PROGRAM PROGRAMME
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Red Seal Occupational Standard

Steamfitter/Pipefitter

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Foreword

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Red Seal Occupational Standard (RSOS) as the Red Seal standard for the Steamfitter/Pipefitter trade.

Background

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

Standards have the following objectives:

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

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

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

Structure of the Occupational Standard

This standard contains the following sections:

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

Description of the Steamfitter/Pipefitter trade: an overview of the trade's duties, work environment, job requirements, similar occupations and career progression

Trends in the Steamfitter/Pipefitter trade: some of the trends identified by industry as being the most important for workers in this trade

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

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

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

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

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

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

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

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

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

Task Descriptor: a general description of the task

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

Skills:

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

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

Range of Variables: elements and examples (not all inclusive) that provide a more in-depth description of a term used in the performance criteria and evidence of attainment

Knowledge:

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

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

Range of Variables: elements and examples (not all inclusive) that provide a more in-depth description of a term used in the learning outcomes and learning objectives

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

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

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

Methodology

Development of the Standard

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

Harmonization of Apprenticeship Training

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

Online Survey

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

Draft Review

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

Validation and Weighting

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

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

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

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

Definitions for Validation and Weighting

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

Provincial/Territorial Abbreviations

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

Description of the Steamfitter/Pipefitter Trade

“Steamfitter/Pipefitter” is this trade’s official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by a Steamfitter/Pipefitter.

Steamfitters/Pipefitters lay out, assemble, fabricate, maintain, repair and service equipment and piping systems carrying water, steam, fluids, gases, chemicals and fuel in various systems such as heating, cooling, lubricating and process piping systems. They read and interpret drawings, specifications and codes to determine layout, type and size of pipe, and tools to use. They measure, cut, thread, groove, bend, solder, braze, tack, assemble and install metallic, plastic and fiberglass pipes, valves, system components and fittings. As well, they must be able to join and secure pipe sections of related equipment using various methods. They check systems for leaks. Steamfitters/Pipefitters also do general maintenance work including repair or replacement of worn components.

Steamfitters/Pipefitters must carry out quality control checks on work performed. The system must be tested and commissioned to verify the quality of work and to confirm that the system is functioning to design specifications. They use welding, cutting, shaping, soldering, threading, mechanical and brazing equipment to join pipes and fabricate sections of piping systems.

Areas of specialization in this trade include maintenance, quality control, rigging, hoisting, fabrication and installation of various types of systems and specialty piping. Some steamfitters/pipefitters collaborate with consultants and owners in the design and planning stages.

Safety practices are of utmost importance in this trade. Steamfitters/Pipefitters work both indoors and outdoors at physically demanding tasks that often require working at heights. There is some risk of injury when working in and around trenches, on work platforms, and with power tools and heavy equipment. The piping systems may carry dangerous substances and contents at high pressures. Safety practices and training are emphasized in order to minimize risks.

Steamfitters/Pipefitters must have mechanical aptitude, manual dexterity, mathematical skills, an ability to read and understand complex instructions, and an ability to do careful and exacting work. They sometimes work in uncomfortable or cramped positions. In aspects of layout, work organization, project planning and supervisory tasks, steamfitters/pipefitters may also make use of many digital tools and applications.

Steamfitters/Pipefitters work in many sectors including pipelines, nuclear energy, mining, petrochemical, natural gas, sawmills, inland and offshore oil and gas, shipbuilding, automotive, pulp and paper, renewable energy, residential, commercial and institutional. With experience, steamfitters/pipefitters may advance to positions such as supervisor, contractor, owner, superintendent and instructor.

Trends in the Steamfitter/Pipefitter Trade

Technology

There is an ongoing trend towards the use of computers for generating reports, schedules, requests for information (RFI), ordering material, completion of forms, rendering drawings (computer-aided design or CAD), system analysis and service, and control of heating/cooling systems.

Digital devices can be used to access piping apps and online sources to quickly access information such as pipe weights, bolt sizes and wall thickness. Laser and digital layout equipment such as total station and global positioning system (GPS) technology is increasingly important for trade activities.

3D software and equipment are gaining popularity for drawing production, model manipulation and measuring. 3D scanning is also being used, allowing contractors to scan entire mechanical rooms and pre-fabricate off of the digital dimensions. The use of virtual reality (VR) through VR headsets, allows the user to see a finished installation through Building Information Modelling (BIM).

Robotic layout stations are being used in new designs and installations. Laser levels and laser plumb bobs along with robotic stations facilitate layout in various installations such as boiler rooms, making it easier to locate interferences.

Tools and Equipment

There is an increase in the use of hydraulic/pneumatic/electric cutting and bevelling tools for pipe-end preparation. Hydraulic/pneumatic/electric tensioning and torquing equipment are also becoming more common in the trade. There is an increase in the use of poly fusion methods which increase efficiency and safety.

Press fit joining techniques are being used more in the commercial heating sectors for heating and cooling applications. It is also becoming more popular in some industrial applications, shipbuilding and where intrinsically safe methods are required.

New access equipment such as rope access systems are being used in place of scaffolding in various work locations.

Battery-operated tools are becoming far more efficient, powerful, brushless, and less costly, as well as far lighter and safer to use in tight work areas.

Health and Safety

Steamfitters/Pipefitters are expected to obtain and maintain a high level of safety knowledge and training.

Health and safety are the most important parts of a job. Safety certifications and records can be the difference between getting a job and not being able to bid for work.

New safety equipment is also available to protect workers and equipment. There is more stringent *Working at Heights* training. Improved fall restraint systems are being utilized.

Environmental

Similar to Health and Safety, environmental concerns are at an all-time high. Leadership in Energy and Environmental Design (LEED) design and construction is being used by owners and designers more often.

Contracts increasingly have built-in requirements for health, safety and environmental performance so attention needs to be given to proper waste disposal and management.

Renewable and sustainable energy systems such as geo-exchange, geothermal, solar, radiant, refrigeration, heat recovery, CO_2 capture and central cooling plants are becoming more prevalent. There is new technology for water-heating such as low-mass boilers, on-demand (flow-through) hot water systems, condensing boilers, biomass, high efficiency boilers and co-generation boilers. Heating and cooling systems are becoming increasingly hybridized, making it less clear where one system ends and the other begins.

Products/Materials

New materials and products are becoming economically feasible, and driving changes in structural design, especially in industrial and institutional sectors. New materials and products such as high heat/corrosion resistant rubbers, gaskets, new low-pressure steam couplings and new steam traps are being used more frequently to replace components and perform repairs.

Plastic pipe is increasingly being used in residential, commercial and institutional sectors for certain applications. In industries such as pulp and paper, shipbuilding, mining and chemical, there is an increase in the use of specialized materials.

The movement to more specialized materials will require more training for steamfitters/pipefitters. This will also require a more in-depth knowledge of quality control procedures.

Modularization and pre-fabrication is becoming more common and installation of these materials requires fewer field runs.

Legislative and Regulatory

Steamfitters/Pipefitters must keep current on a large number of regulations and codes. Governments continue to pass more stringent safety, health and environmental regulations. LEED standards are becoming more common in many jurisdictions. These promote increased energy efficiency and environmentally friendly building practices.

With regulations becoming more stringent, steamfitters/pipefitters may be held liable for their actions when performing rigging, hoisting, lifting and positioning activities. It is the responsibility of steamfitters/pipefitters to be aware of changes in regulations.

In some jurisdictions, steamfitters/pipefitters require specialty licenses such as gas, fuel and oil licences or other special endorsements for working with materials such as medical gas. Certification may also be required for performing welding, tacking processes and backflow prevention. Licensing and certifications for aerial work platforms, zoom booms, articulated forklifts and scissor lifts are becoming essential for operating these pieces of equipment. Hoisting and rigging certification is becoming increasingly necessary in some jurisdictions.

There is an increase in the enforcement in new and existing systems by jurisdictional regulators. Documentation on the quality and safety of a system has become paramount and it is often a requirement by most insurance companies. As such, steamfitters/pipefitters must keep updated and pay careful attention to these safety regulations and requirements.

Skills for Success Summary

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

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

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

Reading

Steamfitters/Pipefitters require strong reading skills to refer to and interpret manufacturers' manuals and instructions including diagrams, charts and graphs. They also need to consult multiple professional codes and regulations concerning industry standards and safety requirements.

Document Use

Steamfitters/Pipefitters must be comfortable in document use to interpret work schedules. They consult reference manuals on measurement, materials and pipe sizing, pressures and mathematical formulas for calculations. They interpret information from mechanical drawings, schematic diagrams and architectural plans to ensure proper installation of piping. They also use quality control documentation and job specifications which records information such as heat numbers, weld mapping and material identification.

Writing

Writing skills are used by steamfitters/pipefitters to write lists of materials and fittings needed for a job, complete forms to request materials and keep daily logs to record measurements and reminders. When required, they must write incident or accident reports.

Oral Communication

Steamfitters/Pipefitters require good oral communication skills to interact with colleagues, supervisors and other tradespersons when co-ordinating work, resolving problems and ensuring safety. They interact with apprentices to provide mentorship and speak with vendors to order materials.

Numeracy

Numeracy skills are very important in the everyday work of steamfitters/pipefitters. They frequently take or calculate measurements of temperature, pressure and volume. They verify conformity with manufacturers' recommendations, specifications, and operating practices. The work requires a strong understanding of mathematical calculations and trigonometry. The ability to estimate the quantity of piping material required and to convert between imperial and metric systems of measurement is also important.

Thinking

Steamfitters/Pipefitters identify the steps and develop a plan to accomplish a task and coordinate the work. They must decide how to configure and relocate pipes. The ability to problem solve during testing or when a pipe or system failure is encountered is important. Decision making is important when considering job safety and risk prevention. Steamfitters/Pipefitters must also be able to find information they need in multiple sources such as blueprints, code documents, reference manuals and product catalogues. They must also be able to estimate a working cost for the project based on job specifications and drawings

Working with Others

Steamfitters/Pipefitters liaise with supervisors, site inspectors, consultants, health and safety inspectors, colleagues and other trades to coordinate multiple tasks. They may work with trades such as welders, crane operators, pipe insulators and electricians. They supervise others and mentor apprentices, offering both practical training and safety information. Additionally, the conduct, behaviour, appearance and attitude of a steamfitter/pipefitter are essential to the success of a job or project.

Digital Technology

Steamfitters/Pipefitters may use communications software for e-mail or use the Internet to look up material and trade-related information, to order materials online or to access training. They may use a spreadsheet to keep track of the status of materials ordered. They may also use CAD software to input measurements taken on the job site, to generate drawings and for referencing purposes. The use of digital equipment for the trade such as smart phones, laser and digital layout equipment such as total station, BIM and GPS technology is increasingly important for trade activities.

Continuous Learning

Steamfitters/Pipefitters may pursue refresher courses or specialty certifications and attend supplier seminars. Continuous learning is essential as they must keep up-to-date with the regulatory requirements and the various codes that are periodically revised. Also, they must keep abreast of technological advances in their field to select the most appropriate equipment, tools and materials and be able to perform a proper installation.

Roles and Opportunities for Skilled Trades in a Sustainable Future

Climate change affects all of us. Trades play a large role in implementing solutions and adjusting to changes in the world.

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

For example:

- Construction tradespeople need to consider the materials they are using, building methods, and improvements to mechanical and electrical installations. There are important changes to codes and standards to help meet the climate change goals and commitments set for 2030 and 2050. Retrofits and new construction of low-energy buildings provide enormous opportunities for workers in this sector. Concepts, such as energy efficiency and regarding buildings as systems are foundational.

- Automotive and mechanical trades are seeing a shift towards the electrification of vehicles and equipment. As a result, new skills and knowledge will be required for tradespeople working in this sector. There are mandates for sales of new light-duty zero-emission vehicles (ZEV) in Canada, with the goal of achieving 100% ZEV sales by 2035. Due to this mandate, the demand for these vehicles is growing quickly among consumers and fleets. With this escalating demand, the need for skilled workers to maintain and repair these vehicles is also increasing.

- In industrial and resource sectors, there is pressure to move towards increased electrification of industrial processes. Many industrial and commercial facilities are also being upgraded to improve energy efficiency in areas such as lighting systems, and new production processes and technologies. There are also opportunities in carbon capture, utilization and storage (CCUS), as well as the production and export of low-carbon hydrogen.

- Trades in the service sector may also need to be aware of responsible sourcing, as well as efficient use of products and materials. New ways of working better are always a part of the job.

There are fast-moving changes in guidelines, codes, regulations and specifications. Many are being implemented for the purpose of energy efficiency and climate change. Those that affect specific trades may be mentioned within the standard. Examples of these guidelines and legislation include:

- The National Energy Code of Canada for Buildings (NECB).

- The Canadian Net-Zero Emissions Accountability Act (CNZEAA).

- programs that encourage sustainable building design and construction such as Leadership in Energy and Environmental Design (LEED) and the Zero Carbon Building (ZCB) standards.

- the Montreal Protocol for phasing out R22 refrigerants.

- energy efficiency programs such as ENERGY STAR.

- principles of the United Nations Declaration for the Rights of Indigenous Peoples pertaining to energy sector development.

Apprentices and tradespeople need to increase their climate literacy and reinforce their own understanding of energy issues and environmental practices. It is important for them to understand why these changes are happening and their effect on trades' work. While individual tradespeople and apprentices may not be able to choose certain elements like; the architectural design of buildings, building material selection, regulatory requirements, use of electric vehicles and technologies, they must understand the impact of using these elements in their work. Impacts include using environmentally friendly products and following requirements related to the disposal and recycling of materials.

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

All in all, it's about doing the work better and building a better world.

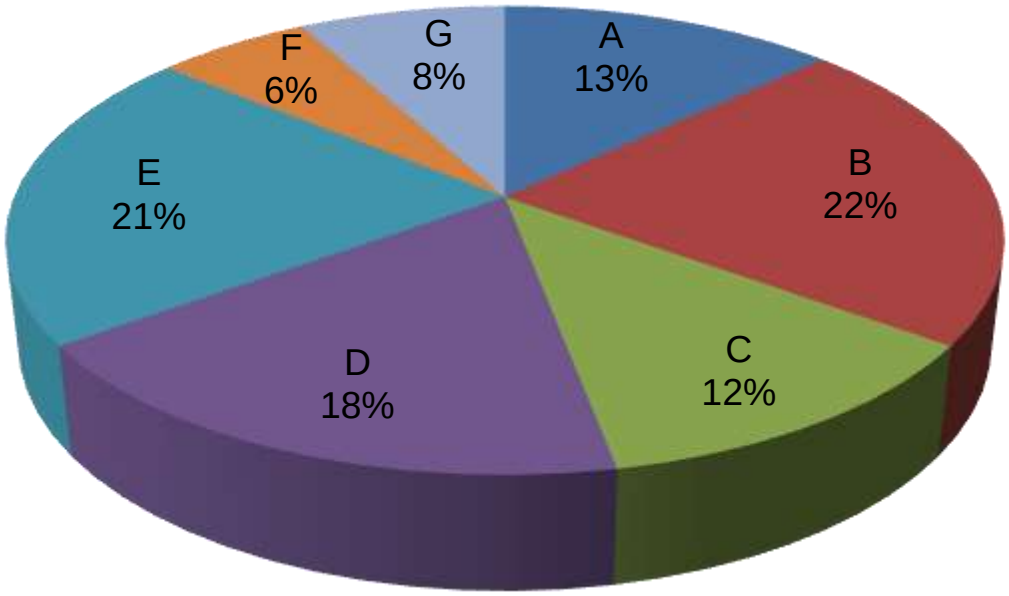
Industry Expected Performance

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

Language Requirements

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

Pie Chart
of Red Seal Examination Weightings



MWA A	Performs common occupational skills	13%
MWA B	Performs layout, fabrication and piping installation	22%
MWA C	Performs rigging, hoisting, lifting and positioning	12%
MWA D	Installs, tests, maintains, troubleshoots and repairs low and high pressure steam and condensate systems	18%
MWA E	Installs, tests, maintains, troubleshoots and repairs heating, cooling and process piping systems	21%
MWA F	Installs, tests, maintains, troubleshoots and repairs renewable energy systems	6%
MWA G	Performs commissioning, start-up and turnover	8%

This pie chart represents a breakdown of the interprovincial Red Seal examination. Percentages are based on the collective input from workers from the trade from across Canada. The Task Matrix on the next pages indicates the breakdown of tasks and sub-tasks within each Major Work Activity and the breakdown of questions assigned to the Tasks. The Interprovincial examination for this trade has 130 questions.

Steamfitter/Pipefitter

Task Matrix and Weightings

A - Performs common occupational skills — 13%

Task A-1 **Performs safety-related functions** **27%**	**A-1.01 Maintains safe work environment**	**A-1.02 Uses personal protective equipment (PPE) and safety equipment**	**A-1.03 Follows lock-out and tag-out (LOTO) procedures**
Task A-2 **Uses and maintains tools and equipment** **37%**	**A-2.01 Uses common tools and equipment**	**A-2.02 Uses access equipment**	**A-2.03 Uses welding equipment**
	A-2.04 Uses soldering and brazing equipment	**A-2.05 Uses oxy-fuel and plasma cutting equipment**	
Task A-3 **Organizes job** **23%**	**A-3.01 Plans work**	**A-3.02 Generates drawings**	**A-3.03 Interprets drawings and specifications**
	A-3.04 Develops piping templates	**A-3.05 Performs quality control functions**	**A-3.06 Handles materials and components**
Task A-4 **Uses communication and mentoring techniques** **13%**	**A-4.01 Uses communication techniques**	**A-4.02 Uses mentoring techniques**	

B – Performs layout, fabrication and piping installation — 22%

Task B-5 **Performs fabrication** **33%**	**B-5.01 Fabricates piping system components**	**B-5.02 Fabricates brackets, supports, hangers, guides and anchors**	
Task B-6 **Lays out and installs piping, tubing, fittings and related components** **43%**	**B-6.01 Lays out and installs copper tube, tubing, fittings and related components**	**B-6.02 Lays out and installs plastic piping, fittings and related components**	**B-6.03 Lays out and installs carbon steel piping, fittings and related components**
	B-6.04 Lays out and installs stainless steel piping, tubing, fittings and related components	**B-6.05 Lays out and installs fibreglass piping, fittings and related components**	**B-6.06 Lays out and installs specialty piping, fittings and related components**
Task B-7 **Installs, maintains, troubleshoots, repairs and tests valves** **14%**	**B-7.01 Installs valves**	**B-7.02 Maintains, troubleshoots, repairs and tests valves**	
Task B-8 **Installs, tests, maintains, troubleshoots and repairs heat tracing systems** **10%**	**B-8.01 Installs steam tracing systems**	**B-8.02 Maintains, troubleshoots, repairs and tests steam tracing systems**	**B-8.03 Installs liquid-filled tracing systems**
	B-8.04 Maintains, troubleshoots, repairs and tests liquid-filled tracing systems		

C – Performs rigging, hoisting, lifting and positioning — 12%

Task C-9 **Performs common rigging, hoisting, lifting and positioning** **66%**	**C-9.01 Determines load**	**C-9.02 Prepares lift plan(s) for common rigging, hoisting, lifting and positioning**	**C-9.03 Selects rigging, hoisting, lifting and positioning equipment for common lifts**
	C-9.04 Inspects rigging, hoisting, lifting and positioning equipment	**C-9.05 Secures lift area**	**C-9.06 Sets up rigging, hoisting, lifting and positioning equipment for common lifts**
	C-9.07 Performs common lift and positioning	**C-9.08 Maintains and stores rigging, hoisting, lifting and positioning equipment**	
Task C-10 **Performs complex and critical rigging, hoisting, lifting and positioning** **34%**	**C-10.01 Prepares lift plan for complex and critical rigging, hoisting, lifting and positioning**	**C-10.02 Performs calculations for complex and critical rigging, hoisting, lifting and positioning**	**C-10.03 Selects rigging, hoisting, lifting and positioning equipment for complex and critical lifts**
	C-10.04 Sets up rigging, hoisting, lifting and positioning equipment for complex and critical lifts	**C-10.05 Performs complex and critical lifts and positioning**	

D – Installs, tests, maintains, troubleshoots and repairs low and high pressure steam and condensate systems

18%

Task D-11
Installs, tests, maintains, troubleshoots and repairs low pressure steam and condensate systems
43%

- **D-11.01 Installs equipment for low pressure steam and condensate systems**
- **D-11.02 Installs piping for low pressure steam and condensate systems**
- **D-11.03 Tests low pressure steam and condensate systems**
- **D-11.04 Maintains, troubleshoots and repairs low pressure steam and condensate systems**

Task D-12
Installs, tests, maintains, troubleshoots and repairs high pressure steam and condensate systems
57%

- **D-12.01 Installs equipment for high pressure steam and condensate systems**
- **D-12.02 Installs piping for high pressure steam and condensate systems**
- **D-12.03 Tests high pressure steam and condensate systems**
- **D-12.04 Maintains, troubleshoots and repairs high pressure steam and condensate systems**

E – Installs, tests, maintains, troubleshoots and repairs heating, cooling and process piping systems

21%

Task E-13 **Installs, tests, maintains, troubleshoots and repairs hydronic systems** **21%**	**E-13.01 Installs equipment for hydronic systems**	**E-13.02 Installs piping for hydronic systems**	**E-13.03 Tests hydronic systems**
	E-13.04 Maintains, troubleshoots and repairs hydronic systems		
Task E-14 **Installs, tests, maintains, troubleshoots and repairs process piping systems** **18%**	**E-14.01 Installs equipment for process piping systems**	**E-14.02 Installs piping for process piping systems**	**E-14.03 Tests process piping systems**
	E-14.04 Maintains, troubleshoots and repairs process piping systems		
Task E-15 **Installs, tests, maintains, troubleshoots and repairs industrial water and waste treatment systems** **12%**	**E-15.01 Installs equipment for industrial water and waste treatment systems**	**E-15.02 Installs piping for industrial water and waste treatment systems**	**E-15.03 Tests industrial water and waste treatment systems**
	E-15.04 Maintains, troubleshoots and repairs industrial water and waste treatment systems		
Task E-16 **Installs, tests, maintains, troubleshoots and repairs hydraulic systems** **10%**	**E-16.01 Installs equipment for hydraulic systems**	**E-16.02 Installs piping and hoses for hydraulic systems**	**E-16.03 Tests hydraulic systems**
	E-16.04 Maintains, troubleshoots and repairs hydraulic systems		

Task E-17 **Installs, tests, maintains, troubleshoots and repairs heating, ventilation, air conditioning and refrigeration (HVACR) systems** **9%**	**E-17.01 Installs equipment for HVACR systems**	**E-17.02 Installs piping for HVACR systems**	**E-17.03 Tests HVACR systems**
	E-17.04 Maintains, troubleshoots and repairs HVACR systems		
Task E-18 **Installs, tests, maintains, troubleshoots and repairs fuel systems** **10%**	**E-18.01 Installs equipment for fuel systems**	**E-18.02 Installs piping for fuel systems**	**E-18.03 Tests fuel systems**
	E-18.04 Maintains, troubleshoots and repairs fuel systems		
Task E-19 **Installs, tests, maintains, troubleshoots and repairs medical gas systems** **9%**	**E-19.01 Installs equipment for medical gas systems**	**E-19.02 Installs piping for medical gas systems**	**E-19.03 Tests medical gas systems**
	E-19.04 Maintains, troubleshoots and repairs medical gas systems		
Task E-20 **Installs, tests, maintains, troubleshoots and repairs compressed air and pneumatic systems** **11%**	**E-20.01 Installs equipment for compressed air and pneumatic systems**	**E-20.02 Installs piping for compressed air and pneumatic systems**	**E-20.03 Tests compressed air and pneumatic systems**
	E-20.04 Maintains, troubleshoots and repairs compressed air and pneumatic systems		
Task E-21 **Installs and tests fire protection systems** **0% Not Common Core**	**E-21.01 Installs equipment for fire protection systems- Not Common Core**	**E-21.02 Installs piping for fire protection systems- Not Common Core**	**E-21.03 Tests fire protection systems- Not Common Core**

F – Installs, tests, maintains, troubleshoots and repairs renewable energy systems

6%

Task F-22 **Installs, tests, maintains, troubleshoots and repairs geo-exchange and geothermal systems** **27%**	**F-22.01 Installs equipment for geo-exchange and geothermal systems**	**F-22.02 Installs piping for geo-exchange and geo-thermal systems**	**F-22.03 Tests geo-exchange and geothermal systems**
	F-22.04 Maintains, troubleshoots and repairs geo-exchange and geothermal systems		
Task F-23 **Installs, tests, maintains, troubleshoots and repairs solar heating systems** **23%**	**F-23.01 Installs equipment for solar heating systems**	**F-23.02 Installs piping for solar heating systems**	**F-23.03 Tests solar heating systems**
	F-23.04 Maintains, troubleshoots and repairs solar heating systems		
Task F-24 **Installs, tests, maintains, troubleshoots and repairs heat recovery systems** **50%**	**F-24.01 Installs equipment for heat recovery systems**	**F-24.02 Installs piping for heat recovery systems**	**F-24.03 Tests heat recovery systems**
	F-24.04 Maintains, troubleshoots and repairs heat recovery systems		

G – Performs commissioning, start-up and turnover — 8%

Task G-25 **Prepares system for commissioning, start-up and turnover** **55%**	**G-25.01 Flushes system**	**G-25.02 Chemically treats system**	**G-25.03 Pre-checks system for commissioning**
	G-25.04 Selects and connects commissioning equipment		
Task G-26 **Commissions systems** **45%**	**G-26.01 Secures commissioning area**	**G-26.02 Pressurizes system**	**G-26.03 Inspects system**
	G-26.04 Corrects faulty conditions	**G-26.05 Participates in start-up and turnover procedures**	

Harmonization of Apprenticeship Training

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

1. Trade name

The official Red Seal name for this trade is Steamfitter/Pipefitter.

