubricate bearings and couplings
D-13.03.05	energize equipment and start-up/return to operations

Sub-task

D-13.04 Maintains fans and blowers.

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

Key Competencies

D-13.04.01	perform sensory inspection of fan and blower components using tools such as tachometers as well as condition-based monitoring tools to locate defects such as wear, misalignment and debris build-up
D-13.04.02	verify maintenance requirements according to manufacturers' specifications
D-13.04.03	clean fan blades
D-13.04.04	lubricate bearings and couplings
D-13.04.05	re-align, replace and adjust fan and blower components

Task 14 Services compressors.

Context Compressors are the source which supplies and controls pressurized air systems. The failure of compressors can result in safety issues and lost productivity when not installed, repaired and maintained properly.

Required Knowledge

K 1	types of compressors such as dynamic and positive displacement
K 2	compressor accessories such as air dryers, filters, regulators, lubricators, pressure relief valves, intercoolers and aftercoolers
K 3	compressor components such as pistons, screws, vanes, impellers, valves.
K 4	compressor applications such as supply air, gas supply and process control
K 5	compressor faults such as lack of pressure, and excessive loading and unloading
K 6	compressor specifications such as CFM, horsepower, pressure and volumes
K 7	cooling and lubrication systems
K 8	drive components such as couplings and belts
K 9	manufacturers' specifications
K 10	jurisdictional regulations governing compressors
K 11	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis

K 12	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 13	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools
K 14	pressurized air systems and process gas systems

Sub-task

D-14.01 Installs compressors.

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

Key Competencies

D-14.01.01	select and use tools and equipment such as combination wrenches, impact wrenches, dial indicators, precision levels, and optical or laser alignment equipment
D-14.01.02	confirm flow/pressure requirement acccording to engineered drawings and plant demand
D-14.01.03	determine location and elevation for installation according to engineered drawings
D-14.01.04	clean and rough-up base for compressor by methods such as filing, sandblasting and buffing
D-14.01.05	prepare foundation according to engineered drawings
D-14.01.06	position compressor in place using rigging, hoisting/lifting and moving equipment
D-14.01.07	level, align and secure compressor
D-14.01.08	grout to distribute load and minimize vibration
D-14.01.09	check direction of rotation
D-14.01.10	check for vibration
D-14.01.11	connect inlet/outlet
D-14.01.12	install accessories such as silencers, filters, air dryers, lubricators and scrubbers
D-14.01.13	connect and align compressors to prime mover through couplings, sheaves and belts
D-14.01.14	install safety guards according to manufacturers' specifications and OH&S regulations
D-14.01.15	energize equipment and start-up/return to operations

Sub-task

D-14.02 Diagnoses compressors.

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

Key Competencies

D-14.02.01	obtain a description of the problem and symptoms
D-14.02.02	perform sensory inspection of components such as temperature gauges, sheaves, piping, valves, bearings and belts
D-14.02.03	use test/evaluation procedures and specialized equipment according to results of sensory inspection
D-14.02.04	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
D-14.02.05	determine type of repair required such as bearing and coupling replacement, and refurbishing of valves, according to inspection and vibration analysis results
D-14.02.06	identify conditions that led to failure or breakdown of compressors

Sub-task

D-14.03 Repairs compressors.

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

Key Competencies

D-14.03.01	select and use tools and equipment such as hand tools and rigging, hoisting/lifting and moving equipment
D-14.03.02	refurbish or replace defective compressor components such as impellers, heads, cross heads, pistons, filters, valves, rings, auto drains and temperature gauges according to manufacturers' specifications
D-14.03.03	lubricate bearings and couplings
D-14.03.04	align prime mover to compressor
D-14.03.05	energize equipment and start-up/return to operations

Sub-task

D-14.04 Maintains compressors.

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

Key Competencies

D-14.04.01	perform sensory inspection of compressor components using tools such as tachometers as well as condition-based monitoring tools to locate defects such as wear and misalignment
D-14.04.02	verify maintenance requirements according to manufacturers' specifications
D-14.04.03	clean or replace oil filters and air filters
D-14.04.04	check fluid levels such as coolant, oil and grease
D-14.04.05	check temperatures and pressures
D-14.04.06	re-align drive coupling
D-14.04.07	adjust loading and unloading set points
D-14.04.08	drain moisture from compressors, coolers and receivers
D-14.04.09	verify operation of relief valves, check valves and auto drain valves

Task 15 Services pumps.

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

Required Knowledge

K 1	positive displacement pumps such as gear, vane and piston
K 2	non-positive displacement pumps, such as centrifugal and axial
K 3	pump components such as bearings, mechanical seals, impellers, sleeves, lantern rings and packings
K 4	pump specifications such as pump curves, volumes, pressures, flow and clearances
K 5	cooling and lubrication systems
K 6	drive components such as couplings, sheaves and belts
K 7	faults such as low and excessive flows, cavitation and insufficient pressures

K 8	manufacturers' specifications
K 9	product being pumped
K 10	piping and tubing sizing and schematics
K 11	pump terminology such as static head, suction head and suction lift
K 12	prime movers
K 13	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 14	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 15	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools

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Sub-task

D-15.01 Installs pumps.

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

Key Competencies

D-15.01.01	select and use tools and equipment such as torque wrenches, and levelling and alignment equipment
D-15.01.02	determine location and elevation for installation according to engineered drawings
D-15.01.03	clean base for pump by methods such as filing, sandblasting and buffing
D-15.01.04	prepare and rough-up foundation according to engineered drawings
D-15.01.05	position pump in place using rigging, hoisting/lifting and moving equipment
D-15.01.06	level, align and secure pump
D-15.01.07	grout to distribute load and minimize vibration
D-15.01.08	set pump clearances according to manufacturers' specifications
D-15.01.09	install seals and adjust components such as packings
D-15.01.10	connect inlet/outlet
D-15.01.11	eliminate stress on pump by relieving pipe strain

Sub-task

D-15.02 Diagnoses pumps.

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

Key Competencies

D-15.02.01	obtain a description of the problem and symptoms
D-15.02.02	perform sensory inspection of pump components such as seals, bearings and filters for defects such as leaks and noise
D-15.02.03	use test/evaluation procedures such as monitoring temperature and vibration levels with specialized equipment according to results of sensory inspection
D-15.02.04	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
D-15.02.05	determine type of repair required such as bearing, impeller and coupling replacement, and refurbishing of valves according to inspection
D-15.02.06	identify conditions that led to failure or breakdown of pumps

Sub-task

D-15.03 Repairs pumps.

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

Key Competencies

D-15.03.01	select and use tools and equipment such as wrenches, induction heaters and pullers
D-15.03.02	refurbish or replace defective pump component such as impellers, pistons, filters, valves, rings, mechanical seals, shafts, couplings, wear rings and pressure gauges according to manufacturers' specifications
D-15.03.03	lubricate bearings and couplings
D-15.03.04	measure component dimensions such as shaft run-out, fits, clearances and tolerances

Sub-task

D-15.04 Maintains pumps.

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

Key Competencies

D-15.04.01	perform sensory inspection and use condition-based monitoring tools to locate defects such as wear and misalignment
D-15.04.02	verify maintenance requirements according to manufacturers' specifications
D-15.04.03	clean or replace oil filters and strainers
D-15.04.04	check fluid levels such as coolant, oil and grease
D-15.04.05	check temperatures, vacuum, pressure and flow rates
D-15.04.06	re-align drive coupling
D-15.04.07	verify operation of valves
D-15.04.08	adjust packings and monitor mechanical seals
D-15.04.09	check clearances against manufacturers' specifications

Task 16 Services conveying systems.

Context Conveying systems are used to transfer products safely and efficiently. This task includes installation, diagnosis, repair and maintenance of conveying systems.

Required Knowledge

K 1	types of mechanical conveying systems such as belt, chain, screw, roller and bucket
K 2	types of pneumatic and hydraulic conveying systems such as low pressure and high pressure
K 3	conveying system accessories such as trippers, ploughs, chutes, screens, skirt boards and flights
K 4	conveying system faults such as belt tracking, worn components and improper tension
K 5	conveying system specifications such as speed, distance travelled and load weight
K 6	conveyor components such as scrapers, bearings, sprockets, chains, belts and counter-weight assemblies

K 7	types of filters such as cyclones, bag shakers and precipitators
K 8	types of pulleys and rollers such as crowned, tail, take-up, tracking, idler and snub
K 9	types of gear boxes
K 10	manufacturers' specifications
K 11	material to be conveyed
K 12	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 13	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 14	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools

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Sub-task

D-16.01 Installs conveying systems.

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

Key Competencies

D-16.01.01	select and use tools and equipment such as hand tools, and levelling and alignment equipment
D-16.01.02	determine location and elevation for installation according to engineered drawings
D-16.01.03	prepare base or mounting brackets according to design specifications and type of installation
D-16.01.04	prepare foundation according to engineered drawings
D-16.01.05	assemble conveying system according to design specifications
D-16.01.06	install conveyor components such as bearings, pulleys, rollers, gear reduction units and take-ups
D-16.01.07	position conveying system in place using rigging, hoisting/lifting and moving equipment
D-16.01.08	align, level and secure conveying system according to type
D-16.01.09	grout to distribute load and minimize vibration
D-16.01.10	set clearances according to manufacturers' specifications
D-16.01.11	check direction of rotation
D-16.01.12	connect in-feed and discharge

D-16.01.13	connect belts using splicing techniques such as vulcanizing, cold splicing and applying mechanical fasteners
D-16.01.14	connect chains using components such as connecting links, rivets and locking clips
D-16.01.15	connect and align prime mover through couplings, sheaves and belts
D-16.01.16	install sensory devices such as motion detectors and depth sensors
D-16.01.17	install safety guards according to manufacturers' specifications and OH&S regulations
D-16.01.18	energize equipment and start-up/return to operation

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Sub-task

D-16.02 Diagnoses conveying systems.

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

Key Competencies

D-16.02.01	obtain a description of the problem and symptoms
D-16.02.02	perform sensory inspection of components such as limit switches, gear reduction units, emergency stops, couplings, magnets, pulleys, rollers, bearings, sheaves, sprockets, chains and belts
D-16.02.03	perform sensory inspection of filters such as cyclones, bag shakers, screens and precipitators
D-16.02.04	select and use tools and equipment such as hand tools, and levelling and alignment equipment to locate and troubleshoot defects
D-16.02.05	use test/evaluation procedures such as monitoring temperature and vibration levels with specialized equipment according to results of sensory inspection
D-16.02.06	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
D-16.02.07	determine type of repair required such as bearings, couplings, idlers, conveyor belts, mechanical splices, and rotary valve replacement according to inspection
D-16.02.08	identify conditions that led to failure or breakdown of conveying system

Sub-task

D-16.03 Repairs conveying systems.

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

Key Competencies

D-16.03.01	select and use tools and equipment such as hand tools, saws, and hoisting/ lifting and rigging equipment
D-16.03.02	refurbish or replace defective conveying system components such as gear reduction units, couplings, pulleys, rollers, bearings, sheaves, sprockets, screens, chains, skirting and belts according to manufacturers' specifications
D-16.03.03	lubricate bearings and couplings
D-16.03.04	align prime mover to conveyor system
D-16.03.05	connect belts using splicing techniques such as vulcanizing, cold splicing and applying mechanical fasteners
D-16.03.06	connect chains using components such as connecting links, rivets and locking clips
D-16.03.07	correct tracking issues with belt
D-16.03.08	energize equipment and start-up/return to operation

Sub-task

D-16.04 Maintains conveying systems.

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

Key Competencies

D-16.04.01	perform sensory inspection and use tools and equipment such as wrenches and tachometers as well as condition-based monitoring tools, to locate defects such as wear and misalignment
D-16.04.02	verify maintenance requirements according to manufacturers' specifications
D-16.04.03	check fluid levels such as oil and grease
D-16.04.04	check temperatures
D-16.04.05	re-align drive coupling
D-16.04.06	check clearances against manufacturers' specifications
D-16.04.07	maintain components by methods such as cleaning, lubricating and adjusting

D-16.04.08	maintain drive components by methods such as checking fluid levels and tensioning according to type of drive
D-16.04.09	adjust tracking of mechanical conveying systems
D-16.04.10	adjust conveying system accessories such as belt scraper, guides and training idlers
D-16.04.11	replace filters

Task 17 Services process tanks and containers.

Context Process tanks and containers are usually used to store and mix materials. Tanks and containers may be pressurized or open to atmosphere. This task includes installation, diagnosis, repair and maintenance of process tanks and containers such as bins and hoppers.

Required Knowledge

K 1	types of process tanks and containers such as pressurized vessels and storage tanks
K 2	process tank and container components such as piping, agitators, vents, pumps, compressors, blowers and level indicators
K 3	process tank and container specifications such as capacity and compatibility
K 4	material to be held and holding requirements such as corrosion resistance, tank pressures and temperature
K 5	piping schematics
K 6	environmental containment systems
K 7	hazards of and procedures for working in confined spaces
K 8	process tank and container faults such as leaks, and loss of or excess pressure
K 9	jurisdictional regulations governing steam and pressure vessels
K 10	cleaning requirements
K 11	diagnostic procedures and tools such as NDT
K 12	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis and infrared thermography
K 13	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 14	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools
K 15	vessel integrity and thickness testing (tank access to top/lid)

Sub-task

D-17.01 Installs process tanks and containers.