2. Number of Levels of Apprenticeship

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

3. Total Training Hours during Apprenticeship Training

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

4. Sequencing Topics and Related Sub-tasks

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

Level 1	Level 2	Level 3	Level 4
	Context	Context	Context
	Tools and Equipment		
		Organizes Job	Organizes Job
	Rigging, Hoisting Lifting	Rigging, Hoisting Lifting	
		Fabrication	Fabrication
		Piping, Tubing, Fittings, Fitting and Related Components (Layout)	Piping, Tubing, Fittings, Fitting and Related Components (Layout)
	Valves	Valves	Valves
			Heat Tracing Systems

Industrial Water and Waste Treatment Systems

Fuel Systems

Commissions Systems

Commissions Systems

Safety-Related Functions

1.01 Maintains safe work environment.

1.02 Selects, inspects and uses personal protective equipment (PPE) and safety equipment.

1.03 Follows lock-out and tag-out (LOTO) procedures.

Tools and Equipment

2.01 Uses common tools and equipment

2.02 Uses access equipment

2.03 Uses welding equipment

2.04 Uses soldering and brazing equipment

2.05 Uses oxy-fuel and plasma cutting equipment

Organizes Job

3.01 Plans work

3.02 Generates drawings

3.03 Interprets drawings and specifications

3.04 Develops piping templates

3.05 Performs quality control functions

3.06 Handles materials and components

Organizes Job

3.04 Develops piping templates

Communication Techniques

4.01 Uses communication techniques

Mentoring Techniques

4.02 Uses mentoring techniques

Fabrication

5.02 Fabricates brackets, supports, hangers, guides and anchors

Fabrication

5.01 Fabricates piping system components

Piping, Tubing, Fittings, Fitting and Related Components (Layout)

6.01 Lays out and installs copper tube, tubing, tubing, fittings and related components

6.02 Lays out and installs plastic piping, fittings and related components

6.03 Lays out and installs carbon steel piping, fittings and related components

6.04 Lays out and installs stainless steel piping, tubing, fittings and related components

Piping, Tubing, Fittings, Fitting and Related Components (Layout)

6.05 Lays out and installs fiberglass piping, fittings and related components

6.06 Lays out and installs specialty piping, fittings and related components

Valves

7.01 Installs valves

7.02 Maintains, troubleshoots, repairs and tests valves

Heat Tracing Systems (Liquid)

8.03 Installs liquid-filled tracing systems

8.04 Maintains, troubleshoots, repairs and tests liquid-filled tracing systems

Heat Tracing Systems (Steam)

8.01 Installs steam tracing systems

8.02 Maintains, troubleshoots, repairs and tests steam tracing systems

Rigging, Hoisting, Lifting and Positioning (Common)

9.01 Determines load.

9.02 Prepares lift plan(s) for common rigging, hoisting, lifting and positioning

9.03 Selects rigging, hoisting, lifting and positioning equipment for common lifts

9.04 Inspects rigging, hoisting, lifting and positioning equipment

9.05 Secures lift area

9.06 Sets up rigging, hoisting, lifting and positioning equipment for common lifts

9.07 Performs common lift and positioning

9.08 Maintains and stores rigging, joisting, lifting and positioning equipment

Rigging, Hoisting, Lifting and Positioning (Complex)

10.01 Prepares lift plan for complex and critical rigging, hoisting, lifting and positioning

10.02 Performs calculations for complex and critical rigging, hoisting, lifting and positioning

10.03 Selects rigging, hoisting, lifting and positioning equipment for complex and critical lifts

10.04 Sets up rigging, hoisting, lifting and positioning equipment for complex and critical lifts

10.05 Performs complex and critical lifts and positioning

Low Pressure Steam and Condensate Systems

11.01 Installs equipment for low pressure steam and condensate systems

11.02 Installs piping for low pressure steam and condensate systems

11.03 Tests low pressure steam and condensate systems

11.04 Maintains, troubleshoots and repairs low pressure steam and condensate systems

High Pressure Steam and Condensate Systems

12.01 Installs equipment for high pressure steam and condensate systems.

12.02 Installs piping for high pressure steam and condensate systems.

12.03 Tests high pressure steam and condensate systems.

12.04 Maintains, troubleshoots and repairs high pressure steam and condensate systems

Hydronic Systems

13.01 Installs equipment for hydronic systems

13.02 Installs piping for hydronic systems

13.03 Test hydronic systems

13.04 Maintains, troubleshoots and repairs hydronic systems

Hydronic Systems

13.01 Installs equipment for hydronic systems

13.02 Installs piping for hydronic systems

13.03 Tests hydronic systems

13.04 Maintains, troubleshoots and repairs hydronic systems

Process Piping Systems

14.01 Installs equipment for process piping systems

14.02 Installs piping for process piping systems

14.03 Tests process piping systems

14.04 Maintains, troubleshoots and repairs process piping systems

Industrial Water and Waste Water Treatment Systems

15.01 Installs equipment for industrial water and waste treatment systems.

15.02 Installs piping for industrial water and waste treatment systems.

15.03 Tests industrial water and waste treatment systems.

15.04 Maintains, troubleshoots and repairs industrial water and waste treatment systems

Hydraulic Systems

16.01 Installs equipment for hydraulic systems

16.02 Installs piping, tubing and hoses for hydraulic systems

16.03 Tests hydraulic systems

16.04 Maintains, troubleshoots and repairs hydraulic systems

Heating, Ventilation, Air Conditioning and Refrigeration (HVACR)

17.01 Installs equipment for HVACR systems

17.02 Installs piping for HVACR systems

17.03 Tests HVACR systems

17.04 Maintains, troubleshoots and repairs HVACR systems

Fuel Systems

18.01 Installs equipment for fuel systems.

18.02 Installs piping and tubing for fuel systems.

18.03 Tests fuel systems.

18.04 Maintains, troubleshoots and repairs fuel systems.

Medical Gas Systems

19.01 Installs equipment for medical gas systems

19.02 Installs piping and tubing for medical gas systems

19.03 Tests medical gas systems

19.04 Maintains, troubleshoots and repairs medical gas systems

Compressed Air and Pneumatic Systems

20.01 Installs equipment for compressed air and pneumatic systems

20.02 Installs piping and tubing for compressed air and pneumatic systems

20.03 Tests compressed air and pneumatic systems

20.04 Maintains, troubleshoots and repairs compressed air and pneumatic systems

Fire Protection Systems (NCC)

21.01 Installs equipment for fire protection systems

21.02 Installs piping for fire protection systems

21.03 Tests fire protection systems

Geo-Exchange and Geothermal Systems

22.01 Installs equipment for geo-exchange and geothermal systems

22.02 Installs piping for geo-exchange and geothermal systems

22.03 Tests geo-exchange and geothermal systems

22.04 Maintains, troubleshoots and repairs geo-exchange and geothermal systems

Solar Heating Systems

23.01 Installs equipment for solar heating systems

23.02 Installs piping for solar heating systems

23.03 Tests solar heating systems

23.04 Maintains, troubleshoots and repairs solar heating systems

Heat Recovery Systems

24.01 Installs equipment for heat recovery systems

24.02 Installs piping for heat recovery systems

24.03 Tests heat recovery systems

24.04 Maintains, troubleshoots and repairs heat recovery systems

Prepares System for Commissioning, Start-Up and Turnover

25.01 Flushes system

25.02 Chemically treats system

25.03 Pre-checks system for commissioning

25.04 Selects and connects commissioning equipment

Commissions Systems

26.01 Secures commissioning area

26.02 Pressurizes system

26.03 Inspects system

26.04 Corrects faulty conditions

26.05 Participates in start-up and turnover

Major Work Activity A

Performs common occupational skills

Task A-1 Performs safety-related functions

Task Descriptor

Safety is integral to any and every aspect of the steamfitter/pipefitter trade. Steamfitters/Pipefitters maintain a safe work environment in order to prevent and correct any potential or immediate hazard, address an incident or accident, and follow up to ensure the safety and wellness of every person on the work site. The use and maintenance of personal protective equipment (PPE) and safety equipment are essential to every job. It is also very important to be proficient in the use of safety documentation. Lock-out of equipment and piping is important before working on systems to prevent spills, property damage, personal injury and fatalities. Each steamfitter/pipefitter is responsible for their own lock-out and tag-out equipment.

A-1.01 Maintains safe work environment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-1.01.01P	participate in tool box meetings	documentation of participation in tool box meetings is signed off
A-1.01.02P	plan pre-hazard assessments before performing each task	pre-hazard assessment plan is in place, ***safety documentation*** is completed and task is completed without incident
A-1.01.03P	reference ***safety regulations***	***safety regulations*** are being followed by workers on site
A-1.01.04P	handle and store hazardous materials	hazardous materials are handled and stored according to Workplace Hazardous Materials Information System (WHMIS) and controlled products regulations
A-1.01.05P	locate and interpret ***WHMIS materials***	***WHMIS materials*** are located and interpreted, and directions on safety data sheets (SDS) are being followed
A-1.01.06P	identify and report unsafe conditions and ***worksite hazards***	unsafe conditions and ***worksite hazards*** are reported to Health and Safety Representative and supervisor, and documented

A-1.01.07P	address or correct ***worksite hazards***	***worksite hazards*** are mitigated or eliminated as soon as possible and information is documented and communicated to Health and Safety Representative and supervisor immediately
A-1.01.08P	communicate ***worksite hazards*** to co-workers	***worksite hazards*** are communicated to co-workers using various ***methods***
A-1.01.09P	keep workplace tidy and organized (housekeeping)	workplace is free of debris and clutter

Range of Variables

safety documentation includes: field-level risk assessments (FLRA), hazard assessments, equipment inspections, incident reports

safety regulations include: lock-out and tag-out regulations, jurisdictional safety and health regulations, site-specific regulations

WHMIS materials are: SDS, labels

worksite hazards include: poor housekeeping, overhead hazards, tripping hazards, trenching and shoring hazards, confined space hazards, hot work hazards, asbestos, noise hazards, environmental hazards, vibration hazards, air quality hazards, energy hazards, site-specific hazards, chemical hazards

methods include: verbally, safety meetings, sirens, warning lights, flagging off area, putting up signage

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-1.01.01L	demonstrate knowledge of safe work practices	identify ***worksite hazards***, and describe safe work practices
A-1.01.02L	demonstrate knowledge of procedures for emergency response	identify and describe company, site-specific and jurisdictional procedures for emergency response
A-1.01.03L	demonstrate knowledge of regulatory requirements pertaining to workplace safety	identify and describe ***safety regulations***, local and jurisdictional laws and requirements

Range of Variables

worksite hazards include: poor housekeeping, overhead hazards, tripping hazards, trenching and shoring hazards, confined space hazards, hot work hazards, asbestos, noise hazards, environmental hazards, vibration hazards, air quality hazards, energy hazards, site-specific hazards, chemical hazards

safety regulations include: lock-out and tag-out regulations, jurisdictional safety and health regulations, site-specific regulations

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

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-1.02.01P	complete ***training and certification***	***training and certification*** for use of ***PPE*** and ***safety equipment*** are completed to meet ***jurisdictional regulations*** and site-specific requirements
A-1.02.02P	select ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are selected according to application, limitations, fit and site-specific requirements
A-1.02.03P	maintain ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are maintained by cleaning and ensuring they are in safe working condition
A-1.02.04P	identify and replace worn, damaged or defective ***PPE*** and ***safety equipment***	worn, damaged or defective ***PPE*** and ***safety equipment*** are tagged and removed from service
A-1.02.05P	organize and store ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are organized and stored to prevent damage, contamination and theft
A-1.02.06P	inspect for function, expiration date and fit of ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are inspected for function, expiration date and fit, and all deficiencies are identified and tagged, and equipment is removed from service
A-1.02.07P	connect, tie or hook fall protection and fall arrest equipment	fall protection and fall arrest equipment is connected in a manner that restricts user's free fall movement according to manufacturers' instructions
A-1.02.08P	ensure fall protection and fall arrest equipment is re-certified	fall protection and fall arrest equipment is re-certified according to ***jurisdictional regulations*** and company policies
A-1.02.09P	use ***PPE*** and ***safety equipment***	***PPE*** and ***safety equipment*** are used according to ***jurisdictional regulations*** and manufacturers' instructions

Range of Variables

PPE includes: fall arrest systems, respirators, steel toe boots, hardhats, safety glasses, hearing protection, gloves, face shields, protective wristlets, fire-retardant clothing, self-contained breathing apparatus (SCBA), site-specific

safety equipment includes: fire extinguishers, first aid kits, eye wash stations, welding screens, smoke and fume extractors

training and certification includes: first aid, confined space, working at heights (fall protection, fall restraint and fall arrest), fit test, site-specific

jurisdictional regulations include: by-laws, standards, codes

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-1.02.01L	demonstrate knowledge of ***PPE*** and ***safety equipment***, their characteristics and applications	identify types of ***PPE*** and ***safety equipment***, and describe their characteristics, limitations and applications
		identify hazards, and describe safe work practices pertaining to ***PPE*** and ***safety equipment***
A-1.02.02L	demonstrate knowledge of procedures to use and maintain ***PPE*** and ***safety equipment***	describe procedures to use ***PPE*** and ***safety equipment***
		describe procedures to handle, maintain and store ***PPE*** and ***safety equipment***
A-1.02.03L	demonstrate knowledge of ***training and certification requirements*** pertaining to ***PPE*** and ***safety equipment***	identify jurisdictional, company and site-specific ***training and certification requirements*** pertaining to ***PPE*** and ***safety equipment***
A-1.02.04L	demonstrate knowledge of regulatory requirements pertaining to ***PPE*** and ***safety equipment***	identify ***jurisdictional regulations*** and safety documentation pertaining to use of ***PPE*** and ***safety equipment***

Range of Variables

PPE includes: fall arrest systems, respirators, steel toed boots, hardhats, safety glasses, hearing protection, gloves, face shields, protective wristlets, fire-retardant clothing, SCBA, site-specific

safety equipment includes: fire extinguishers, hand rails, first aid kits, smoke and fume extractors

training and certification requirements include: first aid, confined space, working at heights (fall protection, fall restraint and fall arrest), fit test, site-specific

jurisdictional regulations include: by-laws, standards, codes

A-1.03 Follows lock-out and tag-out (LOTO) procedures

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-1.03.01P	determine LOTO requirements for ***system components***	LOTO requirements for ***system components*** are met according to local regulations and company policies and site-specific conditions
A-1.03.02P	obtain and install designated ***lock-out equipment*** and tags	***lock-out equipment*** and tags are obtained and installed according to company policy and ***jurisdictional requirements***
A-1.03.03P	complete ***lock-out documentation***	***lock-out documentation*** is completed and signed off by all personnel involved
A-1.03.04P	apply ***isolation methods***	***isolation methods*** are applied and system being locked out is verified at a zero-energy state
A-1.03.05P	remove ***lock-out equipment*** and tags	***lock-out equipment*** and tags are removed according to ***procedures***

Range of Variables

system components include: pumps, valves, electrical panels

lock-out equipment includes: lock and key, chains and tags, lock-out scissor clamp, lock-box, electrical breaker lock-outs

jurisdictional regulations include: by-laws, standards, codes

lock-out documentation includes: lock verifications, LOTO permits, tool box meeting reports, sign-in and sign-out sheets

isolation methods include: double-block-and-bleed, blinding and breaker locks, opening low point valves, checking gauges and switches, inspecting sight glasses

procedures include: tag-in and tag-out, sign-in and sign-out

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-1.03.01L	demonstrate knowledge of LOTO procedures and applications	identify situations and ***system components*** that require LOTO
		identify ***lock-out equipment***, and describe their characteristics and applications
		describe ***procedures*** for locking out and tagging out equipment and piping

		identify hazards, and describe safe work practices pertaining to LOTO procedures
A-1.03.02L	demonstrate knowledge of regulatory requirements for LOTO	identify safety regulations pertaining to locking out and tagging out ***system components***

Range of Variables

system components include: pumps, valves, electrical panels

lock-out equipment includes: lock and key, chains and tags, lock-out scissor clamp, lock-box, electrical breaker lock-outs

procedures include: tag-in and tag-out, sign-in and sign-out

Task A-2 Uses and maintains tools and equipment

Task Descriptor

Tools and equipment must be used, maintained and stored in a safe manner to complete all tasks of the steamfitter/pipefitter trade. A thorough list of the tools used in this trade is found in Appendix B – Tools and Equipment.

Steamfitters/Pipefitters use various tools and equipment to assemble piping systems. Assembly of these systems use tools for tasks such as welding, soldering, bolting, grooving, threading, fusion and mechanical joint.

Ladders and work platforms are often required to access job locations.

Steamfitters/Pipefitters perform welding and soldering tasks including orbital welding, oxy-fuel welding and heat fusion welding. They also assist certified welders with electric arc welding, gas tungsten arc welding (GTAW), shielded metal arc welding (SMAW) and gas metal arc welding (GMAW) processes, and all other welding processes as required. They must be knowledgeable in setting up the welding, soldering, brazing and oxy-fuel equipment, in welding practices and in pipe preparation.

A-2.01 Uses common tools and equipment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-2.01.01P	perform visual inspection	visual inspection is performed, and any ***deficiencies or defects*** are identified before using ***tools and equipment***
A-2.01.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements

A-2.01.03P	identify and replace worn, damaged or defective ***tools and equipment***	worn, damaged or defective ***tools and equipment*** are tagged with ***identification markings*** and removed from service according to manufacturers' instructions and company policies
A-2.01.04P	maintain ***tools and equipment***	***tools and equipment*** are maintained according to manufacturers' instructions and specifications, and are in safe working condition
A-2.01.05P	document tool maintenance and inspection	documentation is completed according to company policies
A-2.01.06P	organize and store ***tools and equipment***	***tools and equipment*** are organized and stored to prevent damage and theft

Range of Variables

deficiencies or defects include: worn, misused, bent, broken, missing parts, damaged and inoperable tools

tools and equipment include: see Appendix B

identification markings include: tape, colour codes, markings, tags

maintain includes: clean, lubricate, sharpen

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-2.01.01L	demonstrate knowledge of ***tools and equipment***, their applications and procedures for use	identify types of hand tools and describe their applications and procedures for use
		identify types of power tools and describe their applications and procedures for use
		identify types of measuring tools and equipment, and describe their applications and procedures for use
		identify types of powder-actuated tools, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to ***tools and equipment***
A-2.01.02L	demonstrate knowledge of procedures to inspect, ***maintain*** and store ***tools and equipment***	describe procedures to inspect, ***maintain*** and store ***tools and equipment***

Range of Variables

tools and equipment include: See Appendix B

maintain includes: clean, lubricate, sharpen

A-2.02 Uses access equipment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-2.02.01P	complete ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems*** training	***ladders, scaffolding, motorized work platforms,*** and ***remote access systems*** training is completed according to ***jurisdictional regulations*** and ***site-specific requirements***
A-2.02.02P	select ***ladder***	***ladder*** is selected according to job requirements
A-2.02.03P	select ***scaffolding***	***scaffolding*** is selected according to job requirements
A-2.02.04P	select ***motorized work platforms***	***motorized work platform*** is selected according to job requirements and site-specific requirements
A-2.02.05P	select ***remote access system***	***remote access system*** is selected according to job requirements and site-specific requirements
A-2.02.06P	perform visual inspection of ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems***	visual inspection of ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems*** is performed prior to, and during use according to ***jurisdictional regulations***, and safety documentation is completed with required signatures
A-2.02.07P	secure ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems***	***ladders, scaffolding, motorized work platforms,*** and ***remote access systems*** are secured according to ***jurisdictional regulations*** and ***site-specific requirements***
A-2.02.08P	identify, tag and replace worn, damaged or defective ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems***	worn, damaged or defective ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems*** are tagged and reported to supervisor, removed from service, and replaced

A-2.02.09P	store ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems***	***ladders, scaffolding, motorized work platforms,*** and ***remote access systems*** are organized and stored to prevent damage and theft
A-2.02.10P	verify certification dates for ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems***	documentation demonstrates that ***ladders, scaffolding, motorized work platforms,*** and ***remote access systems*** certifications are current according to ***jurisdictional regulations*** and ***site-specific requirements***

Range of Variables

ladders include: step ladders, extension ladders, platform ladders

scaffolding includes: tube and clamp scaffolding, swing stage scaffolding, frame scaffolding

motorized work platforms include: scissor lift, articulated boom, personnel basket

remote access systems include: rope access systems, bosun's chair

jurisdictional regulations include: by-laws, standards, codes

site-specific requirements include: personnel training/certification, equipment certification requirements, proper use and limitations of equipment