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

Key Competencies

D-17.01.01	select and use tools and equipment such as layout and levelling tools
D-17.01.02	determine location and elevation for installation according to engineered drawings
D-17.01.03	clean base for process tanks and containers by methods such as filing, sandblasting and buffing
D-17.01.04	prepare and rough-up foundation according to engineered drawings
D-17.01.05	position process tanks and containers in place using rigging, hoisting/lifting and moving equipment
D-17.01.06	level, align and secure process tanks and containers
D-17.01.07	check orientation of tank
D-17.01.08	grout to distribute load and minimize vibration
D-17.01.09	connect inlet/outlet
D-17.01.10	install components such as agitators, impellers, scrapers and mixers
D-17.01.11	install safety guards according to manufacturers' specifications and OH&S regulations

Sub-task

D-17.02 Diagnoses process tanks and containers.

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

Key Competencies

D-17.02.01	obtain a description of the problem and symptoms
D-17.02.02	perform sensory inspection of components such as filters, strainers, piping, agitators, vents and level indicators
D-17.02.03	determine if NDT or condition-based monitoring is required according to the results of sensory inspection
D-17.02.04	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection

D-17.02.05 determine type of repair required such as patching, overlay, re-coating and piping according to inspection and analysis results

D-17.02.06 identify conditions that led to failure or breakdown of process tanks and containers

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Sub-task

D-17.03 Repairs process tanks and containers.

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

Key Competencies

D-17.03.01 select and use tools and equipment such as hand tools and welding equipment

D-17.03.02 refurbish or replace defective components such as piping, agitators, vents, liners, seals and level indicators

D-17.03.03 measure component dimensions such as piping and length of shaft

D-17.03.04 adjust components such as agitators and mixers

D-17.03.05 lubricate components such as agitators, pull chains and mixers

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Sub-task

D-17.04 Maintains process tanks and containers.

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

Key Competencies

D-17.04.01 perform sensory inspection as well as use condition-based monitoring tools and NDT to locate defects such as leaks and wear

D-17.04.02 verify maintenance requirements according to manufacturers' specifications

D-17.04.03 clean or replace oil filters and strainers

D-17.04.04 check fluid levels such as coolant, oil and grease

D-17.04.05 check temperatures, pressures, vacuum and flow rates

D-17.04.06 verify operation of valves

D-17.04.07 adjust process tank and container components-by setting pressure relief valves and patching holes

D-17.04.08	check clearances of components such as agitators according to manufacturers' specifications
D-17.04.09	change liners
D-17.04.10	clear ventilation systems of blockages

BLOCK E HYDRAULIC, PNEUMATIC AND VACUUM SYSTEMS

Trends	With a greater number of computer-engineered and fabricated components and the evolution of electronics, systems and components are more compact and complex. Hydraulic, pneumatic and vacuum systems are continually evolving to operate faster and with greater power and efficiencies.
Related Components (including, but not limited to)	Pumps, compressors, valves, actuators, tanks, reservoirs, receivers, filters, piping, tubing, hoses, dryers, regulators, fluids, coolers, heaters, accumulators, intensifiers, strainers, seals, controllers, motors, cylinders.
Tools and Equipment	See Appendix A.

Task 18 Services hydraulic systems.

Context Hydraulic systems are versatile systems that use high pressure fluids to transmit power in a variety of industries. Industrial mechanics (millwrights) service these systems to ensure proper and efficient operation.

Required Knowledge

K 1	lock-out, tag-out and zero energy procedures
K 2	symbols, and reading and interpreting schematics
K 3	environmental concerns such as disposal of fluids
K 4	types of hydraulic circuits such as sequence, pressure reducing and counter-balance
K 5	hydraulic systems and components
K 6	auxiliary components such as coolers, heaters and accumulators
K 7	hydraulic principles
K 8	viscosity of fluids
K 9	installation procedures for hydraulic systems and components

K 10	hydraulic system faults such as loss of pressure, cavitations, contamination of fluid, aeration, leaks, loss of movement and speed, and overheating
K 11	basic electrical principles
K 12	trade calculations and theories such as Bernoulli's principle and Pascal's law
K 13	hydraulic system components such as pumps, control valves and actuators
K 14	types of valves such as directional control, flow control and pressure control
K 15	hazards and isolating procedures associated with high pressure fluids, zero energy and stored energy
K 16	operation of primary components such as actuators, pumps and valves
K 17	fluid conductors such as hoses, piping and tubing
K 18	types of fluids such as petroleum-based, fire resistant, food grade and environmentally friendly and synthetic
K 19	system operating parameters such as temperature, pressure and flow
K 20	filters, strainers and related contamination control equipment
K 21	basic control functions
K 22	programmable logic controller (PLC) operating principles
K 23	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 24	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 25	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools

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Sub-task

E-18.01 Installs hydraulic systems.

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

Key Competencies

E-18.01.01	select and use tools and equipment such as torque wrenches, pressure gauges and hand tools
E-18.01.02	select system components such as pumps, valves, actuators, reservoirs, hoses, seals, fittings, strainers and filters according to schematics and job specifications
E-18.01.03	select hydraulic fluids to meet site and system requirements
E-18.01.04	position and secure reservoirs for hydraulic systems according to schematics, manually or with rigging, hoisting/lifting and moving equipment

E-18.01.05	position, align and secure hydraulic pumps and motors according to schematics, manually or with rigging, hoisting/lifting and moving equipment
E-18.01.06	install components such as filters, strainers, hydraulic valves, actuators and motors according to schematics, manually or with rigging, hoisting/lifting and moving equipment
E-18.01.07	measure, cut, bend and connect piping, hoses and tubing according to schematics
E-18.01.08	test system by fine tuning pressure and fluid flow operation prior to start-up

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Sub-task

E-18.02 Diagnoses hydraulic systems.

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

Key Competencies

E-18.02.01	obtain a description of the problem and symptoms
E-18.02.02	perform sensory inspection of hydraulic systems such as listening for excessive noise, smelling burned components and feeling for excessive vibration
E-18.02.03	visually inspect for leaks, abnormal movements and oil conditions, and fluid levels
E-18.02.04	use test/evaluation procedures and specialized equipment according to results of sensory inspection
E-18.02.05	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
E-18.02.06	interpret specifications from technical manuals
E-18.02.07	inspect hydraulic systems to identify faults such as pressure and speed drop or increase
E-18.02.08	identify components that require repair or replacement
E-18.02.09	record hydraulic data

Sub-task

E-18.03 Repairs hydraulic systems.

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

Key Competencies

E-18.03.01	release pressure to ensure system or system component is in a zero energy state
E-18.03.02	mechanically lock the components in place.
E-18.03.03	prevent contamination during repairs by ensuring clean components
E-18.03.04	repair and replace components such as actuators, pumps, filters and valves
E-18.03.05	remove and replace component parts such as seals, pistons and valve spools
E-18.03.06	modify systems according to schematics
E-18.03.07	test system by fine tuning pressure and fluid flow operation prior to returning to service

Sub-task

E-18.04 Maintains hydraulic systems.