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-2.02.01L	demonstrate knowledge of ***ladders***, ***scaffolding, motorized work platforms,*** and ***remote access systems,*** their applications, limitations and procedures for use	identify hazards, and describe safe work practices pertaining to ***ladders***, ***scaffolding, motorized work platforms,*** and ***remote access systems***
		identify types of ***ladders***, and describe their applications, limitations and procedures for use
		identify types of ***scaffolding***, and describe their applications, configurations, limitations and procedures for use
		identify types of ***motorized work platforms***, and describe their applications, limitations and procedures for use
		identify types of ***remote access systems***, and describe their applications, limitations and procedures for use
A-2.02.02L	demonstrate knowledge of procedures to erect and dismantle ***ladders*** and ***scaffolding***	describe procedures to erect and dismantle ***ladders*** and ***scaffolding***

A-2.02.03L	demonstrate knowledge of training and certification requirements pertaining to ***ladders***, ***scaffolding, motorized work platforms,*** and ***remote access systems***	identify training and certification requirements pertaining to ***ladders***, ***scaffolding, motorized work platforms,*** and ***remote access systems***
A-2.02.04L	demonstrate knowledge of regulatory requirements pertaining to ***ladders***, ***scaffolding, motorized work platforms,*** and ***remote access systems***	identify ***jurisdictional regulations*** and ***site-specific requirements*** pertaining to ***ladders***, ***scaffolding, motorized work platforms,*** and ***remote access systems***

Range of Variables

ladders include: step ladders, extension ladders, platform ladders

scaffolding includes: tube and clamp scaffolding, swing stage scaffolding, frame scaffolding

motorized work platforms include: scissor lift, articulated boom, personnel basket

remote access systems include: rope access systems, bosun's chair

jurisdictional regulations include: by-laws, standards, codes

site-specific requirements include: personnel training/certification, equipment certification requirements, proper use and limitations of equipment

A-2.03 Uses welding equipment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-2.03.01P	select ***welding equipment***	***welding equipment*** is selected according to application and materials to be welded
A-2.03.02P	select and store ***welding consumables***	***welding consumables*** are selected and stored according to quality control requirements and to prevent damage, contamination and theft
A-2.03.03P	match alloys to specific components to be welded	alloys are matched to specific components to be welded according to quality control requirements
A-2.03.04P	set up welding machine	welding machine is set up according to application
A-2.03.05P	protect equipment and surrounding flammable materials	equipment and flammable materials are protected or removed from vicinity of welding
A-2.03.06P	perform tack welding	tack welds are performed according to ***jurisdictional regulations***
A-2.03.07P	perform visual inspections in order to maintain ***welding equipment***	visual inspections are performed and defects in ***welding equipment*** are identified and documented

A-2.03.08P	identify, tag and replace worn, damaged or defective ***welding equipment***	worn, damaged or defective ***welding equipment*** is identified, tagged and replaced according to company procedures
A-2.03.09P	organize and store ***welding equipment***	***welding equipment*** is organized and stored to prevent damage and theft

Range of Variables

welding equipment includes: SMAW equipment, orbital welding machines, GTAW equipment, GMAW equipment, heat fusion welding equipment

welding consumables include: welding rods, flux, grinding discs, purge gases

jurisdictional regulations include: by-laws, standards, codes

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-2.03.01L	demonstrate knowledge of welding, its characteristics, applications and limitations	identify ***welding processes***, and describe their characteristics, applications and limitations
		identify ***welding equipment***, and describe their characteristics, applications and limitations
		identify ***welding consumables***, and describe their characteristics, applications and limitations
		identify hazards, and describe safe work practices pertaining to use of ***welding equipment***
A-2.03.02L	demonstrate knowledge of procedures to use, inspect, maintain and store ***welding equipment***	describe procedures for use of ***welding equipment***
		describe procedures to inspect, maintain and store ***welding equipment***
A-2.03.03L	demonstrate knowledge of training and certification requirements to use ***welding equipment***	identify training and certification requirements to use ***welding equipment***
A-2.03.04L	demonstrate knowledge of regulatory requirements to use ***welding equipment***	identify ***jurisdictional regulations*** pertaining to use of ***welding equipment***

Range of Variables

welding processes include: SMAW, orbital welding, GTAW, GMAW, heat fusion

welding equipment includes: SMAW equipment, orbital welding machines, GTAW equipment, GMAW equipment, heat fusion welding equipment

welding consumables include: welding rods, flux, grinding discs, purge gases

jurisdictional regulations include: by-laws, standards, codes

A-2.04 Uses soldering and brazing equipment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-2.04.01P	select ***soldering and brazing equipment***	***soldering and brazing equipment*** is selected according to application and materials to be soldered and brazed
A-2.04.02P	set up ***soldering or brazing equipment***	***soldering or brazing equipment*** is set up according to application
A-2.04.03P	match alloys to specific components to be soldered or brazed	alloys are matched to specific components to be soldered or brazed according to quality control requirements
A-2.04.04P	select ***soldering and brazing consumables***	***soldering and brazing consumables*** are selected according to application and quality control requirements
A-2.04.05P	join piping, fittings and components	piping, fittings and components are joined according to standards for brazed or soldered materials
A-2.04.06P	purge piping and tubing	piping and tubing are purged according to system requirements to prevent contamination of piping and tubing
A-2.04.07P	protect surrounding equipment and flammable materials	equipment and flammable materials are protected or removed from vicinity of soldering and brazing work
A-2.04.08P	maintain ***soldering and brazing equipment***	***soldering and brazing equipment*** is maintained according to manufacturers' instructions and company procedures, and is in safe and operable condition
A-2.04.09P	identify, tag and replace worn, damaged or defective ***soldering and brazing equipment***	worn, damaged or defective ***soldering and brazing equipment*** is identified, tagged and replaced according to company procedures
A-2.04.10P	organize and store ***soldering and brazing equipment***	***soldering and brazing equipment*** is organized and stored to prevent damage, contamination and theft
A-2.04.11P	store fuel and gas cylinders	fuel and gas cylinders are stored in ventilated storage unit in an upright position according to ***jurisdictional regulations***

Range of Variables

soldering and brazing equipment includes: oxy-acetylene and air-acetylene torches, attachments (strikers, methylacetylene-propadiene propane [MAPP], fuel cylinder, gas cylinder, torch heads)
soldering and brazing consumables include: silver solder, flux, soft solder, brazing rod, sand cloth
jurisdictional regulations include: by-laws, standards, codes

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-2.04.01L	demonstrate knowledge of soldering and brazing, their characteristics and applications	identify soldering and brazing processes, and describe their characteristics and applications
		describe ***purge procedures*** required for brazing
		identify ***soldering and brazing equipment***, and describe their characteristics and applications
		identify ***soldering and brazing consumables***, and describe their characteristics and applications
		identify hazards, and describe safe work practices pertaining to use of ***soldering and brazing equipment***
A-2.04.02L	demonstrate knowledge of procedures to use, inspect, maintain and store ***soldering and brazing equipment***	describe limitations and procedures for use of ***soldering and brazing equipment***
		describe procedures to inspect, maintain and store ***soldering and brazing equipment***
A-2.04.03L	demonstrate knowledge of training and certification requirements to solder and braze	identify certification requirements to perform soldering and brazing
A-2.04.04L	demonstrate knowledge of regulatory requirements to use ***soldering and brazing equipment***	identify ***jurisdictional regulations*** to use ***soldering and brazing equipment***

Range of Variables

purge procedures include: dams, purge gas, pressures, flow rates
soldering and brazing equipment includes: oxy-acetylene and air-acetylene torches, attachments (strikers, MAPP, fuel cylinder, gas cylinder, torch heads)
soldering and brazing consumables include: silver solder, flux, soft solder, brazing rod, sand cloth
jurisdictional regulations include: by-laws, standards, codes

A-2.05 Uses oxy-fuel and plasma cutting equipment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-2.05.01P	select ***oxy-fuel equipment***	***oxy-fuel equipment*** is selected according to application and materials
A-2.05.02P	select ***plasma cutting equipment***	***plasma cutting equipment*** is selected according to application and materials
A-2.05.03P	set up oxy-fuel gauges and torches	oxy-fuel gauges and torches are set up according to application and materials
A-2.05.04P	select tips	tips are selected according to application, fuel use and material being cut or heated
A-2.05.05P	select and set up ***plasma cutting equipment settings***	***plasma cutting equipment settings*** are selected and set up according to application and materials
A-2.05.06P	protect equipment and flammable materials	equipment and flammable materials are protected or removed from vicinity of work
A-2.05.07P	identify, tag and replace worn, damaged or defective ***oxy-fuel*** and ***plasma cutting equipment***	worn, damaged or defective ***oxy-fuel*** and ***plasma cutting equipment*** is identified, tagged and replaced according to company procedures
A-2.05.08P	store ***oxy-fuel*** and ***plasma cutting equipment***	***oxy-fuel*** and ***plasma cutting equipment*** are stored to prevent damage, contamination and theft
A-2.05.09P	store oxy-fuel cylinders	oxy-fuel cylinders are stored in ventilated storage unit in an upright position according to ***jurisdictional regulations***

Range of Variables

oxy-fuel equipment includes: flashback arrestors, regulators

plasma cutting equipment includes: air plasma, Computer Numeric Control (CNC) plasma cutters, oxygen plasma, high definition plasma

plasma cutting equipment settings include: tips, voltages, air pressure

jurisdictional regulations include: by-laws, standards, codes

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-2.05.01L	demonstrate knowledge of ***oxy-fuel equipment***, their ***components***, characteristics and applications	identify ***oxy-fuel equipment***, and describe their characteristics and applications
		identify ***oxy-fuel equipment components***, and describe their characteristics and applications
		identify hazards, and describe safe work practices pertaining to use of ***oxy-fuel equipment***
A-2.05.02L	demonstrate knowledge of ***plasma cutting equipment***, their components, characteristics and applications	identify ***plasma cutting equipment***, and describe their characteristics and applications
		identify ***plasma cutting equipment settings***, and describe their characteristics and applications
		identify hazards, and describe safe work practices pertaining to use of ***plasma cutting equipment***
A-2.05.03L	demonstrate knowledge of procedures to use, inspect, maintain and store ***oxy-fuel equipment***	describe limitations and procedures for use of ***oxy-fuel equipment***
		describe procedures to inspect, maintain and store ***oxy-fuel equipment***
A-2.05.04L	demonstrate knowledge of procedures to use, inspect, maintain and store ***plasma cutting equipment***	describe limitations and procedures for use of ***plasma cutting equipment***
		describe procedures to inspect, maintain and store ***plasma cutting equipment***
A-2.05.05L	demonstrate knowledge of training requirements to perform oxy-fuel and plasma cutting	identify training requirements to perform oxy-fuel and plasma cutting

Range of Variables

oxy-fuel equipment includes: flashback arrestors, regulators

oxy-fuel equipment components include: hoses, flashback arrestors, cylinders

plasma cutting equipment includes: air plasma, CNC plasma cutters, oxygen plasma, high definition plasma

plasma cutting equipment settings include: tips, voltages, air pressure

Task A-3 Organizes job

Task Descriptor

Steamfitters/Pipefitters participate in organizing jobs, planning the work, generating material lists and managing their time to meet project deadlines. They ensure the systems are assembled correctly by following drawings, regulations and specifications, and participating in quality control practices.

Steamfitters/Pipefitters use drawings and specifications to determine scope of work, and materials and methods to be used for specific installations. Drawings are also used to communicate detailed construction information such as dimensions, materials used and joining methods, which are used in the layout and fabrication of fittings such as mitres and branch connections. Steamfitters/Pipefitters also use drawings to develop templates.

It is very important for steamfitters/pipefitters to develop a strong understanding of labour costs, material costs, and efficiencies in their work. To maintain productivity, lifelong learning is crucial in this trade. Being able to keep “the big picture” in mind, while paying close attention to detail and maintaining a commitment to safe work practices, is an important ability for career success.

Steamfitters/Pipefitters must develop the ability to continuously do quality control checks to ensure compliance with specifications and regulatory requirements.

A-3.01 Plans work

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.01.01P	identify tasks and sequence of tasks	task planning is done according to construction sequence
A-3.01.02P	identify tools, piping, equipment and components required for task	tools, piping, equipment and components required for task are identified according to bill of materials and drawings
A-3.01.03P	estimate time and labour requirements to complete tasks	productivity reports and monthly progress reports reflect estimates
A-3.01.04P	coordinate schedule and work with other trades	schedule and work is coordinated with other trades for safety, sequence and productivity
A-3.01.05P	verify permits are in place before commencing work	required documentation is filed and permits are verified according to site-specific requirements
A-3.01.06P	adapt to changing ***environmental conditions***	work schedule includes back-up plan to accommodate for unexpected ***environmental conditions***

A-3.01.07P	organize ***work area requirements***	***work area requirements*** are reported to supervisors and tracked in productivity reports and work schedule
A-3.01.08P	expedite tools, piping, equipment and components to installation location	tools, piping, equipment and components are at installation location and documentation is complete

Range of Variables

environmental conditions include: site-specific, inclement weather, air quality, asbestos abatement requirements, flooding

work area requirements include: installing temporary shelters, platforms and heaters, waste disposal, site-specific safety requirements

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.01.01L	demonstrate knowledge of procedures to plan and organize job	identify ***sources of information*** relevant to job planning
		describe ***considerations*** for determining job requirements
		describe ***procedures to plan work***
		describe procedures to organize and maintain inventory
A-3.01.02L	demonstrate knowledge of project costs and efficient trade practices	calculate labour and time costs
		calculate material costs and wastage
		identify work methods and planning to maximize practices that are most efficient while maintaining commitment to safety

Range of Variables

sources of information include: bid packages, productivity reports, requests for information (RFI), work schedules, drawings, related professionals, clients

considerations include: site layout, crane requirements, excavation, access

procedures to plan work include: scheduling, estimating, assessing environmental conditions

A-3.02 Generates drawings

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.02.01P	select and use ***layout and drafting tools and equipment***	***layout and drafting tools and equipment*** are selected and used according to job requirements
A-3.02.02P	sketch ***drawings***	***drawings*** are sketched according to requirements of application and can be interpreted for fabrication
A-3.02.03P	modify ***engineered drawings***	***engineered drawings*** are modified with "red-line" changes according to job requirements
A-3.02.04P	apply ***trade-related symbols*** to sketches	***trade-related symbols*** are applied to sketches according to ***drawings***
A-3.02.05P	create as-built drawings	as-built drawings reflect final installation
A-3.02.06P	determine location of piping and equipment	piping and equipment location is determined according to drawings
A-3.02.07P	compare site dimensions with ***engineered drawing*** dimensions	site dimensions are compared with ***engineered drawings*** and discrepancies are documented
A-3.02.08P	illustrate three-dimensional visualization	three-dimensional visualization is illustrated using orthographic and isometric drawings, and 3-D drawings produced resemble dimensions of actual piping and equipment

Range of Variables

layout and drafting tools and equipment include: levelling instruments, squares, scale rulers, scribers, calculators, compasses

drawings include: as-built, isometric, weld maps, spool drawings, schematics, process and instrumentation drawings (P&ID)

engineered drawings include: civil/site, mechanical, electrical, architectural, manufacturers', structural

trade-related symbols include: valves, socket welds, caps, tees, elbows, flanges, tie-ins, weld symbols, penetrations, equipment, supports, components

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.02.01L	demonstrate knowledge of ***drawings*** and ***engineered drawings*** and their applications	describe metric and imperial systems of measurement and procedures to perform conversions
		identify ***layout and drafting tools and equipment***, and describe their characteristics and applications
		identify types of ***drawings*** and describe their applications
		identify types of ***engineered drawings*** and describe their applications
		identify types of ***trade-related symbols***, and describe their characteristics and applications
		identify ***drawing projections*** and ***views***, and describe their applications
		describe use of scales
A-3.02.02L	demonstrate knowledge of basic drawing and sketching techniques	describe basic drawing and sketching techniques

Range of Variables

layout and drafting tools and equipment include: levelling instruments, squares, scale rulers, scribers, calculators, compasses

drawings include: as-built, isometric, weld maps, spool drawings, schematics, P&ID

engineered drawings include: civil/site, mechanical, electrical, architectural, manufacturers', structural

trade-related symbols include: valves, socket welds, caps, tees, elbows, flanges, tie-ins, weld symbols, penetrations, equipment, supports, components

drawing projections include: orthographic, oblique, isometric, pictorial, 3D drawings

drawing views include: plan, section, detail, elevation, cross-section.

A-3.03 Interprets drawings and specifications

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.03.01P	prepare material list	material list is prepared according to specifications, bill of material and ***drawings***
A-3.03.02P	transfer ***information*** from specifications to ***drawings***	***information*** from specifications is transferred to ***drawings***

A-3.03.03P	communicate discrepancies to ***authorities***	change orders and revisions are documented and reported to ***authorities***
A-3.03.04P	identify drawing revisions	piping installation reflects revisions from engineer
A-3.03.05P	gather information from multiple ***drawings***	information is gathered from multiple ***drawings*** and confirmed, or an RFI is completed
A-3.03.06P	confirm dimensions	dimensions are confirmed by comparing field measurements and engineered drawings
A-3.03.07P	reference spool drawings	spool drawings are referenced to identify scope of work, fabricate piping and components, and install systems
A-3.03.08P	identify types of piping systems, piping and equipment from ***drawings***	types of piping systems, piping and equipment are identified from ***drawings***
A-3.03.09P	relate line numbering systems to ***drawings***	line numbers are correct on ***drawings***
A-3.03.10P	access drawings and specification information	***digital tools and software*** and hard-copy documentation are used to identify layout and installation (dimensional control) of piping and equipment in relation to job requirements

Range of Variables

drawings include: structural, electrical, mechanical, architectural, manufacturers', P&ID, schematic, civil, general arrangement (GA) drawings, orthographic, isometric

information includes: material, equipment, abbreviations, trade-related symbols (valves, socket welds, caps, tees, elbows, flanges, tie-ins, weld symbols, penetrations, equipment, supports, components), identification codes

authorities include: supervisor, engineer, site inspector, consultant, health and safety inspector

digital tools and software include: total station, CAD, CAD software, Building Information Modelling (BIM)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.03.01L	demonstrate knowledge of ***information*** on ***drawings*** their characteristics and applications	identify types of ***drawings*** and describe their applications
		identify ***trade-related symbols*** on drawings and describe their characteristics and applications
		identify types of piping systems, piping and equipment from ***drawings***
		interpret and extract ***information*** from ***drawings*** and specifications

A-3.03.02L	demonstrate knowledge of ***drawings***, their applications and characteristics	describe metric and imperial systems of measurement and procedures to perform conversions
		identify ***drawing projections*** and ***views***, and describe their applications
		describe procedures to use scales
A-3.03.03L	demonstrate knowledge of ***digital tools and software*** for layout and design	identify types of ***digital tools and software*** for layout and design
		identify ***applications for digital software*** tools

Range of Variables

information includes: abbreviations, drafting symbols (valves, socket welds, caps, tees, elbows, flanges, tie-ins, weld symbols, penetrations, equipment, supports, components), identification codes

drawings include: structural, electrical, architectural, P&ID, schematic, civil, GA drawings

trade-related symbols include: valves, socket welds, caps, tees, elbows, flanges, tie-ins, weld symbols, penetrations, equipment, supports, components

drawing projections include: orthographic, oblique, isometric, pictorial

drawing views include: plan, section, detail, elevation, cross section

digital tools and software include: total station, CAD, CAD software, BIM

applications for digital software include: dimensional control, visualization of construction

A-3.04 Develops piping templates

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.04.01P	identify required ***template***	***template*** is identified according to requirements of application
A-3.04.02P	plan development of ***template***	***template*** development is planned according to job and situation
A-3.04.03P	determine measurements for coordinates on pipe	measurements for coordinates on pipe are determined by pipe size and orientation
A-3.04.04P	lay out coordinates onto ***material*** to cut template	coordinates are laid out onto ***material*** to cut template

Range of Variables

template includes: tee, wye, mitre, dummy leg

material includes: gaskets, card stock, wrap-arounds, cladding

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.04.01L	demonstrate knowledge of ***template*** development	identify information pertaining to ***template*** development found on drawings
		identify ***specifications for piping requirements*** used in ***template*** development
A-3.04.02L	demonstrate knowledge of procedures to develop ***templates***	identify ***tools and equipment*** relating to ***template*** development, and describe their applications and procedures for use
		describe procedures to develop ***templates***
		identify hazards, and describe safe work practices pertaining to ***template*** development

Range of Variables

template includes: tee, wye, mitre, dummy leg

specifications for piping requirements include: wall thickness, type of material, diameter, function of piping system

tools and equipment include: dividers, scribers, protractors, compasses, wrap-around, paper, cardboard, plywood, mitre board, squares

A-3.05 Performs quality control functions

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.05.01P	acquire ***quality control (QC) documentation***	***QC documentation*** is acquired from engineer, client or supplier
A-3.05.02P	verify and identify piping materials	piping materials are identified and verified that they match specifications and documentation
A-3.05.03P	verify ***QC criteria*** prior to work	***QC criteria*** is verified prior to work
A-3.05.04P	reference weld procedures	***QC documentation*** indicates welding procedures, ***monitoring sensors***, and consumables for application
A-3.05.05P	fabricate components	components are fabricated according to ***QC criteria***

A-3.05.06P	perform visual inspection of components and system	visual inspection of components and system is performed and documentation indicates that it is in compliance with specifications
A-3.05.07P	arrange for ***non-destructive examination (NDE)*** of welded joints and piping	***NDE*** documentation received from third party indicates that examination was performed according to ***QC documentation***
A-3.05.08P	perform ***pressure tests***	***pressure tests*** are performed according to ***QC documentation***
A-3.05.09P	apply recommended ***coatings*** to welded joints on piping	***coatings*** are applied to welded joints on piping according to specifications
A-3.05.10P	verify installation meets ***QC criteria***	installation meets ***QCcriteria*** and ***documentation*** is completed

Range of Variables

QC documentation includes: manuals, mill test reports, Canadian Registration Numbers (CRN), inspection test plan, weld procedures

QC criteria include: storage requirements, cross-contamination, high/low tolerances, alignment, heat number transfers, traceability, pre- and post-heating, stress relieving, torque requirements, tensioning requirements

monitoring sensors include: temp sticks, infrared thermometers, contact probes

NDEs include: dye penetrant, magnetic particle, x-ray, ultrasonic, Brinell hardness, visual

pressure tests include: vacuum, hydrostatic, pneumatic

coatings include: tape, paint, passivation, synthetic coatings

documentation includes: tagging, flange torque sheets, torque pattern identification, torque specifications

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.05.01L	demonstrate knowledge of quality control and its applications	interpret information pertaining to quality control found on ***QC documentation*** and specifications
		identify ***QC criteria***
A-3.05.02L	demonstrate knowledge of procedures to perform quality control	identify ***tools and equipment*** relating to quality control, and describe their procedures for use
		identify methods of visual inspection
		identify methods of ***NDE***
		identify methods of ***pressure tests***
		identify methods of heat treatment and stress relief
		identify hazards and safe work practices pertaining to quality control, ***NDE*** and ***pressure tests***

Range of Variables

QC documentation includes: manuals, mill test reports, CRN, inspection test plan, weld procedures

QC criteria include: storage requirements, cross-contamination, high/low tolerances, alignment, heat number transfers, traceability, pre- and post-heating, stress relieving, torque requirements, tensioning requirements

tools and equipment include: see Appendix B

NDEs include: dye penetrant, magnetic particle, x-ray, ultrasonic, Brinell hardness, visual

pressure tests include: vacuum, hydrostatic, pneumatic

A-3.06 Handles materials and components

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-3.06.01P	identify ***materials*** and ***components***	***materials*** and ***components*** are identified according to packing slips and order sheets
A-3.06.02P	determine weights of ***materials*** and ***components***	weights of ***materials*** and ***components*** are determined by calculating and referring to material documentation
A-3.06.03P	organize ***materials*** and ***components***	***materials*** and ***components*** are organized according to space availability, type of material and sequence of installation
A-3.06.04P	store ***materials*** and ***components***	***materials*** and ***components*** are stored in a protected location to prevent ***contamination***
A-3.06.05P	bundle, load and unload ***materials*** and ***components***	***materials*** and ***components*** are bundled, loaded and unloaded considering ***hazards of loading/unloading*** and ***contamination***
A-3.06.06P	dispose of waste materials	waste materials are disposed of according to jurisdictional regulations and site-specific requirements

Range of Variables

materials include: tube and pipe, angle iron, hollow structural sections (HSS), tools

components include: valves, vessels, pumps, gaskets, exchangers

hazards of loading/unloading include: uneven weight distribution, capacity of hoisting equipment, over-sized loads, load shifting

contamination includes: corrosion, cross-contamination, dirt, oil, water, pests

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-3.06.01L	demonstrate knowledge of types, properties and handling requirements of ***materials*** and ***components***	describe space constraints
		identify types of ***metals***
		identify ***materials*** and ***components***
		interpret the designations and schedules for pipe and tube
		identify various types, grades and size of bolts, studs and screws
		identify ***standard fittings***, their sizing, designation, function and pressure rating
A-3.06.02L	demonstrate knowledge of safe handling practices for ***materials*** and ***components***	describe safety requirements for handling ***material*** and ***components***
		describe safety requirements for storing gas cylinders and hazardous materials

Range of Variables

materials include: tube and pipe, angle iron, HSS, tools

components include: valves, vessels, pumps, gaskets, exchangers

metals include: cast iron, carbon steels, alloy metals, stainless steel, copper, aluminum

standard fittings include: nozzles, couplings, tees, elbows, flanges, blind flanges, blanking plates, plugs, valves

Task A-4 Uses communication and mentoring techniques

Task Descriptor

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

A-4.01 Uses communication techniques

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-4.01.01P	demonstrate communication practices with individuals or in a group	instructions and messages are interpreted by all parties involved in communication
A-4.01.02P	listen using ***active listening*** practices	***active listening*** practices are utilized

A-4.01.03P	speak clearly using correct industry terminology to ensure understanding	understanding of message is confirmed by both parties
A-4.01.04P	receive and respond to instructions	response to instructions indicates understanding
A-4.01.05P	receive and respond to feedback on work completed or performed	response to feedback indicates understanding and corrective measures are taken
A-4.01.06P	explain and provide feedback	explanation and feedback is provided and task is carried out as directed
A-4.01.07P	use questions to improve communication	questions enhance understanding, on-the-job training, and goal setting
A-4.01.08P	participate in safety and information meetings	meetings are attended, information is relayed to workforce, and is applied
A-4.01.09P	send and receive ***electronic messages***	***electronic messages*** are sent and received using professionalism, plain language and clear expressions according to company policy

Range of Variables

active listening includes: hearing, interpreting, reflecting, responding, paraphrasing
electronic messages include: email, text messages

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-4.01.01L	demonstrate knowledge of trade terminology	define terminology used in trade
A-4.01.02L	demonstrate knowledge of effective communication practices	describe importance of using effective verbal and non-verbal communication with ***people in the workplace***
		identify ***sources of information*** to effectively communicate
		identify communication and ***learning styles***
		describe effective listening and speaking skills
		describe how to receive and give instructions effectively
		identify ***personal responsibilities and attitudes*** that contribute to on-the-job success
		identify value of equity, diversity and inclusion in workplace

	identify communication that constitutes bullying, ***harassment*** and ***discrimination***
	identify communication styles appropriate to different systems and applications of ***electronic messages***

Range of Variables

people in the workplace include: other tradespeople, colleagues, apprentices, supervisors, clients, jurisdictional representatives, manufacturers, visitors

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

learning styles include: visual, auditory, reading, writing, hands-on

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

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

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

electronic messages include: email, text messages

A-4.02 Uses mentoring techniques

	Skills	
	Performance Criteria	**Evidence of Attainment**
A-4.02.01P	identify and communicate learning objective and point of lesson	apprentice or learner can explain objective and point of lesson
A-4.02.02P	link lesson to other lessons and project	lesson order and unplanned learning opportunities are defined
A-4.02.03P	demonstrate performance of a skill to an apprentice or learner	***steps required to demonstrate a skill*** are performed
A-4.02.04P	set up conditions required for apprentice or learner to practice a skill	***practice conditions*** are set up so that skill can be practiced safely by apprentice or learner
A-4.02.05P	assess apprentice or learner's ability to perform tasks with increasing independence	performance of apprentice or learner improves with practice to a point where task can be done with little supervision
A-4.02.06P	give supportive and corrective feedback	apprentice or learner adopts best practice after having been given supportive or corrective feedback
A-4.02.07P	support apprentices or learners in pursuing technical training opportunities	technical training is completed within timeframe prescribed by apprenticeship authority

A-4.02.08P	support anti-***harassment*** and anti-***discrimination*** practices in workplace	workplace is ***harassment*** and ***discrimination***-free
A-4.02.09P	assess apprentice or learner suitability to trade during probationary period	apprentice or learner is provided constructive feedback that helps them identify their own strengths and weaknesses and suitability for the trade

Range of Variables

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

practice conditions means: guided, limited independence, full independence

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

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

	Knowledge	
	Learning Outcomes	**Learning Objectives**
A-4.02.01L	demonstrate knowledge of strategies for learning skills in workplace	describe importance of individual experience
		describe shared responsibilities for workplace learning
		determine one's own learning preferences and explain how these relate to learning new skills
		describe importance of different types of skills in workplace
		describe importance of ***skills for success (essential skills)*** in workplace
		identify different ***learning styles***
		identify different ***learning needs*** and strategies to meet them
		identify ***strategies to assist in learning a skill***
A-4.02.02L	demonstrate knowledge of strategies for ***teaching*** workplace ***skills***	identify different roles played by workplace mentor
		describe ***teaching skills***
		explain importance of identifying point of lesson
		identify how to choose a good time to present lesson
		explain importance of linking lessons
		identify context for learning skills
		describe considerations in setting up opportunities for skill practice
		explain importance of providing feedback

	identify techniques for giving effective feedback
	describe a skills assessment
	identify methods of assessing progress
	explain how to adjust lesson to different situations, ***learning styles*** and ***needs***

Range of Variables

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

learning styles include: visual, auditory, reading, writing, hands-on

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

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

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

Major Work Activity B

Performs layout, fabrication and piping installation

Task B-5 Performs fabrication

Task Descriptor

Prior to installation of piping and equipment, steamfitters/pipefitters perform fabrication of pipes, piping systems, and associated equipment and supports, either in an off-site fabrication shop or on-site.

B-5.01 Fabricates piping system components

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-5.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-5.01.02P	select ***materials***	***material*** quantities and type are selected according to material list and item to be fabricated
B-5.01.03P	assemble ***piping system components***	***piping system components*** are assembled using layout techniques, ***joining methods*** and ***fabrication techniques*** according to specifications and ***drawings***
B-5.01.04P	clean and protect ***piping system components***	***piping system components*** are cleaned and protected using ***treating methods*** according to specifications
B-5.01.05P	fit and position ***piping system components***	***piping system components*** are orientated, fitted and positioned according to ***drawings***, ***fitting tolerance practices*** and joining method for application
B-5.01.06P	pre-heat or purge piping material and verify joining method	***verification tools and equipment*** are used to ensure ***piping system components*** meet quality assurance (QA)/QC procedures and documentation

B-5.01.07P	perform ***post-weld activities***	***post-weld activities*** are performed according to QA/QC procedures and documentation
B-5.01.08P	check completed work	completed work is checked according to QA/QC procedures and documentation
B-5.01.09P	generate field drawings	drawings are legible and clear, and reflect field installation
B-5.01.10P	document weld mapping	weld mapping is documented according to QA/QC procedures and documentation
B-5.01.11P	identify ***piping system components***	***piping system components*** are identified according to ***installation drawings***
B-5.01.12P	test ***piping system components***	***piping system components*** are tested using ***testing methods*** according to QA/QC procedures and documentation
B-5.01.13P	complete documentation	documentation is completed according to project specifications

Range of Variables

tools and equipment include: pipe stands, pipe vises, bevelling machines, levels, measuring tools, flange squares, grinders, welding equipment

materials include: structural steel, pipe fittings, pipe

piping system components include: pipe spools, fittings, valves, pipe supports

joining methods include: threading, grooving, mechanical joint, gluing, welding, fusion

fabrication techniques include: cutting, bending, bevelling, drilling

drawings include: engineered, mechanical, electrical, manufacturers, architectural

treating methods include: applying protective coatings, tape, paint, passivation, chemical flushing

fitting tolerance practices include: two-holing, gap, high-low, transitioning, alignment

verification tools and equipment include: temperature sticks, oxygen analyzers

post-weld activities include: stress relieving, controlled cooling, NDE

installation drawings include: flow sheets, blueprints, P&ID, GA, spool drawings

testing methods include: hydrostatic, pneumatic, vacuum, in-service

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-5.01.01L	demonstrate knowledge of ***piping system component*** fabrication	interpret information pertaining to piping system component fabrication found on drawings and specifications
		identify types of ***fittings***, and describe their characteristics and applications
		identify types of ***joining methods*** and describe their applications
		identify types of ***fabrication techniques*** and describe their applications
		identify types of ***treating methods*** and describe their applications

		identify types of ***fitting tolerance practices*** and describe their applications
		identify ***pre-*** and ***post-weld activities*** and describe their applications
B-5.01.02L	demonstrate knowledge of procedures to fabricate ***piping system components***	identify ***tools and equipment*** used to fabricate ***piping system components***, and describe their applications and procedures for use
		identify hazards and describe safe work practices pertaining to fabrication
		describe procedures to fabricate and assemble ***piping system components***
B-5.01.03L	demonstrate knowledge of regulatory requirements to fabricate ***piping system components***	identify ***jurisdictional regulations*** pertaining to ***piping system component*** fabrication

Range of Variables

piping system components include: pipe spools, fittings, valves
fittings include: elbows, tees, wyes, true wyes, olets, laterals, crosses, reducers
joining methods include: threading, grooving, gluing, welding, compression, fusion
fabrication techniques include: cutting, bending, bevelling, drilling
treating methods include: applying protective coatings, tape, paint, passivation, chemical flushing
fitting tolerance practices include: two-holing, gap, high-low, transitioning, alignment
pre-weld activities include: purging, controlled heating
post-weld activities include: stress relieving, controlled cooling, NDE
tools and equipment include: pipe stands, pipe vises, bevelling machines, levels, measuring tools, flange squares, temperature sticks, oxygen analyzers, grinders, welding equipment
jurisdictional regulations include: by-laws, standards, codes, American Society of Mechanical Engineers (ASME) B31, Canadian Standards Association (CSA)

B-5.02 Fabricates brackets, supports, hangers, guides and anchors

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-5.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-5.02.02P	select ***material***	***material*** quantities and type are selected according to material list and item to be fabricated

B-5.02.03P	assemble ***materials*** and ***support components***	***materials*** and ***support components*** are assembled according to QA/QC procedures and documentation, and design specifications for completed project using ***joining methods*** and ***fabrication techniques***
B-5.02.04P	apply ***pipe protection***	***pipe protection*** is applied ensuring pipe is protected from wear on support
B-5.02.05P	orientate, fit and position ***materials*** and ***support components***	***materials*** and ***support components*** are orientated, fitted and positioned according to dimensions of insulation and calculated expansion, and joining method for application
B-5.02.06P	verify joining methods	joining methods meet QA/QC procedures and documentation, and welding specifications
B-5.02.07P	pre-heat ***materials*** and ***support components***	***materials*** and ***support components*** are preheated according to QA/QC procedures and documentation and using ***verification tools and equipment***
B-5.02.08P	perform ***post-weld activities***	***post-weld activities*** are performed according to QA/QC procedures and documentation, and welding specifications
B-5.02.09P	check completed work	completed work is checked according to QA/QC procedures and documentation
B-5.02.10P	generate field bracket and support drawings	drawings are legible and clear, and reflect field installation
B-5.02.11P	document weld mapping	weld mapping is documented according to QA/QC procedures and documentation
B-5.02.12P	identify brackets, supports, hangers, guides, anchors and fittings	brackets, supports, hangers, guides, anchors and fittings are identified according to ***installation drawings***
B-5.02.13P	inspect final installation	final installation is inspected according to ***inspection procedures***
B-5.02.14P	complete QA/QC documentation	QA/QC documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: chop saws, cutting torches, band saws, grinders, magnetic base drills, pipe vises, two-foot squares

materials include: structural steel, pipe, pipe clamps, threaded rods, isolation barriers, clevis hangers, nuts, washers

support components include: anchors, shoes, trunions, dummy legs, guides

joining methods include: bolt-on, inserting, welding, chemical anchored

fabrication techniques include: cutting, bending, bevelling

pipe protection includes: chafing shields, rubber grommets, wear pads

verification tools and equipment include: temperature sticks, pyrometers

post-weld activities include: stress relieving, controlled cooling

installation drawings include: GA, orthographic, isometric

inspection procedures include: visual, torque, NDE

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-5.02.01L	demonstrate knowledge of bracket, support, hanger, guide and anchor fabrication	identify information pertaining to brackets, supports, hangers, guides and anchors fabrication found on drawings and specifications
		identify types of ***joining methods*** and describe their applications
		identify types of ***fabrication techniques*** and describe their applications
		identify ***post-weld activities*** and describe their applications
B-5.02.02L	demonstrate knowledge of procedures to fabricate brackets, supports, hangers, guides and anchors	identify ***fabrication tools and equipment*** to fabricate brackets, supports, hangers, guides and anchors, and describe their applications and procedures for use
		identify hazards and describe safe work practices pertaining to fabrication
		describe procedures to fabricate and assemble brackets, supports, hangers, guides and anchors
B-5.02.03L	demonstrate knowledge of regulatory requirements to fabricate brackets, supports, hangers, guides and anchors	identify ***jurisdictional regulations*** pertaining to fabrication of brackets, supports, hangers, guides and anchors

Range of Variables

joining methods include: bolt-on, inserting, welding, chemical anchored

fabrication techniques include: cutting, bending, bevelling, drilling

post-weld activities include: stress relieving, controlled cooling

fabrication tools and equipment include: chop saws, cutting torches, band saws, grinders, magnetic base drills, pipe vises, two-foot squares

jurisdictional regulations include: by-laws, standards, codes, ASME B31, Canadian Welding Bureau (CWB)

Task B-6 Lays out and installs piping, tubing, fittings and related components

Task Descriptor

The layout and installation of various piping, tubing, fittings and related components requires a wide range of skills including preparation, measuring, cutting and joining techniques. Layout and installation methods can vary considerably depending on the material of the piping and tubing.

B-6.01 Lays out and installs copper tube, tubing, fittings and related components

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-6.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-6.01.02P	select and inspect ***copper tube and tubing*** material	***copper tube and tubing*** material is selected according to drawings and has visible American Society of Testing and Materials (ASTM) incised markings
B-6.01.03P	prepare material list	material list is prepared according to packing list and drawings
B-6.01.04P	take field measurements	field measurements taken are complete and accurate to confirm drawings and installation instructions
B-6.01.05P	measure, calculate, mark and lay out ***copper tube and tubing***	***copper tube and tubing*** is measured, calculated, marked and laid out according to drawings
B-6.01.06P	cut and ream ***copper tube and tubing***	***copper tube and tubing*** is cut and reamed according to type and size of tube and tubing

B-6.01.07P	bend ***copper tube and tubing***	***copper tube and tubing*** is bent according to required dimensions
B-6.01.08P	prepare, assemble and join ***copper tube and tubing***	***copper tube and tubing*** is prepared, assembled and joined using ***preparation*** and ***joining methods*** to produce a leak-free joint
B-6.01.09P	install ***copper tube and tubing***, expansion joints, swing joints, expansion loops and ***components***	***copper tube and tubing,*** expansion joints, swing joints, expansion loops and ***components*** are installed according to drawings and QA/QC specifications
B-6.01.10P	install ***accessories***	***accessories*** are installed according to drawings and QA/QC specifications
B-6.01.11P	generate field bracket and support drawings	field bracket and support drawings are legible and clear, and reflect field installations
B-6.01.12P	perform mapping of joints	mapping of joints is documented according to QA/QC procedures
B-6.01.13P	itemize ***copper tube and tubing***, ***fittings*** and ***components***	***copper tube and tubing***, ***fittings*** and ***components*** are itemized according to drawings
B-6.01.14P	torque flanged joints	flanged joints are torqued according to QA/QC specifications and task is documented
B-6.01.15P	anneal ***copper tube and tubing***	***copper tube and tubing*** is annealed so that it is pliable and not kinked
B-6.01.16P	test ***copper tube and tubing***, ***fittings*** and ***components***	***testing methods*** are used to test ***copper tube and tubing***, ***fittings*** and ***components*** according to testing requirements
B-6.01.17P	complete documentation	documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: tube cutters, tube benders, reamers, soldering, brazing, flaring and grooving equipment, hack saws, power cutting tools, hand benders, hydraulic benders

copper tube and tubing includes: G, M, L, K, drain, waste and vent (DWV), air-conditioning and refrigeration (ACR) tubing

preparation methods include: reaming, sanding, cleaning

joining methods include: brazing, soldering, flaring, grooving, extrusion Ts, compression fittings

components include: valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

fittings include: elbows, tees, crosses, flared, compression, couplings

testing methods include: hydrostatic, pneumatic, vacuum, in-service

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-6.01.01L	demonstrate knowledge of ***copper tube and tubing***, ***fittings*** and ***components***	identify ***copper tube and tubing***, and describe their characteristics and applications
		identify ***fittings*** used with ***copper tube and tubing***, and describe their characteristics and applications
		identify copper tube and tubing ***components***, and describe their characteristics and applications
		identify copper tube and tubing ***accessories***, and describe their characteristics and applications
		interpret information pertaining to ***copper tube and tubing*** found on drawings and specifications
		describe identification systems for ***copper tube and tubing***
		identify systems and criteria used in referencing, selecting and ordering ***copper tube and tubing***
B-6.01.02L	demonstrate knowledge of procedures to measure and size ***copper tube, tubing*** and ***components***	explain ***measurements*** for ***copper tube and tubing***
		describe ***procedures to measure*** and size ***copper tube, tubing*** and ***fittings***
B-6.01.03L	demonstrate knowledge of procedures to cut, bend and join ***copper tube, tubing***, and ***fittings***	identify ***tools and equipment*** used to cut, bend and join ***copper tube, tubing***, ***fittings*** and joints, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to cutting, bending and joining ***copper tube, tubing***, and ***fittings***
		identify methods used to cut ***copper tube and tubing***, and describe their associated procedures
		identify ***joining methods*** for ***copper tube and tubing***, and describe their associated applications and procedures
		describe procedures to bend ***copper tube and tubing***
B-6.01.04L	demonstrate knowledge of procedures to install and test ***copper tube, tubing, fittings*** and ***components***	describe procedures to install ***copper tube, tubing***, ***fittings*** and ***components***

		describe procedures to test ***copper tube, tubing***, ***fittings*** and ***components***
B-6.01.05L	demonstrate knowledge of regulatory requirements pertaining to ***copper tube and tubing***	interpret ***jurisdictional regulations*** pertaining to ***copper tube and tubing***

Range of Variables

copper tube and tubing includes: G, M, L, K, DWV, ACR tubing

fittings include: elbows, tees, crosses, flared, compression, couplings

components include: valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, spring cans, guides, anchors

measurements include: dimension, diameter, length

procedures to measure include: fitting allowance, offset calculations, bend allowance

tools and equipment include: tube cutters, tube benders, reamers, soldering, brazing, flaring, grooving equipment, hack saws, power cutting tools, hand benders, hydraulic benders

joining methods include: brazing, soldering, flaring, grooving, compression fittings

jurisdictional regulations include: by-laws, standards, codes, ASTM, ASME, American National Standards Institute (ANSI), National Fire Protection Association (NFPA)

B-6.02 Lays out and installs plastic piping, fittings and related components

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-6.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-6.02.02P	select and inspect plastic piping material	***plastic piping*** material is selected according to drawings and markings
B-6.02.03P	prepare material list	material list is prepared according to packing list and drawings
B-6.02.04P	take field measurements	field measurements taken are complete and accurate to confirm drawings and installation instructions
B-6.02.05P	measure, calculate, mark and lay out ***plastic piping***	***plastic piping*** is measured, calculated, marked and laid out according to drawings
B-6.02.06P	cut and ream ***plastic piping***	***plastic piping*** is cut and reamed according to type and size of piping
B-6.02.07P	bend ***plastic piping***	***plastic piping*** is bent according to required dimensions