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

Key Competencies

E-18.04.01	perform sensory inspection of hydraulic systems as well as use condition-based monitoring tools to detect defects
E-18.04.02	verify and adjust fluid levels according to site and manufacturers' specifications
E-18.04.03	check and adjust system pressure, temperature and flow according to manufacturers' specifications
E-18.04.04	check and change filters according to manufacturers' specifications
E-18.04.05	assess overall performance of hydraulic systems according to performance specifications
E-18.04.06	clean hydraulic systems and components
E-18.04.07	record maintenance results

Task 19 Services pneumatic and vacuum systems.

Context 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.

Required Knowledge

K 1	inline lubrication systems
K 2	types and location of system components
K 3	symbols, and reading and interpreting schematics
K 4	types of pneumatic circuits such as sequence and pressure reducing
K 5	operation of vacuum systems
K 6	types of pneumatic valves such as time delay, quick exhaust, directional control valves and regulators
K 7	pneumatic and vacuum principles
K 8	basic electrical principles
K 9	installation procedures for all types of pneumatic and vacuum systems and components
K 10	pneumatic system faults such as leaks, loss of movement and speed, and overheating
K 11	vacuum system faults such as loss of vacuum pressure, overheating and leaks
K 12	trade calculations and theories such as Bernoulli's principle and Boyle's law
K 13	pneumatic system components such as compressors, control valves and actuators
K 14	vacuum system components such as vacuum pumps, valves and filters
K 15	hazards associated with high pressure air and stored energy
K 16	operation of primary components such as actuators, pumps, compressors and valves
K 17	conductors such as hoses, piping and tubing
K 18	system operating parameters such as temperature, dew point, pressure and flow
K 19	filters and related contamination control equipment
K 20	PLC operating principles
K 21	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis

K 22	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns
K 23	diagnostic procedures using appropriate condition-based monitoring technology(ies) and tools

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Sub-task

E-19.01 Installs pneumatic and vacuum systems.

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

Key Competencies

E-19.01.01	obtain a description of the problem and symptoms
E-19.01.02	select and use tools and equipment such as torque wrenches, pressure/vacuum gauges and hand tools
E-19.01.03	select system components such as hoses, seals, fittings, strainers and filters according to schematics and job specifications
E-19.01.04	position and secure components such as receivers, tanks and accumulators for pneumatic and vacuum systems according to schematics, manually or with rigging, hoisting/lifting and moving equipment
E-19.01.05	position, align and secure blowers, compressors, vacuum pumps and motors according to schematics, manually or with rigging, hoisting/lifting and moving equipment
E-19.01.06	measure, cut, bend and connect piping, hoses and tubing according to schematics
E-19.01.07	test system by fine tuning pressure and vacuum prior to start-up

Sub-task

E-19.02 Diagnoses pneumatic and vacuum systems.

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

Key Competencies

E-19.02.01	perform sensory inspection of pneumatic and vacuum systems such as listening for excessive noise, smelling burned components and feeling for excessive vibration
E-19.02.02	visually inspect for leaks, abnormal movements and oil conditions, and fluid levels
E-19.02.03	use test/evaluation procedures and specialized equipment according to results of sensory inspection
E-19.02.04	perform condition-based monitoring routine procedures to detect underlying defects not identified through sensory inspection
E-19.02.05	interpret specifications from technical manuals
E-19.02.06	inspect pneumatic and vacuum systems to identify faults such as pressure, vacuum and speed variance
E-19.02.07	identify components that require repair or replacement
E-19.02.08	record pneumatic and vacuum data

Sub-task

E-19.03 Repairs pneumatic and vacuum systems.

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

Key Competencies

E-19.03.01	release pressure to ensure system or system component is in a zero energy state
E-19.03.02	mechanically lock the components in place
E-19.03.03	prevent contamination during repairs by ensuring clean components
E-19.03.04	repair and replace components such as blowers, compressors, vacuum pumps, motors, valves and actuators according to site and manufacturers' specifications
E-19.03.05	remove and replace component parts such as filters, seals, strainers, dryers, lubricators and regulators

E-19.03.06	tighten components such as hoses, seals, fittings and flanges according to manufacturers' specifications
E-19.03.07	test system by fine tuning pressure and vacuum prior to returning to service

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Sub-task

E-19.04 Maintains pneumatic and vacuum systems.

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

Key Competencies

E-19.04.01	perform sensory inspection of pneumatic and vacuum systems as well as use condition-based monitoring tools to detect defects
E-19.04.02	verify and adjust fluid levels according to site and manufacturers' specifications
E-19.04.03	check and adjust system pressure, vacuum, lubricators, regulators, temperature, cycling and flow according to manufacturers' specifications
E-19.04.04	check and change gauges, filters and dryers according to manufacturers' specifications
E-19.04.05	assess overall performance of pneumatic and vacuum systems according to performance specifications
E-19.04.06	clean pneumatic and vacuum systems and components
E-19.04.07	record maintenance results
E-19.04.08	modify system to accommodate a change in requirements according to schematics

BLOCK F PREVENTIVE AND PREDICTIVE MAINTENANCE, TESTING AND COMMISSIONING

Trends

Reliability-centered maintenance (RCM) methodology and condition-based monitoring are becoming more accepted for their cost-effectiveness benefits.

Advancements in technologies have made the tools more user-friendly and easier to operate, for example ultrasound grease guns and vibration analysis tools and software. These tools can provide earlier detection of underlying defects, thus eliminating the guesswork in terms of which work to perform and providing more adequate time to schedule the repairs.

Related Components

All components apply.

Tools and Equipment

See Appendix A.

Task 20 Performs preventive and predictive maintenance.

Context

Industrial mechanics (millwrights) may perform preventive and predictive maintenance tasks to ensure functional and consistent performance of machinery and equipment.

Preventive maintenance involves the routine scheduling of maintenance activities based on past history and manufacturers' recommendations. 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.

These types of maintenances can be done while the equipment or system is energized or when it is shut down.

Required Knowledge

K 1	benefits of RCM methodology
K 2	preventive and predictive maintenance programs and schedules
K 3	safe operating temperatures of equipment

K 4	specialized predictive maintenance tools such as data collectors and computerized maintenance management systems (CMMS)
K 5	specialized tools and equipment such as ultrasound grease guns
K 6	safe use and operation of specialized tools and equipment (awareness of surrounding)
K 7	maintenance history of equipment
K 8	manufacturers' specifications
K 9	condition-based monitoring technologies such as vibration analysis, UT, fluid analysis, infrared thermography and motor current analysis
K 10	condition-based monitoring tools such as strobe lights, stethoscope, vibration data collectors, infrared cameras and temperature guns

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Sub-task

F-20.01 Performs preventive maintenance activities.