B-6.02.08P	prepare, assemble and join ***plastic piping***	***plastic piping*** is prepared, assembled and joined using ***joining*** and ***preparation methods*** to produce a leak-free joint
B-6.02.09P	install ***plastic piping***, expansion joints, swing joints and expansion loops, and ***components***	***plastic piping***, expansion joints, swing joints and expansion loops, and ***components*** are installed according to drawings and QA/QC specifications
B-6.02.10P	install ***accessories***	***accessories*** are installed according to drawings and QA/QC specifications
B-6.02.11P	generate field bracket and support drawings	field bracket and support drawings are legible and clear, and reflect field installations
B-6.02.12P	perform mapping of joints	mapping of joints is documented according to QA/QC procedures
B-6.02.13P	itemize ***plastic piping***, ***fittings*** and ***components***	***plastic piping***, ***fittings*** and ***components*** are itemized according to drawings
B-6.02.14P	torque flanged joints	flanged joints are torqued according to QA/QC specifications and task is documented
B-6.02.15P	test ***plastic piping***, ***fittings*** and ***components***	***testing methods*** are used to test ***plastic piping***, ***fittings*** and ***components*** according to testing requirements
B-6.02.16P	complete documentation	documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: tube cutters, fusion machines, scrapers, facers, reamers, hack saws, power cutting tools, heated bending tools, crimpers, expansion tools

plastic piping includes: acrylonitrile butadiene styrene (ABS), polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), cross-linked polyethylene (PEX), plastic tubing, high-density polyethylene (HDPE), low density polyethylene (LDPE), chlorinated polyvinyl chloride (CPVC)

joining methods include: compression fittings, solvent cementing, threading, fusion

preparation methods include: sanding, priming, bevelling, chemical cleaning

components include: valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

fittings include: elbows, tees, crosses, wyes

testing methods include: hydrostatic, pneumatic, vacuum, in-service

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-6.02.01L	demonstrate knowledge of ***plastic piping***, fittings and ***components***	identify ***plastic piping***, and describe their characteristics and applications
		identify ***fittings*** used with plastic piping, and describe their characteristics and applications

		identify plastic piping ***components***, and describe their characteristics and applications
		identify plastic piping ***accessories***, and describe their characteristics and applications
		interpret information pertaining to ***plastic piping*** found on drawings and specifications
		describe identification systems for ***plastic piping***
		identify systems and criteria used in referencing, selecting and ordering ***plastic piping***
B-6.02.02L	demonstrate knowledge of ***procedures to measure*** and size ***plastic piping, fittings*** and ***components***	explain ***measurements*** for ***plastic piping***
		describe ***procedures to measure*** and size ***plastic piping*** and fittings
B-6.02.03L	demonstrate knowledge of procedures to cut, bend and join ***plastic piping, fittings*** and ***components***	identify ***tools and equipment*** used to cut, bend and join ***plastic piping***, ***fittings*** and joints, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to cutting, bending and joining ***plastic piping*** and ***fittings***
		identify methods used to cut ***plastic piping***, and describe their associated procedures
		identify ***joining methods*** for ***plastic piping***, and describe their associated applications and procedures
		describe procedures to bend ***plastic piping***
B-6.02.04L	demonstrate knowledge of procedures to install and test ***plastic piping, fittings*** and ***components***	describe procedures to install ***plastic piping***, ***fittings*** and ***components***
		describe procedures to test ***plastic piping***, ***fittings*** and components using ***testing methods***
B-6.02.05L	demonstrate knowledge of regulatory requirements pertaining to ***plastic piping***	interpret ***jurisdictional regulations*** pertaining to ***plastic piping***

Range of Variables

plastic piping include: ABS, PVC, PP, PE, PEX, plastic tubing, HDPE, LDPE, CPVC
fittings include: elbows, tees, crosses, wyes
components include: valves, controls, instruments, traps, strainers
accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors
procedures to measure include: fitting allowance, offset calculations, bend allowance
measurements include: dimension, length, diameter
tools and equipment include: tube cutters, fusion machines, scrapers, facers, reamers, tubing cutters, hack saws, power cutting tools, heated bending tools, crimpers, expansion tools
joining methods include: compression fittings, solvent cementing, threading, fusion
testing methods include: hydrostatic, pneumatic, vacuum, in-service
jurisdictional regulations include: by-laws, standards, codes, ASTM, ASME, ANSI, NFPA

B-6.03 Lays out and installs carbon steel piping, fittings and related components

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-6.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-6.03.02P	select and inspect ***carbon steel piping*** material, grades and schedules	***carbon steel piping*** material, grades and schedules are selected according to drawings and has visible markings
B-6.03.03P	prepare material list	material list is prepared according to packing list and drawings
B-6.03.04P	take field measurements	field measurements taken are correct and accurate to confirm drawings and installation instructions
B-6.03.05P	measure, calculate, mark and lay out ***carbon steel piping***	***carbon steel piping*** is measured, calculated, marked and laid out according to drawings
B-6.03.06P	cut and prepare ***carbon steel piping***	***carbon steel piping*** is cut and prepared according to type and size of piping
B-6.03.07P	bend ***carbon steel piping***	***carbon steel piping*** is bent according to required dimensions
B-6.03.08P	prepare, assemble and join ***carbon steel piping***	***carbon steel piping*** and ***fittings*** are prepared, assembled and joined using ***preparation*** and ***joining methods***, and ***fitting tolerances*** are addressed
B-6.03.09P	perform ***pre/post-weld activities***	***pre/post-weld activities*** are performed according to QA/QC welding procedures

B-6.03.10P	install carbon steel piping ***components*** and ***accessories***	carbon steel piping ***components*** and ***accessories*** are installed according to drawings and QA/QC specifications
B-6.03.11P	generate field bracket and support drawings	field bracket and support drawings are legible, clear and reflect field installations
B-6.03.12P	perform mapping of joints	mapping of joints is documented according to QA/QC procedures
B-6.03.13P	itemize ***carbon steel piping***, ***fittings*** and ***components***	***carbon steel piping***, ***fittings*** and ***components*** are itemized according to drawings
B-6.03.14P	torque flanged joints	flanged joints are torqued according to QA/QC specifications and task is documented
B-6.03.15P	test ***carbon steel piping***, ***fittings*** and ***components***	***testing methods*** are used to test ***carbon steel piping***, ***fittings*** and ***components*** according to testing requirements
B-6.03.16P	complete documentation	documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: grinders, oxy-fuel cutting torches, threading equipment, files, grooving equipment, tube benders, reamers, power cutting tools, cutters, hand benders, hydraulic benders

carbon steel piping includes: standard carbon steel, low temperature, electric resistance welded (ERW), seamless, submerged arc-welded (SAW)

preparation methods include: grinding, reaming, cutting, bevelling, threading

fittings include: elbows, tees, crosses, wyes, olets, compression

joining methods include: threaded fittings, tacking/welding, flanging, grooving, flaring, compression fittings

fitting tolerances include: gap, high-low, alignment

pre/post-weld activities include: stress relieving, cleaning, controlled cooling, preheating or purging, chemical treating, protective coatings

components include: expansion joints, swing joints, expansion loops, valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors, pipe dope, pipe thread sealant tape, anti-seize compound

testing methods include: hydrostatic, pneumatic, vacuum, in-service, NDE

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-6.03.01L	demonstrate knowledge of ***carbon steel piping,*** fittings and ***components*** and ***accessories***	identify ***carbon steel piping*** and describe their characteristics and applications
		identify ***fittings*** used with ***carbon steel piping*** and describe their characteristics and applications
		identify carbon steel piping ***components,*** and describe their characteristics and applications

		identify carbon steel piping ***accessories***, and describe their characteristics and applications
		interpret information pertaining to ***carbon steel piping*** found on drawings and specifications
		describe identification systems for ***carbon steel piping***
		identify systems and criteria used in referencing, selecting and ordering ***carbon steel piping***
B-6.03.02L	demonstrate knowledge of ***procedures to measure carbon steel piping***	explain ***measurements*** for ***carbon steel piping***
		describe ***procedures to measure carbon steel piping,*** and ***fittings***
B-6.03.03L	demonstrate knowledge of procedures to cut, bend and join ***carbon steel piping*** and ***components***	identify ***tools and equipment*** used to cut, bend and join ***carbon steel piping***, ***fittings*** and joints, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to cutting, bending, threading and joining ***carbon steel piping*** and ***fittings***
		describe inspection procedures and QA/QC requirements for ***carbon steel piping***
		describe ***preparation methods*** for the ends of pipe and ***fittings***
		identify methods used to cut ***carbon steel piping***, and describe their associated procedures
		identify ***joining methods*** for ***carbon steel piping***, and describe their associated applications and procedures
		describe ***pre/post-weld activities***
		describe procedures to bend ***carbon steel piping***
B-6.03.04L	demonstrate knowledge of procedures to install and test ***carbon steel piping***, ***fittings*** and ***components***	describe procedures to install and test ***carbon steel piping***, ***fittings*** and ***components***
B-6.03.05L	demonstrate knowledge of regulatory requirements pertaining to ***carbon steel piping***	interpret ***jurisdictional regulations*** pertaining to ***carbon steel piping***

Range of Variables

carbon steel piping includes: standard carbon steel, low temperature, ERW, seamless, SAW

components include: expansion joints, swing joints, expansion loops, valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors, pipe dope, pipe thread sealant tape, anti-seize compound

fittings include: elbows, tees, crosses, wyes, olets, compression

procedures to measure include: fitting allowance, offset calculations, bend allowance

measurements include: dimension, length, wall thickness/schedule, diameter

tools and equipment include: grinders, oxy-fuel cutting torches, threading equipment, files, grooving equipment, tube benders, reamers, power cutting tools, cutters, hand benders, hydraulic benders

preparation methods include: grinding, reaming, cutting, bevelling, threading

joining methods include: threaded fittings, tacking/welding, flanging, grooving, flaring, compression fittings

pre/post-weld activities include: stress relieving, cleaning procedures, controlled cooling, preheating or purging, chemical treating, protective coatings

jurisdictional regulations include: by-laws, standards, codes, ASME B31, CSA, NFPA, United Laboratories (UL)

B-6.04 Lays out and installs stainless steel piping, tubing, fittings and related components

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-6.04.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-6.04.02P	select and inspect ***stainless steel piping and tubing*** material	***stainless steel piping and tubing*** material is selected according to drawings and have visible markings
B-6.04.03P	prepare material list	material list is prepared according to packing list and drawings
B-6.04.04P	take field measurements	field measurements taken are complete and accurate to confirm drawings and installation instructions
B-6.04.05P	measure, calculate, mark and lay out ***stainless steel piping and tubing***	***stainless steel piping and tubing*** is measured, calculated, marked and laid out according to drawings
B-6.04.06P	cut and prepare ***stainless steel piping and tubing***	***stainless steel piping and tubing*** is cut and prepared according to type and size of piping and tubing
B-6.04.07P	bend ***stainless steel piping and tubing***	***stainless steel piping and tubing*** are bent according to required dimension

B-6.04.08P	prepare, assemble and join ***stainless steel piping and tubing***	***stainless steel piping, tubing*** and ***fittings*** are prepared, assembled and joined using ***preparation*** and ***joining methods*** and ***fitting tolerances*** are addressed
B-6.04.09P	perform ***pre/post-weld activities***	***pre/post-weld activities*** are performed according to QA/QC welding procedures
B-6.04.10P	prevent contamination of parent material	***tools and equipment*** are isolated to ***prevent cross-contamination*** between stainless steel and other materials
B-6.04.11P	install ***stainless steel piping, tubing*** and ***components*** and ***accessories***	***stainless steel piping, tubing components*** and ***accessories*** are installed according to drawings and QA/QC specifications
B-6.04.12P	generate field bracket and support drawings	field bracket and support drawings are legible and clear, and reflect field installations
B-6.04.13P	perform mapping of joints	mapping of joints is documented according to QA/QC procedures
B-6.04.14P	itemize ***stainless steel piping, tubing***, ***fittings*** and ***components***	***stainless steel piping, tubing***, ***fittings*** and ***components*** are itemized according to drawings
B-6.04.15P	torque flanged joints	flanged joints are torqued according to QA/QC specifications and task is documented
B-6.04.16P	test ***stainless steel piping, tubing***, ***fittings*** and ***components***	***testing methods*** are used to test ***stainless steel piping, tubing***, ***fittings*** and ***components*** according to testing requirements
B-6.04.17P	complete documentation	documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: grinders, plasma cutters, threading equipment, files, grooving equipment, tube cutters, tube benders, reamers, power cutting tools, cutters, hand benders, hydraulic benders

stainless steel piping and tubing include: 304, 316 stainless steel

fitting tolerances includes: gap, high-low, alignment, welding process pull

fittings include: elbows, tees, crosses, wyes, olets, compression

preparation methods include: grinding, reaming, cutting, bevelling, threading

joining methods include: threading, welding, flanging, grooving, compression fittings

pre/post-weld activities include: stress relieving, cleaning procedures, controlled cooling, preheating, purging, chemical treating, protective coatings, use of purge dams

prevent cross-contamination includes: labelling, physical separation, use of barriers, tool selection

components include: expansion joints, swing joints, expansion loops, valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors, pipe dope, pipe thread sealant tape, anti-seize compound, isolation kits

testing methods include: hydrostatic, pneumatic, vacuum, in-service, NDE

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-6.04.01L	demonstrate knowledge of ***stainless steel piping and tubing***, ***fittings*** and ***components*** and ***accessories***	identify ***stainless steel piping and tubing***, and describe their characteristics and applications
		identify ***fittings*** used with stainless steel piping and tubing, and describe their characteristics and applications
		identify stainless steel piping and tubing ***components***, and describe their characteristics and applications
		identify stainless steel piping and tubing ***accessories***, and describe their characteristics and applications
		interpret information pertaining to ***stainless steel piping and tubing*** found on drawings and specifications
		describe identification systems and methods for ***stainless steel piping and tubing***
B-6.04.02L	demonstrate knowledge of ***procedures to measure stainless steel piping and tubing***	explain ***measurements*** for ***stainless steel piping and tubing***
		describe ***procedures to measure stainless steel piping and tubing*** and ***fittings***
B-6.04.03L	demonstrate knowledge of procedures to cut, bend and join ***stainless steel piping, tubing, fittings*** and ***components***	identify ***tools and equipment*** used to cut, bend and join ***stainless steel piping, tubing, fittings*** and joints and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to cutting, bending, threading and joining ***stainless steel piping, tubing*** and ***fittings***
		describe methods to ***prevent cross contamination***
		describe ***inspection procedures*** for ***stainless steel piping and tubing***
		identify methods used to cut ***stainless steel piping and tubing***, and describe their associated procedures
		describe ***preparation methods*** of pipe and fitting end
		identify ***joining methods*** used for ***stainless steel piping and tubing***, and describe their associated applications and procedures
		describe ***pre/post-weld activities***

		describe procedures to bend ***stainless steel piping and tubing***
B-6.04.04L	demonstrate knowledge of procedures to install and test ***stainless steel piping, tubing***, ***fittings*** and ***components***	describe procedures to install and ***test methods*** used for ***stainless steel piping, tubing***, ***fittings*** and ***components***
B-6.04.05L	demonstrate knowledge of regulatory requirements pertaining to ***stainless steel piping and tubing***	interpret ***jurisdictional regulations*** pertaining to ***stainless steel piping and tubing***

Range of Variables

stainless steel piping and tubing include: 304, 316 stainless steel

fittings include: elbows, tees, crosses, wyes, olets, compression

components include: expansion joints, swing joints, expansion loops, valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors, pipe dope, pipe thread sealant tape, anti-seize compound, isolation kits

procedures to measure include: fitting allowance, offset calculations, bend allowance

measurements include: dimension, length, wall thickness/schedule, diameter

tools and equipment include: grinders, plasma cutters, threading equipment, files, grooving equipment, tube benders, reamers, power cutting tools, cutters, hand benders, hydraulic benders

prevent cross-contamination includes: labelling, physical separation, use of barriers, tool selection

inspection procedures include: visual, positive material identification (PMI)

preparation methods include: grinding, reaming, cutting, bevelling

joining methods include: threading welding, flanging, grooving, compression fittings

pre/post-weld activities include: stress relieving, cleaning procedures, controlled cooling, preheating or purging, chemical treating, protective coatings

testing methods include: hydrostatic, pneumatic, vacuum, in-service, NDE

jurisdictional regulations include: by-laws, standards, codes, ASME B31, CSA, NFPA, UL

B-6.05 Lays out and installs fibreglass piping, fittings and related components

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

Skills

	Performance Criteria	Evidence of Attainment
B-6.05.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-6.05.02P	select and inspect ***fibreglass piping*** material	***fibreglass piping*** is selected according to drawings and has visible markings
B-6.05.03P	prepare material list	material list is prepared according to packing list and drawings

B-6.05.04P	take field measurements	field measurements taken are complete and accurate to confirm drawings and installation instructions
B-6.05.05P	measure, calculate, mark and lay out ***fibreglass piping***	***fibreglass piping*** is measured, calculated, marked and laid out according to drawings
B-6.05.06P	cut and prepare ***fibreglass piping***	***fibreglass piping*** is cut and prepared (tapered and sanded) according to type of piping
B-6.05.07P	assemble and join ***fibreglass piping*** using ***joining methods***	***fibreglass piping*** is assembled and joined using ***joining methods*** to produce a leak-free joint
B-6.05.08P	bend piping	piping is bent according to drawings, specifications and jurisdictional regulations
B-6.05.09P	install ***fibreglass piping***, ***components*** and ***accessories***	***fibreglass piping***, ***components*** and ***accessories*** are installed according to drawings and QA/QC specifications
B-6.05.10P	generate field bracket and support drawings	field bracket and support drawings are legible and clear, and reflect field installations
B-6.05.11P	perform mapping of joints	mapping of joints is documented according to QA/QC procedures
B-6.05.12P	itemize ***fibreglass piping***, fittings and ***components***	***fibreglass piping***, fittings and ***components*** are itemized according to drawings
B-6.05.13P	torque flanged joints	flanged joints are torqued according to QA/QC specifications and task is documented
B-6.05.14P	test ***fibreglass piping,*** fittings and ***components***	***testing methods*** are used to test ***fibreglass piping***, fittings and ***components*** according to testing requirements
B-6.05.15P	complete documentation	documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: heat belts, air saws, jig saws, grinders, hack saws, power cutting tools, sanders

fibreglass piping includes: fibreglass-reinforced plastic (FRP), glass fibreglass-reinforced plastic (GFRP), glass-reinforced epoxy (GRE)

joining methods include: butt and wrap (butt fusion), bell and spigot, flanged

components include: pumps, valves, controls, instruments, traps, strainers

accessories include: washers, bolts, studs, gaskets, brackets, supports, hangers, guides, anchors, rubber saddles

testing methods include: hydrostatic, pneumatic, vacuum, in-service

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-6.05.01L	demonstrate knowledge of ***fibreglass piping***, fittings and ***components*** and ***accessories***	identify types of ***fibreglass piping***, and describe their characteristics and applications
		identify fittings used with ***fibreglass piping***, and describe their characteristics and applications
		identify fibreglass piping ***components***, and describe their characteristics and applications
		identify fibreglass piping ***accessories***, and describe their characteristics and applications
		interpret information pertaining to ***fibreglass piping*** found on drawings and specifications
		describe identification systems and methods for ***fibreglass piping***
		identify systems and criteria used in referencing, selecting and ordering ***fibreglass piping***
B-6.05.02L	demonstrate knowledge of ***procedures to measure fibreglass piping***	explain ***measurements*** for ***fibreglass piping***
		describe ***procedures to measure fibreglass piping***
B-6.05.03L	demonstrate knowledge of procedures to cut and join ***fibreglass piping,*** fittings and ***components***	identify ***tools and equipment*** used to cut and join ***fibreglass piping***, fittings and ***components***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to cutting and joining ***fibreglass piping*** and fittings
		describe procedures to cut ***fibreglass piping***
		identify ***joining methods*** and ***materials*** used for ***fibreglass piping***, and describe their associated applications and procedures
B-6.05.04L	demonstrate knowledge of procedures to install and test ***fibreglass piping***, fittings and ***components***	describe procedures to install and ***test fibreglass piping***, fittings and ***components***
		describe procedures to bend piping for ***fibreglass piping***
B-6.05.05L	demonstrate knowledge of regulatory requirements pertaining to ***fibreglass piping***	interpret ***jurisdictional regulations*** pertaining to ***fibreglass piping***

Range of Variables

fibreglass piping includes: FRP, GFRP, GRE

components include: pumps, valves, controls, instruments, traps, strainers

accessories include: washers, bolts, studs, gaskets, brackets, supports, hangers, guides, anchors, rubber saddles

procedures to measure include: fitting allowance, offset calculations

measurements include: dimension, length, wall thickness/schedule, diameter

tools and equipment include: heat belts, air saws, jig saws, grinders hack saws, power cutting tools, sanders

joining methods include: butt and wrap, bell and spigot, flanged

materials include: vinyl ester, polyester, halogenated resins, epoxies

testing methods include: hydrostatic, pneumatic, vacuum, in-service

jurisdictional regulations include: by-laws, standards, codes, ASME B31, ASTM, NFPA

B-6.06 Lays out and installs specialty piping, fittings and related components

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-6.06.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-6.06.02P	select and inspect ***specialty piping*** material	***specialty piping*** material is selected according to drawings and has visible markings
B-6.06.03P	prepare material list	material list is prepared according to packing list and drawings
B-6.06.04P	take field measurements	field measurements taken are correct and accurate to confirm drawings and installation instructions
B-6.06.05P	measure, calculate, mark and lay out ***specialty piping***	***specialty piping*** is measured, calculated, marked and laid out according to drawings
B-6.06.06P	cut and prepare ***specialty piping***	***specialty piping*** is cut and prepared according to type and size of piping
B-6.06.07P	bend ***specialty piping***	***specialty piping*** is bent according to required dimensions
B-6.06.08P	prepare, assemble and join ***specialty piping*** and ***fittings***	***specialty piping*** and ***fittings*** are prepared, assembled and joined according to ***fitting tolerances*** and installation drawings using ***preparation*** and ***joining methods***
B-6.06.09P	perform ***pre/post-weld activities***	***pre/post-weld activities*** are performed according to QA/QC welding procedures

B-6.06.10P	prevent contamination of parent material	***tools and equipment*** are isolated to ***prevent cross-contamination*** between alloys and other materials
B-6.06.11P	install ***specialty piping***, ***components*** and ***accessories***	***specialty piping, components*** and ***accessories*** are installed according to drawings and QA/QC specifications
B-6.06.12P	generate field bracket and support drawings	field bracket and support drawings are legible and clear, and reflect field installations
B-6.06.13P	perform mapping of joints	mapping of joints is documented according to QA/QC procedures
B-6.06.14P	itemize ***specialty piping***, ***fittings*** and ***components***	***specialty piping***, ***fittings*** and ***components*** are itemized according to drawings
B-6.06.15P	torque flanged joints	flanged joints are torqued according to QA/QC specifications and task is documented
B-6.06.16P	test ***specialty piping***, ***fittings*** and ***components***	***testing methods*** are used to test ***specialty piping***, ***fittings*** and ***components*** according to testing requirements
B-6.06.17P	complete documentation	documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: grinders, reamers, plasma cutters, threading equipment, files, grooving equipment, power cutting tools, cutters, hand benders, hydraulic benders

specialty piping includes: chrome, molybdenum, titanium, duplex, lined pipe, copper, copper-nickel, synthetic-metallic, hastelloy, aluminum

fittings include: elbows, tees, crosses, wyes, olets, compression

fitting tolerances include: gap, high-low, alignment

preparation methods include: grinding, reaming, cutting, bevelling, threading

joining methods include: threaded fittings, tacking/welding, flanging, grooving, compression fittings, brazing, soldering

pre/post-weld activities include: stress relieving, cleaning procedures, controlled cooling, preheating or purging, chemical treating, protective coatings, use of purge dams

prevent cross-contamination includes: labelling, physical separation, use of barriers, tool selection

components include: expansion joints, swing joints, expansion loops, valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors, pipe dope, pipe thread sealant tape, anti-seize compound

testing methods include: hydrostatic, pneumatic, vacuum, in-service, NDE

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-6.06.01L	demonstrate knowledge of ***specialty piping***, ***fittings*** and ***components***, their characteristics and applications	identify ***specialty piping*** and describe their characteristics and applications
		identify ***fittings*** used with specialty piping, and describe their characteristics and applications
		identify specialty piping ***components***, and describe their characteristics and applications
		identify specialty piping ***accessories***, and describe their characteristics and applications
		describe methods to ***prevent cross-contamination***
		interpret information pertaining to ***specialty piping*** found on drawings and specifications
		describe identification systems for ***specialty piping***
B-6.06.02L	demonstrate knowledge of ***procedures to measure specialty piping***	explain ***measurements*** for ***specialty piping***
		describe ***procedures to measure specialty piping*** and ***fittings***
B-6.06.03L	demonstrate knowledge of procedures to cut, bend and join ***specialty piping***	identify ***tools and equipment*** used to cut, bend and join ***specialty piping***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to cutting, threading bending and joining ***specialty piping***
		describe ***inspection procedures*** for ***specialty piping***
		describe procedures to cut ***specialty piping*** and ***fittings***
		describe ***preparation methods*** of pipe and fitting end
		identify ***joining methods*** used for ***specialty piping***, and describe their associated applications and procedures
		describe ***pre/post-weld activities***
		describe procedures to bend ***specialty piping***

B-6.06.04L	demonstrate knowledge of procedures to install and test ***specialty piping***, ***fittings*** and ***components***	describe procedures to install and test ***specialty piping***, ***fittings*** and ***components***
B-6.06.05L	demonstrate knowledge of regulatory requirements pertaining to ***specialty piping***	interpret ***jurisdictional regulations*** pertaining to ***specialty piping***

Range of Variables

specialty piping includes: chrome, molybdenum**,** titanium, duplex, lined pipe, copper, copper-nickel, synthetic-metallic, hastelloy, aluminum

fittings include: elbows, tees, crosses, wyes, olets, compression

components include: expansion joints, swing joints, expansion loops, valves, controls, instruments, traps, strainers

accessories include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors, pipe dope, pipe thread sealant tape, anti-seize compound

prevent cross-contamination includes: labelling, physical separation, use of barriers, tool selection

procedures to measure include: fitting allowance, offset calculations, bend allowances

measurements include: dimension, length, wall thickness/schedule, diameter

tools and equipment include: grinders, reamers, plasma cutters, threading equipment, files, grooving equipment, power cutting tools, cutters, hand benders, hydraulic benders

fitting tolerances include: gap, high-low, alignment

inspection procedures include: visual, PMI

preparation methods include: grinding, reaming, cutting, bevelling, threading

joining methods include: threaded fittings, tacking/welding, flanging, grooving, compression fittings, brazing, soldering

pre/post-weld activities include: stress relieving, cleaning procedures, controlled cooling, preheating or purging, chemical treating, protective coatings, use of purge dams

jurisdictional regulations include: by-laws, standards, codes, ASME B31, CSA, NFPA, UL

Task B-7 Installs, maintains, troubleshoots, repairs and tests valves

Task Descriptor

Valves are commonplace and widely used in industry. The failure or improper selection of these pieces of equipment can shut down plants and cause buildings to lose heat. This failure can cause the release of hazardous materials into the environment at a chemical plant, prevent a refinery from meeting a critical production deadline, or create a dangerous situation by interrupting the daily operation at a health care facility. Steamfitter/pipefitters install piping systems and the valves that are part of those systems.