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

Key Competencies

F-20.01.01	perform sensory inspections of machinery, equipment and components at predetermined scheduled intervals to detect abnormalities such as change in pitch, rattling, cracks, loose bolts and leaks
F-20.01.02	perform hands-on inspections like checking tolerances and clearances of machinery, equipment and components using tools such as hand tools, gauges and strobe lights
F-20.01.03	check for worn, defective, broken or otherwise unacceptable components such as filters, sight glasses, packing, seals, bearings and gaskets
F-20.01.04	check condition, level and temperature of fluids according to manufacturers' recommendations
F-20.01.05	grease and lubricate components according to site, manufacturers' or engineers' specifications
F-20.01.06	adjust tension on components such as belts, chains and tie rods
F-20.01.07	record information for future equipment evaluation and eventual repair

Sub-task

F-20.02 Performs predictive maintenance activities.

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

Key Competencies

F-20.02.01	select specialized tools and equipment to use based on their applications and limitations, and the required accuracy of the result
F-20.02.02	select NDT to be used such as dye penetrant, infrared, ultrasound and magnetic particle based on the characteristics of the machinery, equipment or component being tested
F-20.02.03	detect faults, frequencies or defects in the machinery or the equipment by reviewing spectrums, graphs, logbooks, lab reports and images
F-20.02.04	record information for future equipment evaluation and eventual repair

Sub-task

F-20.03 Schedules preventive and predictive maintenance.

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

Key Competencies

F-20.03.01	determine equipment's criticality and its failure history, or its life expectancy if no history exists by referring to CMMS, similar technology, duplicate equipment on or off-site, design drawings and manufacturers' recommendations
F-20.03.02	review collected data to determine suitable maintenance schedules

Task 21 Performs specialized testing and analysis.

Context Industrial mechanics (millwrights) may perform condition-based monitoring tests on rotating and on non-rotating equipment. These 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.

Required Knowledge

K 1	CMMS
K 2	preventive and predictive maintenance programs and schedules
K 3	rotating and non-rotating equipment faults
K 4	vibration, ultrasound, infrared and tribology theory
K 5	types of fluids to be tested such as oil, glycol and grease
K 6	sample collection techniques
K 7	types of analyzers and transducers and their applications
K 8	types of internal components on which data is being collected
K 9	data collection points
K 10	NDT techniques such as dye penetrant, magnetic particle, radiography and ultrasonic
K 11	testing techniques such as particle count, filter patch, ferrography and viscosity
K 12	types of imbalance such as static, dynamic and coupled
K 13	manufacturers' and company-specific specifications for balancing
K 14	balancing machines and analyzing equipment
K 15	static and dynamic balancing procedures
K 16	single- and multi-plane balancing methods
K 17	alignment procedures
K 18	types of misalignment such as horizontal, vertical and angular
K 19	benefit of properly balanced and aligned equipment
K 20	ferrous and non-ferrous properties

Sub-task

F-21.01 Performs vibration analysis procedures.

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

Key Competencies

F-21.01.01	select vibration analyzing equipment and software depending on application such as overall vibration analysis, modal analysis and operational deflection shape (ODS) analysis
F-21.01.02	install the necessary manufacturer components to achieve consistent readings at predetermined access points
F-21.01.03	set parameters of software for desired data collection
F-21.01.04	collect readings at consistent points across rotating and non-rotating equipment
F-21.01.05	identify vibration frequencies related to type of internal components on which data is being collected
F-21.01.06	identify causes of vibration such as eccentricity, misalignment and shaft faults based on interpretation of data collected

Sub-task

F-21.02 Performs balancing procedures.

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

Key Competencies

F-21.02.01	clean machinery/equipment to confirm if balancing is necessary
F-21.02.02	inspect machinery or equipment for defects such as missing buckets, broken fins, bent shafts, missing weights and loose fit
F-21.02.03	use balancing equipment such as hand-held devices and shop balancing machines to determine location of imbalance
F-21.02.04	identify type of imbalance in equipment and machinery to determine corrective action needed
F-21.02.05	add and/or remove specific weights at identified locations to meet specifications

Sub-task

F-21.03 Performs alignment procedures.

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

Key Competencies

F-21.03.01	clean machinery or equipment to avoid false readings
F-21.03.02	inspect machinery or equipment for defects such as loose bolts, cracked foundations and pipe strain
F-21.03.03	select and use alignment tools such as feeler gauges, straightedges, dial indicators and laser alignment devices to determine degree of misalignment
F-21.03.04	identify cause of misalignment in equipment and machinery to determine corrective action needed
F-21.03.05	correct vertical, horizontal and angular misalignment, and soft foot of direct drive equipment by adding and/or removing shims, and/or by adjusting the angular position of the driver/driven equipment
F-21.03.06	correct misalignment of driver/driven sprockets or sheaves by adjusting their position
F-21.03.07	record alignment data to demonstrate compliance

Sub-task

F-21.04 Performs non-destructive testing (NDT) procedures.

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

Key Competencies

F-21.04.01	prepare the equipment for testing by cleaning, removing paint or rust to avoid false readings
F-21.04.02	select NDT method based on equipment characteristics (ferrous/non-ferrous) and results required to detect faults such as cracks, thin walls and inclusions
F-21.04.03	determine hardness of material to confirm it meets specifications for intended purpose
F-21.04.04	follow dye penetrant procedures to expose cracks in ferrous and non-ferrous materials caused by fatigue, improper welding or impurities

Sub-task

F-21.05 Performs fluid analysis procedures.

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

Key Competencies

F-21.05.01	perform sensory inspections of fluid condition to detect abnormalities such as change in colour and odour, presence of sludge and impurities
F-21.05.02	determine location and frequency of sample collection using established best procedures to ensure reliability of current and future results
F-21.05.03	interpret external test report information such as contamination, abnormal viscosity and wear particles
F-21.05.04	direct information for corrective action

Task 22 Commissions equipment.

Context After installation or repair, industrial mechanics (millwrights) commission machinery to ensure that it operates to specifications. Steps include start-up, assessment and adjustment, and determining baseline operating specifications when necessary.

Required Knowledge

K 1	manufacturers' specifications, recommendations and operating parameters
K 2	intended machine operation
K 3	engineers' intended operating design
K 4	schematics
K 5	mechanical troubleshooting techniques
K 6	commissioning checklists and sequence
K 7	program logics

Sub-task

F-22.01 Commissions mechanical systems and components, and material handling/process systems.

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

Key Competencies

F-22.01.01	review check list to ensure that rotational checks and all other procedures have been completed according to engineering and manufacturers' specifications
F-22.01.02	check safety components such as guards, emergency stops and overrun switches
F-22.01.03	start-up and run-in systems and equipment in predetermined order according to type and design of system
F-22.01.04	perform monitoring activities such as packing adjustments and alignments
F-22.01.05	re-torque bolts such as anchor, base, flanges, bull gears and pinions after manufacturers' recommended run-in period
F-22.01.06	confirm alignment, such as hot alignment from steam turbines and hot/cold fluids, of equipment after manufacturers' recommended run-in period
F-22.01.07	perform baseline readings on preliminary tests such as vibration, fluids, ultrasound and infrared

Sub-task

F-22.02 Commissions hydraulic, pneumatic and vacuum systems.

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

Key Competencies

F-22.02.01	review check list to ensure that rotational checks and all other procedures have been completed according to engineering and manufacturers' specifications
F-22.02.02	check safety components such as guards, emergency stops and overrun switches
F-22.02.03	start-up and run-in systems and equipment in predetermined order according to type and design of system
F-22.02.04	perform monitoring activities such as packing adjustments and alignments

F-22.02.05	re-torque bolts such as anchor, base, flanges and cylinder heads after manufacturers' recommended run-in period
F-22.02.06	confirm alignment of motors and pumps after manufacturers' recommended run-in period
F-22.02.07	perform baseline readings on preliminary tests such as vibration, fluids, ultrasound and infrared

APPENDICES

APPENDIX A TOOLS AND EQUIPMENT

Hand Tools

adjustable wrenches
Allen keys
brushes (wire, cleaning, etc.)
calculators
clamps
chisels
drill bits
files
grease gun
hacksaw
hammer, ball peen
hammer, claw
hammer, dead blow
hammer, soft faced
hammer, rubber
hammer, chipping
honing stone
levels (carpenter, machinist, torpedo, etc.)
alignment bars
locking pliers
locks
nibblers
oil can
parallel bars
piano wire
pipe and tube cutters
pipe wrenches
pliers
plumb bob
pop riveter
pry bars
pullers
punches
scraper
screwdrivers
scribers
socket wrenches
tap and dies
tap extractors
reamers
thread chasers
threading accessories
ultrasound grease gun
tin snip
torque wrench
trammel heads
trowels
tube benders
wheel dresser
wrenches

Measuring and Layout Tools

bore gauge
chalk lines
combination square set
deflection gauge
depth gauge
dial indicator
dividers
engineers' square
feeler gauge
gauge block
gear pitch gauge
height gauge
indicator gauge
inside calipers
laser alignment equipment
lead wire
micrometers
optical levels
outside calipers
plastic gauge
protractor
radius gauge

Measuring and Layout Tools (continued)

rulers
sheave gauge
sine bar
small hole gauge
solid square
straightedge
string line
surface gauge
tape measures
taper gauge
telescopic gauge
tension gauge
thread gauge
transit
V-block
vernier calipers

Portable Power Tools

angle drill
angle grinder
chainsaw
chop saw
circular saw
die grinder
hammer drill
heat gun
hydraulic ram
hydraulic nuts
hydraulic wrenches
impact drill
impact gun (rivet)
impact wrench
jack hammer
jig saw
portable bender
portable drill
powder-actuated tool
power band saw
power threader
routers
reciprocating saw
tube rollers

Shop Tools and Equipment

band saw
bearing heater
brake press
chop saw
cribbing
drill press
dunnage
hydraulic press
iron worker
lathe
milling machine
parts washer
sand blaster
shears
stationary grinder
surface grinder
vices

Welding and Cutting Equipment

arc welding equipment
metal inert gas welding (MIG) equipment
oxy-acetylene equipment
plasma arc cutting equipment
rod ovens
tungsten inert gas welding (TIG) equipment
welding machines

Testing Equipment

balancing equipment
borescope
computers
dye penetrant test equipment
fluid analysis equipment
hydraulic gauge
laser alignment equipment
multimeter
pressure/vacuum gauge
printers
radio transmitter
hardness test equipment
scales
strobe light
tachometer
theodolite
thermographic test equipment
ultrasonic test equipment
ultrasound test equipment
vibration analysis equipment

Access, Rigging, Hoisting and Lifting Equipment

aerial lifts
air jack
air tuggers
block and tackle
cable hoists
caterpillar tracks (skates)
chains
chain fall
come-along
dolly
fork lift
gantry crane
grip hoist
hydraulic blocks
hydraulic jack
ladders
mobile crane
outrigger
overhead crane
pinch bar
power chain blocks
scaffolds
scissor lift
screw jack
shackles
sheaves block
slings
snatch block
spreader bar
trolleys

Personal Protective Equipment and Safety Equipment

apron
breathing protection (paper filter masks to self-contained breathing apparatus)
coveralls - all types (acid/chemical/fire resistant, etc)
gloves
goggles
hearing protection
hard hat
life jackets
eye wash station
face shields
first aid kit
safety footwear
safety glasses
safety harness & fall arresting devices
safety vests
welding blinds

Resource Materials

ANSI/ASME/ASTM standards
blueprints

Canadian Standards Association (CSA) documents
Canadian Welding Bureau materials
industry/contractors safety manual (handbook)
industry manuals such as IPT's handbooks and Machinery's Handbook
Internet resources
local licensing data
Material Safety Data Sheets (MSDS)
National Building Code (NBC)
Occupational Health and Safety (OH&S) regulations
rigging and hoisting manuals

schematics
sketches

manufacturers' specifications

standards documentation
technical manuals
WHMIS labels

APPENDIX B GLOSSARY

agitator	a device which keeps material moving in a tank or vessel; the movement may be required to prevent settling and to mix material
arc of contact	surface contact between the sheave and pulley and the belt, or the sprocket and the chain
axial flow	to flow along the axis of a fan or a pump
babbitt	material used in plain bearings (usually lead-based)
bearing	device that allows two parts to rotate or move in contact with each other
blower	device that moves air at low or high pressures and volumes
centrifugal flow	to flow 90 degrees to the axis of a fan or a pump away from the centre
clutch	device used to engage or disengage a driver to a driven unit
conveying systems	system used to move material (usually solid) from one place to another
couplings	parts used to connect a driver to a driven unit
elastomeric element	flexible element used to join couplings and dampen energy
engineered lift	consulting an engineer for an approved design of a lifting apparatus or lifting procedure without exceeding the rated capacity of the rigging equipment; it should be noted that this is generally done when unusual circumstances of a lift dictate deviations from normal accepted trade practices
fans	device used to create air movement
ferrography	wear analysis of machine bearing surfaces by collection of ferrous (or nonferrous) wear particles from lubricating oil in a ferrograph analyzer
fluid	substance (either a liquid or gas) material that has the ability to flow
gear system	combination of gears used to alter the speed and power from a driver to a driven unit
hypoid gear	set of gearing whose shafts intersect on a different plane