B-7.01 Installs valves

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-7.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-7.01.02P	select and inspect ***valves***	***valves*** are selected and inspected according to ***installation variables***, drawings and valve identification
B-7.01.03P	itemize ***valve components*** and ***accessories***	***valve components*** and ***accessories*** are itemized according to drawings
B-7.01.04P	prepare material list	material list is prepared according to packing list and drawings
B-7.01.05P	take field measurements	field measurements taken are correct and accurate to confirm drawings and installation instructions
B-7.01.06P	measure, calculate and mark piping and tubing	piping and tubing is measured, calculated and marked for ***valve*** installation, and clearances, flange, alignment and orientation are maintained
B-7.01.07P	prepare ***valve***	***valve*** is prepared for installation using ***preparation methods*** according to manufacturers' installation instructions and QA/QC procedures
B-7.01.08P	install ***valve***	***valve*** is installed in piping, tubing and system components using ***joining methods*** to ensure valve functionality, and with seat and handle positioned to required orientation
B-7.01.09P	install ***valve actuators***	***valve actuators*** are installed according to manufacturers' installation instructions, drawings and QA/QC procedures

B-7.01.10P	install and reinstall ***valve components***	***valve components*** are installed and reinstalled according to manufacturers' installation instructions, drawings and QA/QC procedures
B-7.01.11P	generate field bracket and support drawings	drawings are legible, clear and reflect field requirements
B-7.01.12P	perform mapping of joints	mapping of joints is documented according to QA/QC procedures
B-7.01.13P	torque flanged joints	flanged joints are torqued according to QA/QC specifications and task is documented
B-7.01.14P	test system including ***valves***, piping, tubing, and ***valve components***	***testing methods*** are used to test system including ***valves***, piping, tubing, and ***valve components*** according to testing requirements, manufacturers' instructions and QA/QC procedures
B-7.01.15P	complete documentation	documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: assorted wrenches, rigging tools, pin bars, impact guns, soldering and welding equipment

valves include: gate, globe, ball, plug, butterfly, needle, relief, pop safety, toggle, check, pressure reducing, shutter, diaphragm

installation variables include: temperature, medium, pressure, flow, functionality, systems, design, orientation

valve components include: seat, stem, disc, packing, diaphragms, bonnet, handles, springs

accessories include: bolts, studs, gaskets, brackets, chain wheels, actuators, anti-seize material, lubricants, sealing compounds

valve actuators include: electric, pneumatic, manual, hydraulic

preparation methods include: maintaining traceability of removed components, protecting internal components, removing shipping materials, maintaining valve orientation and integrity

joining methods include: threading, tacking/welding, flanging, grooving, compression fittings

testing methods include: hydrostatic, pneumatic, vacuum, in-service, NDE, mechanical

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-7.01.01L	demonstrate knowledge of ***valves***, their ***components***, ***accessories***, characteristics, applications and operation	identify types of ***valves***, ***valve components***, and ***accessories*** and describe their characteristics, applications and operation
		identify ***types of valve actuators*** and describe their characteristics and applications
		interpret information found on drawings and specifications pertaining to ***valves***
		explain ***valve rating*** systems and ***installation variables***

B-7.01.02L	demonstrate knowledge of procedures to install ***valves***, their ***components*** and ***accessories***	identify ***tools and equipment*** used to install ***valves***, their ***components*** and ***accessories*** and describe their applications and procedures for use
		identify hazards and describe safe work practices pertaining to installing valves
		identify ***joining methods*** used to install ***valves***, and describe their associated procedures
		describe ***testing methods*** for testing ***valves*** and their ***components***
B-7.01.03L	demonstrate knowledge of regulatory requirements to install ***valves***	interpret ***jurisdictional regulations*** pertaining to ***valves***

Range of Variables

valves include: gate, globe, ball, plug, butterfly, needle, relief, pop safety, toggle, check, pressure reducing, shutter, diaphragm

valve components include: seat, stem, disc, packing, diaphragms, bonnet, handles, springs

accessories include: bolts, studs, gaskets, brackets, chain wheels, actuators, anti-seize material, lubricants, sealing compounds

types of valve actuators include: electric, pneumatic, manual, hydraulic

valve ratings include: pressure, temperature, seat composition, type of service

installation variables include: temperature, medium, pressure, flow, functionality, systems, design, orientation

tools and equipment include: assorted wrenches, rigging tools, pin bars, impact guns, soldering and welding equipment

joining methods include: threading, tacking/welding, flanging, grooving, compression fittings

testing methods include: hydrostatic, pneumatic, vacuum, in-service, NDE, mechanical

jurisdictional regulations include: by-laws, standards, codes, ANSI, UL, CSA, ASME, NFPA

B-7.02 Maintains, troubleshoots, repairs and tests valves

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-7.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job requirements
B-7.02.02P	perform ***maintenance procedures***	***maintenance procedures*** are performed according to predetermined maintenance schedule and ***documentation*** is updated

B-7.02.03P	determine ***valves, components*** and ***accessories*** that require repair or replacement	***valves, components*** and ***accessories*** that require repair or replacement are determined using ***troubleshooting techniques***
B-7.02.04P	lock out and tag out system	system is locked and tagged out to prevent activation of static, stored and residual ***energy sources*** during repair or maintenance
B-7.02.05P	repair ***valves, components*** and ***accessories***	***valves, components*** and ***accessories*** are repaired to operational condition using ***repair techniques***
B-7.02.06P	re-test ***valve***	***valve*** is ***tested*** to ensure it meets ***operational and functional requirements***
B-7.02.07P	complete ***documentation***	documentation is completed according to QA/QC procedures

Range of Variables

tools and equipment include: valve repair hooks, micrometers, lapping plates, grease gun, stethoscope, temperature gun, assorted wrenches, valve repair kits, snap ring pliers

maintenance procedures include: lubricating, cleaning and inspecting equipment or components for wear, replacing worn components

documentation includes: lock-out and tag-out, maintenance log, QA/QC reports

valves include: gate, globe, ball, plug, butterfly, needle, relief, pop safety, toggle, check, pressure reducing, shutter, diaphragm

valve components include: seat, stem, disc, packing, diaphragms, bonnet, handles, springs

accessories include: bolts, studs, gaskets, brackets, chain wheels, actuators, anti-seize material, lubricants, sealing compounds

troubleshooting techniques include: functional checks, visual inspections, use of temperature sensing devices and stethoscopes

energy sources include: mechanical, electrical, hydraulic, pneumatic

repair techniques include: disc and seat refurbishment, stem realignment, valve repacking, changing gaskets, replacing bolts, replacing actuators

tests include: hydrostatic, pneumatic, vacuum, in-service, function-test

operational and functional requirements include: sealing (body and seat), pressure relief as specified

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-7.02.01L	demonstrate knowledge of ***valves***, ***components***, ***accessories***, their characteristics, applications and operation	identify types of ***valves***, ***components***, and ***accessories***, and describe their characteristics, applications and operation
		identify ***types of valve actuators*** and describe their characteristics and applications
		interpret information found on drawings and specifications pertaining to ***valves***
		identify ***valve*** and component ***defects*** requiring repair

		describe necessary ***documentation*** for valve repair
B-7.02.02L	demonstrate knowledge of procedures to ***maintain***, ***troubleshoot***, ***repair*** and ***test valves***	identify ***tools and equipment*** used to ***maintain***, ***troubleshoot***, ***repair*** and ***test valves***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to ***maintenance***, ***repair***, ***troubleshooting*** and ***testing*** valves
		describe ***maintenance*** and ***troubleshooting procedures*** pertaining to ***valves***
		describe procedures to ***repair*** and ***test*** valves
B-7.02.03L	demonstrate knowledge of regulatory requirements to ***maintain***, ***troubleshoot***, ***repair*** and ***test*** to ***valves***	interpret ***jurisdictional regulations*** pertaining to ***valves***

Range of Variables

valves include: gate, globe, ball, plug, butterfly, needle, relief, pop safety, toggle, check, pressure reducing, shutter, diaphragm

valve components include: seat, stem, disc, packing, diaphragms, bonnet, handles, springs

accessories include: bolts, studs, gaskets, brackets, chain wheels, actuators, anti-seize material, lubricants, sealing compounds

types of valve actuators include: electric, pneumatic, manual, hydraulic

defects include: passing valve seal, leaking packing, leaking flanges, leaking bonnet, compromised valve integrity, seized or damaged components

documentation includes: lock-out and tag-out, maintenance log, QA/QC reports

tools and equipment include: valve repair hooks, micrometers, lapping plates, grease gun, stethoscope, temperature gun, assorted wrenches, valve repair kits, snap ring pliers

maintenance procedures include: lubricating, cleaning and inspecting equipment for components for wear, replacing worn components

troubleshooting procedures include: functional checks, visual inspections, use of temperature sensing devices and stethoscopes

repair includes: disc and seat refurbishment, stem realignment, valve repacking, changing gaskets, replacing bolts, replacing actuators

tests include: hydrostatic, pneumatic, vacuum, in-service, function-test

jurisdictional regulations include: by-laws, standards, codes, ANSI, UL, CSA, ASME, NFPA

Task B-8 Installs, tests, maintains, troubleshoots and repairs heat tracing systems

Task Descriptor

Tracing accompanies existing piping systems to facilitate the delivery of the medium. Tracing systems are made with a variety of materials such as carbon steel, stainless steel and copper. Steamfitters/Pipefitters install, attach, diagnose, repair and energize tracing systems. These systems can be installed during construction or after completion. In liquid-filled tracing systems water, glycol or a combination of both is used as a medium when consistent temperature control is required. Steam is used when high levels of heat energy are required.

B-8.01 Installs steam tracing systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-8.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to type and size of ***steam tracing system***
B-8.01.02P	select and inspect ***materials***	***materials*** are selected and inspected according to installation variables and drawings
B-8.01.03P	itemize ***materials*** and ***components***	***materials*** and ***components*** are itemized according to drawings
B-8.01.04P	prepare material list	material list is prepared according to packing list and drawings
B-8.01.05P	take field measurements	field measurements taken are correct and accurate to confirm drawings and installation instructions
B-8.01.06P	measure, calculate and mark piping and tubing for installation	piping and tubing is measured, calculated and marked for ***steam tracing system*** installation, and clearances, flange, and tubing alignment and orientation are maintained
B-8.01.07P	install ***steam tracing systems*** and ***components***	***steam tracing systems*** are installed using ***joining method*** to produce a leak-free and functional system with joints that are accessible for insulation requirements
B-8.01.08P	generate field bracket and support drawings	drawings are legible, clear and reflect field installations

B-8.01.09P	perform mapping of joints	mapping of joints is documented according to QC procedures
B-8.01.10P	test ***steam tracing systems***, their ***components***, piping and tubing	***testing methods*** are used to test ***steam tracing systems***, their ***components***, piping and tubing according to testing requirements and results are documented

Range of Variables

tools and equipment include: benders, flaring devices, strapping devices, cutters, reamers

steam tracing systems include: low to high pressure, pre-insulated tubing bundles, heat taped, jacketed pipe

materials include: carbon, stainless steel and copper tubing, strapping, related fittings, pre-insulated tubing bundles (electrically traced), standoffs, socking material, pre-insulated

components include: valves, breakouts, valve baskets, steam traps

joining methods include: welding, mechanical joint, brazing, flaring

testing methods include: hydrostatic, pneumatic

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-8.01.01L	demonstrate knowledge of ***steam tracing systems***, their ***components***, characteristics, applications and operation	identify ***steam tracing systems*** and their ***components***, and describe their characteristics, applications and operation
		interpret information found on drawings and manufacturers' and engineers' specifications pertaining to ***steam tracing systems***
		describe working principles of steam systems
		describe ***steam tracing system installation variables***
B-8.01.02L	demonstrate knowledge of procedures to install and test ***steam tracing systems*** and their ***components***	identify ***tools and equipment*** used to install and test ***steam tracing systems*** and their ***components***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installation and testing of ***steam tracing systems*** and their ***components***
		identify ***joining methods*** used to install ***steam tracing systems*** and their ***components***
		describe practices to produce a leak-free and functional system with joints that are accessible for insulation requirements

		describe ***testing methods*** for ***steam tracing systems***
B-8.01.03L	demonstrate knowledge of regulatory requirements to install and test ***steam tracing systems*** and their ***components***	interpret ***jurisdictional regulations*** pertaining to ***steam tracing systems*** and their ***components***

Range of Variables

steam tracing systems include: low to high pressure, pre-insulated tubing bundles, heat taped, jacketed pipe
components include: valves, breakouts, valve baskets, steam traps
installation variables include: temperature, pressure, flow, functionality, systems
tools and equipment include: benders, flaring devices, strapping devices, cutters, reamers
joining methods include: welding, soldering, grooving, mechanical joint, brazing, fittings
testing methods include: hydrostatic, pneumatic
jurisdictional regulations include: by-laws, standards, codes, ASME, WHMIS, LEED, CSA

B-8.02 Maintains, troubleshoots, repairs and tests steam tracing systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-8.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to type of ***steam tracing system***
B-8.02.02P	perform ***maintenance procedures***	***maintenance procedures*** are performed according to predetermined maintenance schedule and ***maintenance documentation*** is updated
B-8.02.03P	determine ***steam tracing system components*** that require repair or replacement	***components*** that require repair or replacement are determined using ***troubleshooting techniques***
B-8.02.04P	lock out and tag out ***steam tracing system*** and ***components***	***steam tracing system*** and ***components*** are locked out and tagged out to prevent activation of ***potential energy sources*** during repair or maintenance according to site-specific requirements and company policies and procedures
B-8.02.05P	repair ***steam tracing system*** and ***components***	***steam tracing system*** and ***components*** are repaired to operational condition using ***repair techniques***

B-8.02.06P	remove lock-out and tag-out from ***steam tracing system*** and ***components***	locks and tags are removed from ***steam tracing system*** and ***components*** according to site-specific requirements and company policies and procedures
B-8.02.07P	reinstate and perform ***test*** on ***steam tracing system***	***steam tracing system*** is reinstated to operating condition and tested
B-8.02.08P	energize ***steam tracing system***	***steam tracing system*** is energized to ensure it meets ***operational and functional requirements***
B-8.02.09P	update ***documentation***	***documentation*** is updated with ***steam tracing system*** repairs

Range of Variables

tools and equipment include: benders, temperature sensing devices, rubber mallets, stethoscopes, flaring devices, strapping devices, cutters, reamers

steam tracing systems include: low to high pressure, pre-insulated tubing bundles, heat taped, jacketed pipe, heat taped, jacketed pipe

maintenance procedures include: checking steam traps; banding; cleaning and inspecting equipment components for correct operation and wear; replacing worn components

maintenance documentation includes: LOTO procedures, maintenance log, quality control reports

components include: valves, breakouts, valve baskets, steam traps

troubleshooting techniques include: functional checks, visual inspections, use of temperature sensing devices and stethoscopes

potential energy sources include: mechanical, electrical

repair techniques include: trap, tubing and fitting replacement

tests include: hydrostatic, pneumatic, in-service

operational and functional requirements include: to prevent freezing, to ensure system integrity

documentation includes: QA/QC verification, recording of sign-off that repair has been completed

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-8.02.01L	demonstrate knowledge of ***steam tracing systems***, their ***components***, characteristics, applications and operation	identify ***steam tracing systems*** and their ***components***, and describe their characteristics, applications and operation
		interpret information found on drawings and specifications pertaining to ***steam tracing systems***
		identify ***steam tracing system*** and component ***defects*** that may require repair
B-8.02.02L	demonstrate knowledge of procedures to ***maintain***, ***troubleshoot***, ***repair*** and ***test steam tracing systems*** and their ***components***	identify ***tools and equipment*** used to ***maintain***, ***troubleshoot***, ***repair*** and ***test steam tracing system*** and their ***components***, and describe their applications and procedures for use

		identify hazards, and describe safe work practices pertaining to ***maintaining***, ***troubleshooting***, ***repairing*** and ***testing*** of ***steam tracing systems*** and their ***components***
		describe ***troubleshooting*** and ***maintenance procedures*** pertaining to ***steam tracing systems*** and their ***components***
		describe procedures to ***repair*** and ***test steam tracing systems*** and their ***components***
		describe necessary ***documentation*** for repairing and testing ***steam tracing systems*** and their ***components***
B-8.02.03L	demonstrate knowledge of regulatory requirements to ***repair*** and ***test steam tracing systems*** and their ***components***	interpret ***jurisdictional regulations*** pertaining to ***steam tracing systems*** and their ***components***

Range of Variables

steam tracing systems include: low to high pressure, pre-insulated tubing bundles, heat taped, jacketed pipe

components include: valves, breakouts, valve baskets, steam traps

defects include: kinked tubing, passing traps, broken straps

tools and equipment includes: benders, temperature sensing devices, rubber mallets, stethoscopes, flaring devices, strapping devices, cutters, reamers

maintenance procedures include: checking steam straps, cleaning, inspecting tubing, fittings and components for correct operation and wear

troubleshooting procedures include: functional checks, visual inspections, use of temperature sensing devices and stethoscopes

repairs include: steam traps, tubing and fitting replacement

tests include: hydrostatic, pneumatic, in-service

documentation includes: QA/QC verification, recording of sign-off that repair has been completed

jurisdictional regulations include: by-laws, standards, codes, ASME, WHMIS, LEED, CSA

B-8.03 Installs liquid-filled tracing systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-8.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to type of ***liquid-filled tracing system***
B-8.03.02P	select and inspect ***materials***	***materials*** are selected and inspected according to installation variables and drawings
B-8.03.03P	itemize ***material*** and ***components***	***material*** and ***components*** are itemized according to drawings
B-8.03.04P	prepare material list	material list is prepared according to packing list and drawings
B-8.03.05P	take field measurements	field measurements taken are correct and accurate to confirm drawings and installation instructions
B-8.03.06P	measure, calculate and mark piping and tubing for installation	piping and tubing are measured, calculated and marked for ***liquid-filled tracing system*** installation; and clearances, flange, and tubing alignment and orientation are maintained
B-8.03.07P	install ***liquid-filled tracing system*** and ***components***	***liquid-filled tracing system*** and ***components*** are installed using ***joining methods*** to produce a leak-free and functional system using ***piping practices***
B-8.03.08P	generate field bracket and support drawings	drawings are legible and clear, and reflect field requirements
B-8.03.09P	perform mapping of joints	mapping of joints is documented according to QA/QC procedures
B-8.03.10P	***test liquid-filled tracing system***, their ***components***, piping and tubing	***testing*** methods are used to test ***liquid-filled tracing system,*** their ***components***, piping and tubing according to testing requirements and results are documented

Range of Variables

tools and equipment include: benders, flaring devices, strapping devices, cutters, reamers
liquid-filled tracing systems include: low and high temperature hot water, glycol
materials include: carbon, stainless steel and copper tubing, strapping, related fittings
components include: valves, breakouts, valve baskets, high point vents, pumps
joining methods include: welding, soldering, mechanical joint, brazing
piping practices include: joints are accessible with consideration given to insulation and tie-in points requirements and ensure high point vents and pumps are installed where necessary
tests include: hydrostatic, pneumatic, in-service

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-8.03.01L	demonstrate knowledge of ***liquid-filled tracing systems***, their ***components,*** characteristics, applications and operation	identify types of ***liquid-filled tracing systems*** and their ***components***, and describe their characteristics, applications and operation
		interpret information found on drawings and manufacturers' and engineers' specifications pertaining to ***liquid-filled tracing systems***
		review working principles of ***liquid-filled tracing systems***
		describe ***installation variables***
B-8.03.02L	demonstrate knowledge of procedures to install ***liquid-filled tracing systems*** and their ***components***	identify ***tools and equipment*** relating to ***liquid-filled tracing systems*** and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installation of ***liquid-filled tracing systems***
		identify ***joining methods*** used to install ***liquid-filled tracing systems*** and describe their associated ***piping practices***
		describe ***testing methods*** for ***liquid-filled systems***
B-8.03.03L	demonstrate knowledge of regulatory requirements to install and test ***liquid-filled tracing systems*** and their ***components***	interpret ***jurisdictional regulations*** pertaining to ***liquid-filled tracing systems*** and their ***components***

Range of Variables

liquid-filled tracing systems include: low and high temperature hot water, glycol
components include: valves, breakouts, valve baskets, high point vents, pumps
installation variables include: temperature, pressure, flow, functionality, systems
tools and equipment include: benders, flaring devices, strapping devices, cutters, reamers
joining methods include: welding, soldering, grooving, mechanical joint, brazing
piping practices include: joints are accessible with consideration given to insulation and tie-in points requirements and ensure high point vents and pumps are installed where necessary
tests include: hydrostatic, pneumatic, in-service
jurisdictional regulations include: by-laws, standards, codes, ASME, WHMIS, LEED, CSA