maintain	keeping a machine or system running efficiently with a minimum amount of down-time; ror use in this analysis the term "maintain" can encompass: checking for worn parts, lubrication, adjustment, inspection and modification
manufacturers' specifications	refers to the performance and engineering standards for a particular machine as detailed by the manufacturer; this information is usually available from drawings, manuals and bulletins provided by the manufacturer
multi-plane balancing	to balance a rotating part on more than two planes; multi-plane balancing is usually performed with computer software that is usually provided with vibration analysis and balancing instruments
non-destructive testing (NDT)	testing procedures that do not damage the material being tested; these may include magnetic particle testing, dye penetrant testing, and fluid sampling
positive displacement	transfer by pump without loss of pressure or material
predictive maintenance	activities utilizing information from past and current performance records to objectively predict mechanical problems; predictive maintenance is a proactive monitoring approach rather than a time-based or reactive approach
preventive maintenance	activities based on a periodic sampling and inspections; it normally involves the routine scheduling of maintenance activities; this schedule is based on past experience and manufacturers' recommendations
prime mover	driver of the machine; it may be an electric, steam, gas or diesel powered
sensory inspection	inspecting through the senses (visual, hearing, feeling, smell)
service	for use in this analysis the term "service" refers to installing, diagnosing, repairing and maintaining
thermographic equipment	equipment that displays the temperatures of components by measuring infrared radiation
tribology	the study of friction, wear, lubrication, and the design of bearings; the science of interacting surfaces in relative motion.
vibration analysis	the process of monitoring the condition of equipment and the diagnosis of faults in equipment through the measurement and analysis of vibration within that equipment

APPENDIX C ACRONYMS

AC / DC	alternating current / direct current
CFM	cubic feet per minute
CMMS	computerized maintenance management system
FCAW	flux-cored arc welding
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)
MCAW	metal-cored arc welding
MIG	See GMAW
MSDS	Material Safety Data Sheets
NATAC	National Apprenticeship and Training Advisory Committee
NDT	non-destructive testing
ODS	operational deflection shape
OH&S	Occupational Health and Safety
PLC	programmable logic controller
PPE	personal protective equipment
RCM	reliability-centered maintenance
SMAW	shielded metal arc welding
SOP	standard operating procedures
TIG	See GTAW
UT	ultrasonic technology
WHMIS	Workplace Hazardous Materials Information System
WLL	working load limit

APPENDIX D BLOCK AND TASK WEIGHTING

BLOCK A COMMON OCCUPATIONAL SKILLS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	11	13	9	NV	20	20	16	20	10	NV	NV	NV	15%

Task 1 Performs safety-related functions.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	25	21	25	20	NV	25	25	22	15	8	NV	NV	NV	21%

Task 2 Maintains and uses tools and equipment.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	17	15	24	NV	30	15	26	20	12	NV	NV	NV	20%

Task 3 Performs routine trade tasks.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	27	20	26	NV	25	15	21	50	25	NV	NV	NV	25%

Task 4 Performs measuring and layout.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	20	20	18	NV	10	15	19	10	30	NV	NV	NV	18%

Task 5 Performs cutting and welding operations.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	15	20	12	NV	10	30	12	5	25	NV	NV	NV	16%

BLOCK B RIGGING, HOISTING/LIFTING AND MOVING

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	12	12	21	NV	10	10	14	10	15	NV	NV	NV	14%

Task 6 Plans rigging, hoisting/lifting and moving.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	35	50	50	NV	70	70	46	15	60	NV	NV	NV	50%

Task 7 Rigs, hoists/lifts and moves load.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	65	50	50	NV	30	30	54	85	40	NV	NV	NV	50%

BLOCK C MECHANICAL COMPONENTS AND SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	27	20	24	NV	26	25	25	20	30	NV	NV	NV	24%

Task 8 Services prime movers.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	25	20	14	NV	10	24	27	20	20	NV	NV	NV	20%

Task 9 Services shafts, bearings and seals.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	25	23	20	24	NV	30	25	22	20	30	NV	NV	NV	24%

Task 10 Services couplings, clutches and brakes.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	25	18	20	26	NV	15	25	16	20	15	NV	NV	NV	20%

Task 11 Services chain and belt drive systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	16	20	22	NV	27	13	20	20	20	NV	NV	NV	19%

Task 12 Services gear systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	18	20	14	NV	18	13	15	20	15	NV	NV	NV	17%

BLOCK D MATERIAL HANDLING/PROCESS SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	20	20	20	18	NV	21	25	20	20	25	NV	NV	NV	21%

Task 13 Services fans and blowers.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	15	15	20	16	NV	15	20	19	20	15	NV	NV	NV	17%

Task 14 Services compressors.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	27	20	23	NV	10	20	19	20	15	NV	NV	NV	19%

Task 15 Services pumps.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	25	25	26	NV	30	30	31	20	30	NV	NV	NV	28%

Task 16 Services conveying systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	25	23	25	26	NV	30	20	18	20	35	NV	NV	NV	25%

Task 17 Services process tanks and containers.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	10	10	10	9	NV	15	10	13	20	5	NV	NV	NV	11%

BLOCK E HYDRAULIC, PNEUMATIC AND VACUUM SYSTEMS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	10	20	17	18	NV	10	10	17	15	15	NV	NV	NV	15%

Task 18 Services hydraulic systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	60	50	50	NV	50	60	55	60	60	NV	NV	NV	55%

Task 19 Services pneumatic and vacuum systems.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	40	50	50	NV	50	40	45	40	40	NV	NV	NV	45%

BLOCK F PREVENTIVE AND PREDICTIVE MAINTENANCE, TESTING AND COMMISSIONING

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	10	10	18	10	NV	13	10	8	15	5	NV	NV	NV	11%

Task 20 Performs preventive and predictive maintenance.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	45	32	50	45	NV	50	30	55	30	30	NV	NV	NV	41%

Task 21 Performs specialized testing and analysis.