B-8.04 Maintains, troubleshoots, repairs and tests liquid-filled tracing systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
B-8.04.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to type of ***liquid-filled tracing system***
B-8.04.02P	perform ***maintenance procedures***	***maintenance procedures*** are performed according to predetermined maintenance schedule and ***maintenance documentation*** is updated
B-8.04.03P	determine liquid-filled tracing system ***components*** that require repair or replacement	liquid-filled tracing system ***components*** that require repair or replacement are determined using ***troubleshooting techniques***
B-8.04.04P	lock out and tag out ***liquid-filled tracing system*** and ***components***	***liquid-filled tracing system*** and ***components*** are locked out and tagged out to prevent activation of ***potential energy sources*** during repair or maintenance according to site-specific requirements and company policies and procedures
B-8.04.05P	repair ***liquid-filled tracing system*** and ***components***	***liquid-filled tracing system*** and ***components*** are repaired to operational condition using ***repair techniques***
B-8.04.06P	remove lock-out and tag-out from ***liquid-filled tracing system*** and ***components***	locks and tags are removed from ***liquid-filled tracing system*** and ***components*** according to site-specific requirements and company policies and procedures
B-8.04.07P	reinstate and perform ***test*** on ***liquid-filled tracing system***	***liquid-filled tracing system*** is reinstated to operating condition and tested

B-8.04.08P	energize ***liquid-filled tracing system***	***liquid-filled tracing system*** is energized to ensure it meets ***operational and functional requirements***
B-8.04.09P	update ***documentation***	***documentation*** is updated with ***liquid-filled tracing system*** repairs
B-8.04.10P	dispose of medium	medium is disposed of according to ***environmental regulations***

Range of Variables

tools and equipment include: benders, temperature sensing devices, rubber mallets, stethoscopes, flaring devices, strapping devices, cutters, reamers

liquid-filled tracing systems include: low and high temperature hot water, glycol

maintenance procedures include: cleaning, inspecting tubing, fitting and components for correct operation and wear, replacing worn components

maintenance documentation includes: LOTO procedures, maintenance log, quality control reports

components include: valves, breakouts, valve baskets, high point vents, pumps

troubleshooting techniques include: functional checks, visual inspections, use of temperature sensing devices

potential energy sources include: mechanical, electrical

repair techniques include: tubing, fitting and component replacement

tests include: hydrostatic, pneumatic, in-service

operational and functional requirements include: to prevent freezing, ensure system integrity

documentation includes: QA/QC verification, recording of sign-off that repair has been completed

environmental regulations include: WHMIS, jurisdictional

	Knowledge	
	Learning Outcomes	**Learning Objectives**
B-8.04.01L	demonstrate knowledge of ***liquid-filled tracing systems***, their ***components***, characteristics, applications and operation	identify ***liquid-filled tracing systems*** and their ***components***, and describe their characteristics, applications and operation
		interpret information found on drawings and manufacturers' and engineers' specifications pertaining to ***liquid-filled tracing systems***
		identify ***liquid-filled tracing systems*** and ***components defects*** that may require repair
B-8.04.02L	demonstrate knowledge of procedures to maintain, troubleshoot, repair and test ***liquid-filled tracing systems*** and their ***components***	identify ***tools and equipment*** to maintain, troubleshoot, repair and test ***liquid-filled tracing systems*** and their ***components***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to maintaining, troubleshooting, repairing and testing ***liquid-filled tracing systems*** and their ***components***

		describe ***troubleshooting*** and ***maintenance procedures*** pertaining to ***liquid-filled tracing systems*** and their ***components***
		describe procedures to ***repair*** and ***test liquid-filled tracing systems*** and their ***components***
		describe necessary ***documentation*** for repairing and testing ***liquid-filled tracing systems*** and their ***components***
		describe disposal procedures for liquid medium
B-8.04.03L	demonstrate knowledge of regulatory requirements to repair and test ***liquid-filled tracing systems*** and their ***components***	interpret ***jurisdictional regulations*** pertaining to ***liquid-filled tracing systems*** and their ***components***

Range of Variables

liquid-filled tracing systems include: low and high temperature hot water, glycol

components include: valves, breakouts, valve baskets, high point vents, pumps

defects include: kinked tubing, broken straps, faulty pumps, plugged vents

tools and equipment include: benders, temperature sensing devices, rubber mallets, stethoscopes, flaring devices, strapping devices, cutters, reamers

troubleshooting procedures include: functional checks, visual inspections, use of temperature sensing devices

maintenance procedures include: cleaning, inspecting tubing, fitting and components for correct operation and wear

repairs include: tubing and fitting replacement

tests include: hydrostatic, pneumatic, in-service

documentation includes: QA/QC verification, recording of sign-off that repair has been completed

jurisdictional regulations include: by-laws, standards, codes, ASME, WHMIS, LEED, CSA

Major Work Activity C

Performs rigging, hoisting, lifting and positioning

Task C-9 Performs common rigging, hoisting, lifting and positioning

Task Descriptor

When performing common rigging, hoisting, lifting and positioning, steamfitter/pipefitters determine the load, prepare a lift plan and select all rigging, hoisting, lifting and positioning equipment in a safe manner. They inspect the equipment and secure lift areas. Steamfitter/Pipefitters may work in conjunction with crane operators to set up equipment and perform lifts. They also maintain and store equipment to prevent premature defects and damage.

C-9.01 Determines load

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-9.01.01P	calculate load weight of rigging and material	load weight of rigging and material is calculated according to ***specifications***
C-9.01.02P	measure ***load dimensions***	***load dimensions*** are determined by measuring height, length, width, area and volume of material and equipment
C-9.01.03P	determine centre of gravity	test lift is performed to identify centre of gravity and to confirm that load is balanced
C-9.01.04P	assess ***load and rigging requirements***	***load and rigging requirements*** are assessed by verifying rigging and hoisting capacity of slings and equipment

Range of Variables

specifications include: name plates, pipefitter handbooks, shop drawings, load rating charts, engineer drawings, engineers' specifications, bills of lading, blueprints

load dimensions include: head room, clearances

load and rigging requirements include: rigging equipment, hoisting equipment, reach, weight capacities

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-9.01.01L	demonstrate knowledge of hoisting, lifting and ***rigging equipment***, their characteristics, applications and procedures for use	identify hoisting, lifting and ***rigging equipment***, and describe their characteristics, applications and procedures for use
		identify types of ***rigging equipment*** and accessories and their weight using various ***sources***
		define terminology associated with hoisting, lifting, rigging and positioning
		identify hazards, and describe safe work practices pertaining to hoisting, lifting, rigging and positioning
		describe importance of determining ***load and rigging requirements***
C-9.01.02L	demonstrate knowledge of calculations for performing hoisting and lifting operations	explain how to calculate load weight
C-9.01.03L	demonstrate knowledge of regulatory requirements for hoisting, lifting and rigging equipment	identify ***jurisdictional regulations*** pertaining to hoisting, lifting and rigging equipment

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

sources include: shop drawings, manufacturers' specifications

hazards include: wind, shock loading, soil condition, power lines, limits of approach

load and rigging requirements include: rigging equipment, hoisting equipment, reach, weight capacities

jurisdictional regulations include: ANSI, CSA, OH&S

C-9.02 Prepares lift plan(s) for common rigging, hoisting, lifting and positioning

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

Skills

	Performance Criteria	Evidence of Attainment
C-9.02.01P	determine ***communication strategy*** with rigging crew	***communication strategy*** is determined with rigging crew and is implemented according to job requirements
C-9.02.02P	secure lift area and ensure work area is clear of ***obstructions*** and personnel	work areas are identified with barrier tapes and signage, and lift area is secured and included in the control zone, and lift plan is revised to work around ***obstructions***
C-9.02.03P	identify new and existing ***hazards***	***hazards*** are identified during tool box talks and ***job safety cards*** are completed
C-9.02.04P	assess ***environmental conditions***	current ***environmental conditions*** are assessed

Range of Variables

communication strategy includes: using hand signals, radio communication and a signaller
obstructions include: waterways, structures, rail lines, vehicular traffic
hazards include: blind spots, power lines, overhead piping, live equipment, site-specific hazards
job safety cards include: job safety analysis (JSA), FLRA, safety plan of action (SPA)
environmental conditions include: rain, high winds, snow, lightning, heat, cold, ice

Knowledge

	Learning Outcomes	Learning Objectives
C-9.02.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components, characteristics, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		define terminology associated with rigging, hoisting, lifting, and positioning
		identify hazards, and describe safe work practices pertaining to rigging, hoisting, lifting, and positioning

		identify types of knots, hitches and bends, and describe their applications and procedures to tie them
C-9.02.02L	demonstrate knowledge of procedures when selecting ***rigging, hoisting and lifting equipment***	identify ***factors*** to consider when selecting ***rigging, hoisting and lifting equipment***
C-9.02.03L	demonstrate knowledge of calculations required when performing hoisting and lifting operations	explain ***sling angles*** when preparing for hoisting and lifting operation
		explain correlation of ***sling angles*** to sling capacities
C-9.02.04L	demonstrate knowledge of regulatory requirements pertaining to ***rigging, hoisting, lifting, and positioning equipment***	identify ***jurisdictional regulations*** pertaining to rigging, hoisting, lifting, and positioning

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

hazards include: environmental conditions, shock loading

factors include: load characteristics, rigging inspection, equipment fatigue, environment, safety factors, sling angles

sling angles include: 45˚, 60˚

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S

C-9.03 Selects rigging, hoisting, lifting and positioning equipment for common lifts

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

Skills

	Performance Criteria	Evidence of Attainment
C-9.03.01P	determine ***rigging, hoisting, lifting and positioning equipment*** requirements	***rigging, hoisting, lifting and positioning equipment*** requirements are determined and rating of equipment is verified to meet or exceed weight of load
C-9.03.02P	determine working load limit (WLL)	WLL is determined and ***rigging, hoisting, lifting and positioning equipment*** chosen is verified to ensure that it is compliant with rigging tables and load charts
C-9.03.03P	determine equipment capacity	equipment capacity is determined and ***rigging, hoisting, lifting and positioning equipment*** chosen is verified to ensure that it is compliant to rigging tables and load charts and meets ***load requirements***

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

load requirements include: WLL, final location of load (elevation and reach)

Knowledge

	Learning Outcomes	Learning Objectives
C-9.03.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components, characteristics, applications, limitations and procedures for use	identify types of ***rigging equipment*** and components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		define terminology associated with rigging, hoisting, lifting and positioning

		identify hazards, and describe safe work practices pertaining to rigging, hoisting, lifting, and positioning
		identify types of ropes used in rigging
C-9.03.02L	demonstrate knowledge of procedures to select ***rigging, hoisting, lifting and positioning equipmen***t	identify ***factors*** to consider when selecting ***rigging, hoisting, lifting and positioning equipment***
C-9.03.03L	demonstrate knowledge of procedures to perform hoisting, lifting and positioning operations	describe procedures to rig material/equipment for lifting
		describe procedures used for attaching rigging equipment to load
C-9.03.04L	demonstrate knowledge of calculations required when performing hoisting and lifting operations	explain ***sling angle*** when preparing for hoisting and lifting operation
		explain correlation of ***sling angles*** to sling capacities
C-9.03.05L	demonstrate knowledge of regulatory requirements pertaining to rigging, hoisting, lifting, and positioning equipment	identify ***jurisdictional regulations*** pertaining to rigging, hoisting, lifting, and positioning equipment

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

hazards include: environmental conditions, shock loading

factors include: load characteristics, rigging inspection, equipment fatigue, environment, safety factor, sling angles

sling angle includes: 45˚, 60˚

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S

C-9.04 Inspects rigging, hoisting, lifting and positioning equipment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-9.04.01P	detect rigging, hoisting, lifting and positioning equipment ***faults***	equipment is inspected physically and visually, and ***faults*** are detected
C-9.04.02P	check for certification on ***equipment***	rating tags are verified and certification of ***equipment*** is current

C-9.04.03P	assess, tag, report and remove damaged ***equipment*** from service	damaged ***equipment*** is tagged, removed from service and documented
C-9.04.04P	document regular inspection requirements	inspections are documented according to ***jurisdictional regulations***
C-9.04.05P	inspect knots, hitches and bends	knots, hitches and bends are de-rated when required

Range of Variables

faults include: rips, tears, cracks, birdcaging, frayed wire rope, frayed synthetic slings, worn shackles, hydraulic oil leaks, missing rating tags

equipment includes: chain falls, tuggers, cranes, forklifts, come-alongs

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-9.04.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components, characteristics, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		define terminology associated with rigging, hoisting, lifting and positioning
		identify ***hazards***, and describe safe work practices pertaining to inspection of ***rigging, hoisting, lifting, and positioning equipment***
		identify types of knots, hitches and bends and describe their applications and procedures to tie them
		identify types of ropes used in rigging
C-9.04.02L	demonstrate knowledge of procedures to inspect ***rigging, hoisting, lifting and positioning equipment***	describe procedures to inspect ***rigging, hoisting, lifting and positioning equipment***
C-9.04.03L	demonstrate knowledge of training and certification requirements pertaining to ***rigging, hoisting, lifting, and positioning equipment***	identify training and certification requirements pertaining to ***rigging, hoisting, lifting, and positioning equipment***
C-9.04.04L	demonstrate knowledge of regulatory requirements pertaining to ***rigging, hoisting, lifting, and positioning equipment***	identify ***jurisdictional regulations*** pertaining to ***rigging, hoisting, lifting, and positioning equipment***

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

hazards include: cuts, pinches, overexertion

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S

C-9.05 Secures lift area

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

Skills

	Performance Criteria	Evidence of Attainment
C-9.05.01P	communicate lift plan to personnel, clients and authorities	personnel, clients and authorities are advised of lift plan
C-9.05.02P	identify swing radius and potential obstructions and hazards	swing radius and potential obstructions and hazards are identified and ***equipment*** is positioned to clear these
C-9.05.03P	restrict access to lift area and path of travel	***safety equipment*** is erected according to site-specific requirements to restrict vehicular and pedestrian traffic to lift area and path of travel

Range of Variables

equipment includes: cranes, zoom booms, swing booms, tower cranes

safety equipment includes: barricades, signage, barrier tape

Knowledge

	Learning Outcomes	Learning Objectives
C-9.05.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components, characteristics, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		describe terminology associated with rigging, hoisting, lifting and positioning

		identify types of ***safety equipment*** used to secure lift area
		identify ***hazards*** and describe safe work practices pertaining to securing lift areas
C-9.05.02L	demonstrate knowledge of ***procedures to ensure work area is safe*** for rigging, hoisting, lifting and positioning	describe ***procedures to ensure work area is safe*** for rigging, hoisting, lifting and positioning

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

safety equipment includes: barricades, signage, barrier tape

hazards include: vehicular traffic, pedestrian traffic

procedures to ensure work area is safe includes: supervision of lift, securing work area, communication

C-9.06 Sets up rigging, hoisting, lifting and positioning equipment for common lifts

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-9.06.01P	communicate lift plan to others	personnel, clients and authorities are advised of lift plan
C-9.06.02P	determine ***methods of connecting rigging, hoisting, lifting and positioning equipment***	***rigging, hoisting, lifting and positioning equipment*** is visually and physically inspected according to safe work practices to determine ***methods of connecting***
C-9.06.03P	attach ***rigging, hoisting, lifting and positioning equipment*** to load	***rigging, hoisting, lifting and positioning equipment*** is attached to load to ensure a safe lift, and visually and physically inspected according to safe work practices
C-9.06.04P	determine placement of equipment on load	placement of equipment on load is determined according to test lift, centre of gravity, lifting points, size and shape of load

C-9.06.05P	tie ***knots***	***knots*** are tied and visually inspected
C-9.06.06P	attach tag line	tag line is secured, using required length according to job requirements, to load, orientate and stabilize lift

Range of Variables

methods of connecting include: hooks, basket hitches, choker hitches, shackles, d-rings

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

knots include: bowline, cat's paw, clove hitch, half hitch

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-9.06.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components, characteristics, application and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications and procedures for use
		describe terminology associated with rigging, hoisting, lifting and positioning
		identify ***hazards***, and describe safe work practices pertaining to setting up ***rigging, hoisting, lifting and positioning equipment***
C-9.06.02L	demonstrate knowledge of procedures to ensure work area is safe for ***rigging, hoisting, lifting and positioning equipment***	identify and describe ***communication procedures*** used during set up of ***rigging, hoisting, lifting and positioning equipment***
C-9.06.03L	demonstrate knowledge of procedures to set up ***rigging, hoisting, lifting and positioning equipment***	describe procedures to set up ***rigging, hoisting, lifting and positioning equipment***
C-9.06.04L	demonstrate knowledge of procedures to inspect ***rigging, hoisting, lifting and positioning equipment***	describe procedures to inspect ***rigging, hoisting, lifting and positioning equipment***
C-9.06.05L	demonstrate knowledge of calculations required when performing hoisting and lifting operations	explain ***sling angles*** when preparing for hoisting and lifting operation

		explain correlation of ***sling angles*** to sling capacities
C-9.06.06L	demonstrate knowledge of regulatory requirements pertaining to ***rigging, hoisting, lifting, and positioning equipment***	identify ***jurisdictional regulations*** pertaining to ***rigging, hoisting, lifting, and positioning equipment***

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

hazards include: energized power lines, environmental conditions, live equipment, ground conditions, multi-tag lines, pinch points, crush points, overexertion, falls from heights

communication procedures include: hand signals, electronic communications, audible/visual

sling angles include: 45°, 60°

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S

C-9.07 Performs common lift and positioning

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

Skills

	Performance Criteria	Evidence of Attainment
C-9.07.01P	perform test lift	test lift is performed to ensure centre of gravity, and load is balanced and plumbed
C-9.07.02P	use ***communication procedures***	***communication procedures*** are used to communicate with operator and workers
C-9.07.03P	use tag lines	tag lines are used to orientate and stabilize load, and load is under control at all times
C-9.07.04P	transfer load to other rigging equipment for final placement	load is transferred without damage to material, equipment or personnel
C-9.07.05P	place (land) and secure load	load is placed (landed) and secured in location using various ***methods*** according to job requirements

Range of Variables

communication procedures include: hand signals, electronic communications, audible/visual

methods include: bolting, lashing, site-specific methods

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-9.07.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components characteristics, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		define terminology associated with ***rigging, hoisting, lifting, and positioning equipment***
		identify types of knots, hitches and bends and describe their applications and procedures to tie them
C-9.07.02L	demonstrate knowledge of procedures to perform rigging, hoisting, lifting and positioning operations	identify hazards, and describe safe work practices pertaining to rigging, hoisting, lifting, and positioning
		describe procedures to rig material/equipment for lifting
		describe procedures used for attaching rigging equipment to load
		describe ***procedures to perform a lift***
C-9.07.03L	demonstrate knowledge of ***procedures to ensure work area is safe*** for rigging, hoisting, lifting and positioning	describe ***procedures to ensure work area is safe*** for rigging, hoisting, lifting and positioning
		identify and describe ***communication procedures*** during rigging, hoisting, lifting and positioning operations
C-9.07.04L	demonstrate knowledge of calculations required when performing hoisting and lifting operations	explain ***sling angle*** when preparing for hoisting and lifting operation
		explain correlation of ***sling angles*** to sling capacities
C-9.07.05L	demonstrate knowledge of regulatory requirements pertaining to ***rigging, hoisting, lifting, and positioning equipment***	identify ***jurisdictional regulations*** pertaining to ***rigging, hoisting, lifting, and positioning equipment***

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

hazards include: environmental conditions, blind spots, power lines, overhead piping, live equipment, site-specific hazards

procedures to perform a lift include: load determination, communication methods, pre-lift checks, placement of load, post-lift inspection

procedures to ensure work area is safe include: supervision of lift, securing work area, communication

communication procedures include: hand signals, electronic communications, audible/visual

sling angles include: 45°, 60°

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S

C-9.08 Maintains and stores rigging, hoisting, lifting and positioning equipment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-9.08.01P	organize ***rigging, hoisting, lifting and positioning equipment***	***rigging, hoisting, lifting and positioning equipment*** is logged, catalogued, organized and stowed according to size, components, capacity and site specifications
C-9.08.02P	clean and lubricate ***rigging, hoisting, lifting and positioning equipment***	***rigging, hoisting, lifting and positioning equipment*** is cleaned, lubricated and maintained according to manufacturers' specifications
C-9.08.03P	perform inspection of ***rigging, hoisting, lifting and positioning equipment***	inspection is performed and faulty ***rigging, hoisting, lifting and positioning equipment*** is identified, reported and removed from service
C-9.08.04P	protect ***rigging, hoisting, lifting and positioning equipment*** from ***elements***	***rigging, hoisting, lifting and positioning equipment*** is stored away from ***elements*** according to manufacturers' recommendations
C-9.08.05P	complete documentation	documentation is completed according to site specifications and company policies

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

elements include: environmental conditions, chemicals

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-9.08.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components, characteristics, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		define terminology associated with ***hoisting, lifting and rigging and positioning equipment***
C-9.08.02L	demonstrate knowledge of procedures to inspect, maintain and store ***rigging, hoisting, lifting and positioning equipment***	describe procedures to inspect, maintain and store ***rigging, hoisting, lifting and positioning equipment***
		identify hazards, and describe safe work practices pertaining to maintenance and storage of ***rigging, hoisting, lifting and positioning equipment***

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

Task C-10 Performs complex and critical rigging, hoisting, lifting and positioning

Task Descriptor

When performing complex and critical rigging, hoisting, lifting and positioning steamfitter/pipefitters determine the load, prepare a lift plan and select all rigging, hoisting, lifting and positioning equipment in a safe manner. They inspect the equipment and secure lift areas. Steamfitter/Pipefitters may work in conjunction with crane operators to set up equipment and perform a lift. They also maintain and store equipment to prevent premature defects and damage.

Lifts are considered to be complex or critical when they include multi-crane lifts, load transferring, unbalanced load, lifting over live equipment and are affected by environmental conditions such as wind, ground conditions and weather. When operating cranes close to maximum rated capacity, according to site and manufacturers' specifications, lifts are considered critical and an engineer may be consulted. Complex and critical lifts may be engineered lifts.