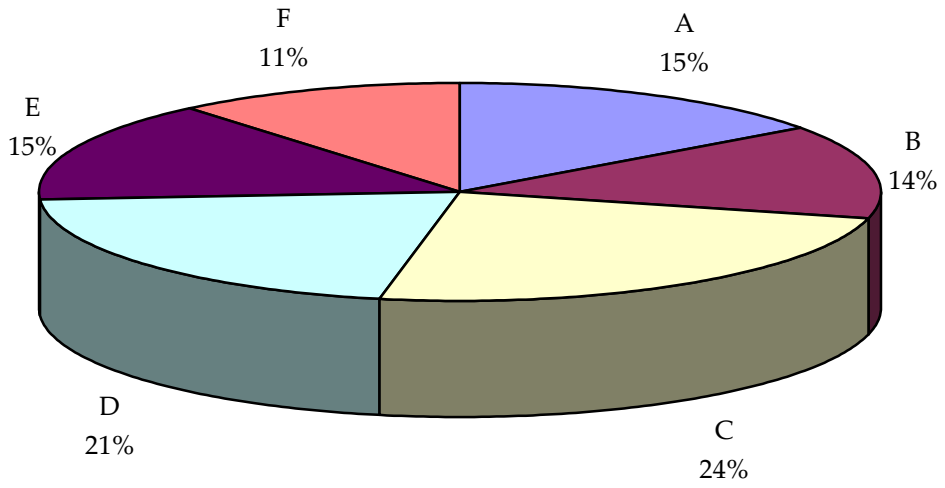
	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	10	28	20	35	NV	20	40	20	50	10	NV	NV	NV	26%

Task 22 Commissions equipment.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	45	40	30	20	NV	30	30	25	20	60	NV	NV	NV	33%

APPENDIX E

PIE CHART*



TITLES OF BLOCKS

BLOCK A	Common Occupational Skills	BLOCK D	Material Handling/Processing Systems
BLOCK B	Rigging, Hoisting/Lifting and Moving	BLOCK E	Hydraulic, Pneumatic and Vacuum Systems
BLOCK C	Mechanical Components and Systems	BLOCK F	Preventive and Predictive Maintenance, Testing and Commissioning

*Average percentage of the total number of questions on an interprovincial examination, assigned to assess each block of the analysis, as derived from the collective input from workers within the occupation from all areas of Canada. Interprovincial examinations typically have from 100 to 150 multiple-choice questions.

APPENDIX F

TASK PROFILE CHART — Industrial Mechanic (Millwright)

BLOCKS	TASKS	SUB-TASKS				
A – COMMON OCCUPATIONAL SKILLS	1. Performs safety-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.	
	2. Maintains and uses tools and equipment.	2.01 Maintains hand and portable power tools.	2.02 Maintains precision measuring and layout tools.	2.03 Maintains rigging, hoisting/lifting and moving equipment.	2.04 Maintains welding equipment.	2.05 Uses shop machines.
		2.06 Uses access equipment.				
	3. Performs routine trade tasks.	3.01 Plans work.	3.02 Fabricates workpiece.	3.03 Lubricates systems and components.	3.04 Performs leveling of components and systems.	3.05 Uses fastening and retaining devices.
		3.06 Tests metal and other materials using standardized procedures.	3.07 Performs heat treatment of metal.	3.08 Uses mechanical drawings and schematics.		
	4. Performs measuring and layout.	4.01 Prepares work area, tools and materials.	4.02 Measures material and components.	4.03 Lays out components.		
	5. Performs cutting and welding operations.	5.01 Cuts material with gas and plasma arc cutting equipment.	5.02 Joins material using gas welding equipment.	5.03 Welds material using arc welding equipment.	5.04 Welds material with gas metal arc welding (GMAW (MIG)) equipment.	5.05 Welds material with gas tungsten arc welding (GTAW (TIG)) equipment.

BLOCKS	TASKS	SUB-TASKS			
B – RIGGING, HOISTING/ LIFTING AND MOVING	6. Plans rigging, hoisting/lifting and moving.	6.01 Determines load.	6.02 Selects rigging equipment.	6.03 Selects hoisting/lifting and moving equipment.	
	7. Rigs, hoists/lifts and moves load.	7.01 Secures area.	7.02 Sets up rigging, hoisting/lifting and moving equipment.	7.03 Performs hoist/lift and move.	
C – MECHANICAL COMPONENTS AND SYSTEMS	8. Services prime movers.	8.01 Installs prime movers.	8.02 Diagnoses prime movers.	8.03 Repairs prime movers.	
	9. Services shafts, bearings and seals.	9.01 Installs shafts, bearings and seals.	9.02 Diagnoses shafts, bearings and seals.	9.03 Repairs shafts, bearings and seals.	9.04 Maintains shafts, bearings and seals.
	10. Services couplings, clutches and brakes.	10.01 Installs couplings, clutches and brakes.	10.02 Diagnoses couplings, clutches and brakes.	10.03 Repairs couplings, clutches and brakes.	
	11. Services chain and belt drive systems.	11.01 Installs chain and belt drive systems.	11.02 Diagnoses chain and belt drive systems.	11.03 Repairs chain and belt drive systems.	11.04 Maintains chain and belt drive systems.
	12. Services gear systems.	12.01 Installs gear systems.	12.02 Diagnoses gear systems.	12.03 Repairs gear systems.	12.04 Maintains gear systems.

BLOCKS	TASKS	SUB-TASKS			
D – MATERIAL HANDLING/ PROCESS SYSTEMS	13. Services fans and blowers.	13.01 Installs fans and blowers.	13.02 Diagnoses fans and blowers.	13.03 Repairs fans and blowers.	13.04 Maintains fans and blowers.
	14. Services compressors.	14.01 Installs compressors.	14.02 Diagnoses compressors.	14.03 Repairs compressors.	14.04 Maintains compressors.
	15. Services pumps.	15.01 Installs pumps.	15.02 Diagnoses pumps.	15.03 Repairs pumps.	15.04 Maintains pumps.
	16. Services conveying systems.	16.01 Installs conveying systems.	16.02 Diagnoses conveying systems.	16.03 Repairs conveying systems.	16.04 Maintains conveying systems.
	17. Services process tanks and containers.	17.01 Installs process tanks and containers.	17.02 Diagnoses process tanks and containers.	17.03 Repairs process tanks and containers.	17.04 Maintains process tanks and containers.
E – HYDRAULIC, PNEUMATIC AND VACUUM SYSTEMS	18. Services hydraulic systems.	18.01 Installs hydraulic systems.	18.02 Diagnoses hydraulic systems.	18.03 Repairs hydraulic systems.	18.04 Maintains hydraulic systems.
	19. Services pneumatic and vacuum systems.	19.01 Installs pneumatic and vacuum systems.	19.02 Diagnoses pneumatic and vacuum systems.	19.03 Repairs pneumatic and vacuum systems.	19.04 Maintains pneumatic and vacuum systems.

BLOCKS	TASKS	SUB-TASKS				
F – PREVENTIVE AND PREDICTIVE MAINTENANCE, TESTING AND COMMISSIONING	20. Performs preventive and predictive maintenance.	20.01 Performs preventive maintenance activities.	20.02 Performs predictive maintenance activities.	20.03 Schedules preventive and predictive maintenance.		
	21. Performs specialized testing and analysis.	21.01 Performs vibration analysis procedures.	21.02 Performs balancing procedures.	21.03 Performs alignment procedures.	21.04 Performs non-destructive testing (NDT) procedures.	21.05 Performs fluid analysis procedures.
	22. Commissions equipment.	22.01 Commissions mechanical systems and components, and material handling/process systems.	22.02 Commissions hydraulic, pneumatic and vacuum systems.			