C-10.01 Prepares lift plan for complex and critical rigging, hoisting, lifting and positioning

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-10.01.01P	review and interpret ***engineering specifications***	***engineering specifications*** are reviewed, interpreted and followed
C-10.01.02P	interpret ***lift information***	***lift information*** is followed
C-10.01.03P	assess jobsite	jobsite is assessed taking into consideration site observations, ***hazards***, clearances, other restrictions, changing conditions and equipment requirements
C-10.01.04P	identify new and existing ***hazards***	new and existing ***hazards*** are identified at tool box talks and ***risk assessments*** are completed prior to lift commencing
C-10.01.05P	review jobsite assessment	jobsite assessment is reviewed with ***essential personnel*** to determine lift plan requirements
C-10.01.06P	determine ***communication strategy***	***communication strategy*** is determined with essential personnel and implemented according to job requirements
C-10.01.07P	determine ***load information***	***load information*** is determined according to documentation and by taking measurements

C-10.01.08P	determine ***equipment requirements***	***equipment requirements*** are determined according to load weight and size, lifting range and type of material being lifted
C-10.01.09P	secure lift area and ensure work area is clear of ***obstructions*** and personnel	work areas are identified with barrier tapes and signage, and lift area is secured and included in the control zone, and lift plan is revised to work around ***obstructions***
C-10.01.10P	assess ***environmental conditions***	current ***environmental conditions*** are assessed
C-10.01.11P	participate in dry run of hoisting equipment and review ***strategy***	dry run of hoisting equipment is completed and ***strategy*** is reviewed to ensure lift plan is accurate and feasible
C-10.01.12P	document lift plan	lift plan is documented according to ***jurisdictional regulations*** and site-specific requirements

Range of Variables

engineering specifications include: drawings, crane prints, lift drawings

lift information includes: type of lift, date of lift, location of lift, time of lift, restrictions

hazards include: blind spots, power lines, overhead piping, live equipment, site-specific hazards, ground conditions, multi-tag lines, underground infrastructure

risk assessments include: JSA, FLRA, SPA

essential personnel includes: crew, engineer, supervisors, client/client representative

communication strategy includes: using hand signals, radio communication, horns

load information includes: centre of gravity, weight and dimensions of load, type of materials being lifted

equipment requirements include: types, weight and length capacities of slings, hoisting capacities (weight and reach of equipment), type of equipment for different ground conditions

obstructions include: waterways, structures, power lines, railways, energy sources, vehicular traffic

environmental conditions include: rain, high winds, snow, lightning, heat, cold, ice

strategy includes: documentation or oral review of procedures

jurisdictional regulations include: by-laws, standards, codes

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-10.01.01L	demonstrate knowledge of ***rigging, hoisting, lifting, and positioning equipment***, their components, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify documentation required for engineered lifts

C-10.01.02L	demonstrate knowledge of ***calculations*** required when performing complex and critical rigging, hoisting, lifting and positioning operations	perform ***calculations*** pertaining to complex and critical rigging, hoisting, lifting and positioning operations
C-10.01.03L	demonstrate knowledge of procedures for ***complex and critical lifts*** and positioning	describe procedures for ***complex and critical lifts*** and positioning
		identify hazards, and describe safe work practices pertaining to complex and critical rigging, hoisting, lifting and positioning operations

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

calculations include: sling angle, load/weight, centre of gravity, WLL

complex and critical lifts include: multi-crane lifts, load transferring, transferring, unbalanced load and positioning load, may include engineered lifts

hazards include: energized power lines, environmental conditions, live equipment, ground conditions, multi-tag lines, underground infrastructure

C-10.02 Performs calculations for complex and critical rigging, hoisting, lifting and positioning

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-10.02.01P	calculate load weight	load weight of rigging and material are calculated according to ***specifications***
C-10.02.02P	measure ***load dimensions***	***load dimensions*** are determined by measuring height, length, width, area and volume of material and equipment
C-10.02.03P	determine centre of gravity	test lift is performed to identify centre of gravity and to confirm that load is balanced
C-10.02.04P	calculate ***load and rigging requirements***	***load and rigging requirements*** are calculated by considering capacity of slings and equipment

Range of Variables

specifications include: name plates, load rating charts, engineer drawings, engineering specifications, bills of lading, blueprints

load dimensions include: head room, clearances

load and rigging requirements include: rigging equipment, hoisting equipment, reach, weight capacities

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-10.02.01L	demonstrate knowledge of ***rigging, hoisting, lifting, and positioning equipment***, their components, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify documentation required for engineered lifts
C-10.02.02L	demonstrate knowledge of procedures for ***complex and critical lifts*** and positioning	describe procedures for ***complex and critical lifts*** and positioning
		identify ***hazards***, and describe safe work practices pertaining to ***complex and critical lifts*** and positioning operations
C-10.02.03L	demonstrate knowledge of ***calculations*** required when performing ***complex and critical lifts*** and positioning operations	perform ***calculations*** pertaining to ***complex and critical lifts*** and positioning operations

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

complex and critical lifts include: multi-crane lifts, load transferring, lifts that involve personnel, lifts over personnel, unbalanced load and positioning load, may include engineered lifts

hazards include: energized power lines, environmental conditions, live equipment, ground conditions, multi-tag lines, underground infrastructure

calculations include: sling angle, load/weight, centre of gravity, WLL

C-10.03 Selects rigging, hoisting, lifting and positioning equipment for complex and critical lifts

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

Skills

	Performance Criteria	Evidence of Attainment
C-10.03.01P	determine ***rigging, hoisting, lifting and positioning equipment*** requirements	rating of ***rigging, hoisting, lifting and positioning equipment*** is verified to exceed weight of load
C-10.03.02P	determine WLL	WLL is determined and ***rigging, hoisting, lifting and positioning equipment*** chosen is verified to ensure that it is compliant with rigging tables and load charts
C-10.03.03P	determine equipment capacity	equipment capacity is determined and ***rigging, hoisting, lifting and positioning equipment*** chosen is verified to ensure that it is compliant to rigging tables and load charts and meets ***load requirements***

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

load requirements include: WLL, final location of load (elevation and reach)

Knowledge

	Learning Outcomes	Learning Objectives
C-10.03.01L	demonstrate knowledge of ***rigging, hoisting, lifting, and positioning equipment***, their components, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify documentation required for engineered lifts

C-10.03.02L	demonstrate knowledge of procedures to select ***rigging, hoisting, lifting, and positioning equipment*** for ***complex and critical lifts*** and positioning	identify ***factors*** to consider when selecting ***rigging, hoisting, lifting and positioning equipment*** for ***complex and critical lifts*** and positioning
		identify ***hazards***, and describe safe work practices pertaining to ***complex and critical lifts*** and positioning operations
		describe procedures for ***complex and critical lifts*** and positioning
C-10.03.03L	demonstrate knowledge of ***calculations*** required when selecting ***rigging, hoisting, lifting, and positioning equipment*** for ***complex and critical lifts*** and positioning	perform ***calculations*** required when selecting ***rigging, hoisting, lifting, and positioning equipment*** for ***complex and critical lifts*** and positioning

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

factors include: load characteristics, rigging inspection, equipment fatigue, environment, safety factor, sling angles

complex and critical lifts include: multi-crane lifts, load transferring, unbalanced load and positioning load, may include engineered lifts

hazards include: energized power lines, environmental conditions, live equipment, ground conditions, multi-tag lines, underground infrastructure

calculations include: sling angle, load/weight, centre of gravity, WLL

C-10.04 Sets up rigging, hoisting, lifting and positioning equipment for complex and critical lifts

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

Skills

	Performance Criteria	Evidence of Attainment
C-10.04.01P	communicate lift plan to personnel	personnel is advised of lift plan
C-10.04.02P	determine ***methods of connecting rigging, hoisting, lifting and positioning equipment***	***rigging, hoisting, lifting and positioning equipment*** is visually and physically inspected according to safe work practices and engineers' recommendations to determine ***methods of connecting***

C-10.04.03P	attach ***rigging, hoisting, lifting and positioning equipment*** to load	***rigging, hoisting, lifting and positioning equipment*** is attached to load considering ***additional equipment*** may be required for a potential load transfer, and visually and physically inspected according to safe work practices
C-10.04.04P	verify engineers' specifications and recommendations	engineers' specifications and recommendations are followed
C-10.04.05P	inspect ***rigging, hoisting, lifting and positioning equipment***	***rigging, hoisting, lifting and positioning equipment*** is visually and physically inspected according to safe work practices
C-10.04.06P	determine placement of equipment on load	placement of equipment on load is determined according to test lift, centre of gravity, lifting points, and size and shape of load
C-10.04.07P	tie ***knots, bends and hitches***	***knots, bends and hitches*** are tied and visually inspected
C-10.04.08P	attach tag line	tag line is secured to load to orientate and stabilize lift

Range of Variables

methods of connecting include: use of hooks, spreader bars, equalizer beams, basket hitches, choker hitches, beam clamps, shackles, d-rings

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

additional equipment include: secondary slings, safety slings

knots, bends and hitches include: bowline, cat's paw, clove hitch, timber hitch, carrick bend, sheet bend, square/reef knot, half hitch

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-10.04.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components, characteristics, application and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications and procedures for use
		identify documentation required for engineered lifts

C-10.04.02L	demonstrate knowledge of procedures to set up ***rigging, hoisting, lifting and positioning equipment*** for ***complex and critical lifts***	describe procedures to set up ***rigging, hoisting, lifting and positioning equipment*** for ***complex and critical lifts***
		identify ***hazards*** and describe safe work practices pertaining to setting up ***complex and critical lift*** operations
C-10.04.03L	demonstrate knowledge of ***calculations*** required when performing ***complex and critical lifts***	perform ***calculations*** pertaining to ***complex and critical lifts***

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

complex and critical lifts include: multi-crane lifts, load transferring, unbalanced load and positioning load, may include engineered lifts

hazards include: energized power lines, environmental conditions, live equipment, ground conditions, multi-tag lines, pinch points, crush points, overexertion, falls from heights

calculations include: sling angle, load/weight, centre of gravity, WLL

C-10.05 Performs complex and critical lifts and positioning

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
C-10.05.01P	use ***communication methods***	***communication methods*** are used to coordinate lift and positioning with operator, lift crew and competent people
C-10.05.02P	use tag lines to orientate and stabilize load	load is under control at all times
C-10.05.03P	transfer load to other rigging equipment for final placement	load is transferred without damage to material, equipment or personnel
C-10.05.04P	place (land) and secure load	load is placed (landed) and secured in location using various ***methods*** according to job requirements

Range of Variables

communication methods include: hand signals, flags, horns, electronic communication devices

methods include: bolting, lashing, site-specific methods

	Knowledge	
	Learning Outcomes	**Learning Objectives**
C-10.05.01L	demonstrate knowledge of ***rigging, hoisting, lifting and positioning equipment***, their components, characteristics, applications, limitations and procedures for use	identify types of ***rigging equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify types of ***hoisting, lifting and positioning equipment*** and their components, and describe their characteristics, applications, limitations and procedures for use
		identify documentation required for engineered lifts
C-10.05.02L	demonstrate knowledge of procedures to perform ***complex and critical lifts and positioning***	describe procedures to perform ***complex and critical lifts and positioning***
		identify ***hazards***, and describe safe work practices pertaining to performing ***complex and critical lifts and positioning***
		describe ***complex and critical lifts and positioning***
C-10.05.03L	demonstrate knowledge of ***calculations*** required when performing ***complex and critical lifts and positioning***	perform ***calculations*** pertaining to ***complex and critical lifts and positioning***
C-10.05.04L	demonstrate knowledge of regulatory requirements pertaining to ***complex and critical lifts and positioning***	identify ***jurisdictional regulations*** pertaining to ***complex and critical lifts and positioning***

Range of Variables

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers, equalizing beams

hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists, tag lines

complex and critical lifts and positioning include: multi-crane lifts, load transferring, lift over live equipment, unbalanced load and positioning load, may include engineered lifts

hazards include: energized power lines, environmental conditions, live equipment, limited visibility, ground conditions, multi-tag lines

calculations include: sling angle, load/weight, centre of gravity, WLL

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S

Major Work Activity D

Installs, tests, maintains, troubleshoots and repairs low and high pressure steam and condensate systems

Task D-11 Installs, tests, maintains, troubleshoots and repairs low pressure steam and condensate systems

Task Descriptor

Steamfitters/Pipefitters install low pressure steam and condensate system equipment and piping in industrial locations such as distilleries, pulp mills, mines, automotive plants, commercial settings and process plants. Processes that use low pressure steam include indirect water heating and central heating.

Steamfitters/Pipefitters are responsible for the maintenance of piping components and equipment for these systems. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are responsible for diagnosing, locating and repairing or replacing equipment and material. These tasks are performed on an as-needed basis.

D-11.01 Installs equipment for low pressure steam and condensate systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-11.01.01P	select ***low pressure steam and condensate equipment*** and ***controls***	***low pressure steam and condensate equipment*** and ***controls*** are selected according to application, type of system***,*** ***drawings***, specifications and ***jurisdictional regulations***
D-11.01.02P	size ***low pressure steam and condensate equipment*** and ***controls***	***low pressure steam and condensate equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
D-11.01.03P	determine high points and low points for ***low pressure steam and condensate equipment*** and ***controls***	high points and low points for ***low pressure steam and condensate equipment*** and ***controls*** are identified according to ***drawings***

D-11.01.04P	determine location and placement of ***low pressure steam and condensate equipment*** and ***controls***	location and placement of ***low pressure steam and condensate equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
D-11.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.01.07P	determine ***installation method***	***installation method*** used to set ***low pressure steam and condensate equipment*** and ***controls*** in place is determined according to size, weight and location
D-11.01.08P	install ***low pressure steam and condensate equipment***	***low pressure steam and condensate equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

low pressure steam and condensate equipment includes: boilers, boiler trim, expansion joints, pumps, heat transfer equipment, steam traps, tanks, valves, water treatment equipment

controls include: flow devices, level devices, temperature devices, pressure devices

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: pipe wrenches, threading equipment

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-11.01.01L	demonstrate knowledge of ***low pressure steam and condensate systems***, their characteristics, applications and operation	identify ***low pressure steam and condensate systems***, and describe their characteristics, applications and operation
		identify ***low pressure steam and condensate equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***low pressure steam and condensate systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***low pressure steam and condensate systems***, and describe their purpose and operation
		identify ***sources of heat*** used in ***low pressure steam and condensate systems***
		identify ***sources of cooling*** used ***low pressure steam and condensate systems***
		identify types of ***fuel*** and ***energy sources*** used in low pressure steam and condensate systems
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
D-11.01.02L	demonstrate knowledge of procedures to install ***low pressure steam and condensate equipment***	identify ***tools and equipment*** used to install ***low pressure steam and condensate equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***low pressure steam and condensate equipment***

		describe procedures to install ***low pressure steam and condensate equipment***, ***controls***, ***supports*** and ***fasteners***
D-11.01.03L	demonstrate knowledge of regulatory requirements to install ***low pressure steam and condensate equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***low pressure steam and condensate equipment***

Range of Variables

low pressure steam and condensate system includes: parallel flow, counter flow, two pipe, gravity return, mechanical return, wet or dry return

low pressure steam and condensate equipment includes: boilers, boiler trim, expansion joints, pumps, heat transfer equipment, steam traps, tanks, valves, water treatment equipment

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sources of heat include: oil, gas, wood, steam, geothermal, solar

sources of cooling include: ground source, cooling towers, chillers, refrigeration, heat exchangers

fuel includes: fuel oil, gas, coal, wood, biomass

energy sources include: solar, nuclear

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, unit heaters, radiant panels, heat exchangers

tools and equipment include: pipe wrenches, threading equipment

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

D-11.02 Installs piping for low pressure steam and condensate systems

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

Skills

	Performance Criteria	Evidence of Attainment
D-11.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
D-11.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***

D-11.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
D-11.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
D-11.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-11.02.01L	demonstrate knowledge of ***properties of steam***	explain ***properties of steam***
		describe use of steam tables to identify relationship between pressure and temperature
D-11.02.02L	demonstrate knowledge of ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***, and describe their characteristics, applications and operation
		identify ***piping configurations***, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***low pressure steam and condensate systems***
		explain effects of trapped air in piping for ***low pressure steam and condensate systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***low pressure steam and condensate systems***
		identify systems that require grade or pitch of piping

D-11.02.03L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***
		describe procedures to install ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***
		describe procedures to bend ***piping*** for ***low pressure steam and condensate systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***
		identify calculations for determining grade
D-11.02.04L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***low pressure steam and condensate systems***

Range of Variables

properties of steam include: pressure, temperature, latent heat, sensible heat, total heat, volume

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE

piping components include: valves, fittings, flexible connectors and hoses, strainers

low pressure steam and condensate systems include: parallel flow, counter flow, two pipe, gravity return, mechanical return, wet or dry return

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

piping configurations include: parallel flow, counter flow, two pipe, gravity return, mechanical return, wet or dry return

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions, protecting worker from burns

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

D-11.03 Tests low pressure steam and condensate systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-11.03.01P	perform visual pre-check inspection of ***low pressure steam and condensate systems***	visual pre-check inspection of ***low pressure steam and condensate systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
D-11.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
D-11.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
D-11.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
D-11.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
D-11.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
D-11.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
D-11.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
D-11.03.09P	perform ***test*** on ***low pressure steam and condensate systems***	***test medium*** is introduced to ***low pressure steam and condensate systems*** and results of ***test*** are documented for purpose of obtaining sign-off
D-11.03.10P	remove ***test medium*** from ***low pressure steam and condensate systems***	***test medium*** is removed from ***low pressure steam and condensate systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***

D-11.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
D-11.03.12P	reinstate ***low pressure steam and condensate systems***	***isolation components*** and ***testing equipment and components*** are removed and low pressure steam and condensate system components are reinstalled according to ***drawings*** and specifications
D-11.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

low pressure steam and condensate system includes: parallel flow, counter flow, two pipe, gravity return, mechanical return, wet or dry return

tests include: hydrostatic, pneumatic, vacuum

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, air, inert gases

method includes: pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces, double block and bleed

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-11.03.01L	demonstrate knowledge of ***low pressure steam and condensate systems***, their characteristics, applications and operation	identify ***low pressure steam and condensate systems***, their characteristics, applications and operation
D-11.03.02L	demonstrate knowledge of testing of ***low pressure steam and condensate system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***low pressure steam and condensate system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications

		interpret information pertaining to ***low pressure steam and condensate system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***low pressure steam and condensate systems***
		explain effects of trapped air in piping for ***low pressure steam and condensate systems*** and describe procedures to prevent it
D-11.03.03L	demonstrate knowledge of procedures to test ***low pressure steam and condensate systems***	identify ***tools and equipment*** used to test ***low pressure steam and condensate systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***low pressure steam and condensate systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***low pressure steam and condensate systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***low pressure steam and condensate systems***
		describe procedures to reinstate ***low pressure steam and condensate systems***
		identify documentation to be completed following ***low pressure steam and condensate system*** testing
		describe ***confirmation of zero energy state*** procedures
D-11.03.04L	demonstrate knowledge of regulatory requirements to test ***low pressure steam and condensate systems***	identify ***jurisdictional regulations*** pertaining to testing of ***low pressure steam and condensate systems***

Range of Variables

low pressure steam and condensate system includes: parallel flow, counter flow, two pipe, gravity return, mechanical return, wet or dry return

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix, air, inert gases

method includes: pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces, double block and bleed

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

D-11.04 Maintains, troubleshoots and repairs low pressure steam and condensate systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-11.04.01P	determine ***low pressure steam and condensate system*** issues that require investigation	***low pressure steam and condensate system*** issues requiring investigation are determined by consulting with system owner/operator
D-11.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
D-11.04.03P	troubleshoot ***low pressure steam and condensate system***	perform ***testing and inspection*** of ***low pressure steam and condensate system*** to determine equipment or components in ***conditions for repair or replacement***
D-11.04.04P	lock out and tag out ***low pressure steam and condensate systems***	***low pressure steam and condensate systems*** are locked and tagged out to prevent activation during repair or maintenance
D-11.04.05P	install ***isolation components*** and ensure ***low pressure steam and condensate system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***low pressure steam and condensate systems***

D-11.04.06P	disassemble ***low pressure steam and condensate system***, repair or replace faulty equipment or components and reassemble ***low pressure steam and condensate system***	equipment and components are removed, repaired or replaced and ***low pressure steam and condensate system*** are reassembled without damage to other components or surrounding area
D-11.04.07P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
D-11.04.08P	reinstate ***low pressure steam and condensate systems*** to operating condition	***low pressure steam and condensate systems*** are filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
D-11.04.09P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***low pressure steam and condensate equipment*** is free of contaminants and operating efficiently
D-11.04.10P	perform ***test*** on ***low pressure steam and condensate systems***	***test medium*** is introduced to ***low pressure steam and condensate systems*** and results of ***test*** are documented for purpose of obtaining sign-off
D-11.04.11P	remove ***test medium*** from ***low pressure steam and condensate systems***	***test medium*** is removed from ***low pressure steam and condensate systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
D-11.04.12P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
D-11.04.13P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

low pressure steam and condensate systems include: parallel flow, counter flow, two pipe, gravity return, mechanical return, wet or dry return

tools and equipment include: pipe wrenches, heat detecting equipment, stethoscopes

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces, double block and bleed

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

low pressure steam and condensate equipment includes: boilers, tanks, heat exchangers, pumps, isolators, valves, chemical feeders

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix, air, inert gases

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-11.04.01L	demonstrate knowledge of ***low pressure steam and condensate systems***, their characteristics, applications and operation	identify ***low pressure steam and condensate systems***, their characteristics, applications and operation
D-11.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***low pressure steam and condensate systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***low pressure steam and condensate systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***low pressure steam and condensate systems***
		explain effects of trapped air in piping for ***low pressure steam and condensate systems*** and describe procedures to prevent it
D-11.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***low pressure steam and condensate systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***low pressure steam and condensate systems***, and describe their applications and procedures for use

		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***low pressure steam and condensate systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***low pressure steam and condensate systems***
		describe procedures to repair ***low pressure steam and condensate systems***
		describe ***maintenance*** procedures for ***low pressure steam and condensate systems***
		identify documentation to be completed following ***low pressure steam and condensate system*** repair or maintenance
D-11.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***low pressure steam and condensate systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***low pressure steam and condensate systems***

Range of Variables

low pressure steam and condensate system includes: parallel flow, counter flow, two pipe, gravity return, mechanical return, wet or dry return

isolation components include: blinds, spades, plugs and caps, temporary spool pieces, double block and bleed

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task D-12 Installs, tests, maintains, troubleshoots and repairs high pressure steam and condensate systems

Task Descriptor

Steamfitters/Pipefitters install high pressure steam and condensate system equipment and piping in industrial locations such as refineries, pulp mills, mines, automotive plants, commercial settings and power generating and process plants. Processes that use high pressure steam include running turbines, pump seals, indirect water heating and central heating. Additional certification may be required in certain jurisdictions.

Steamfitters/Pipefitters are responsible for the maintenance of high pressure components and equipment for these systems. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the high pressure steam and condensate systems. Steamfitters/Pipefitters are responsible for diagnosing, locating and repairing or replacing equipment and material. These tasks are performed on an as-needed basis.

D-12.01 Installs equipment for high pressure steam and condensate systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-12.01.01P	select ***high pressure steam and condensate equipment*** and ***controls***	high pressure steam and condensate ***equipment*** and ***controls*** are selected according to application, type of system***,*** ***drawings***, specifications and ***jurisdictional regulations***
D-12.01.02P	size ***high pressure steam and condensate equipment*** and ***controls***	***high pressure steam and condensate equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
D-12.01.03P	determine high points and low points for ***high pressure steam and condensate equipment*** and ***controls***	high points and low points for ***high pressure steam and condensate equipment*** and ***controls*** are identified according to ***drawings***
D-12.01.04P	determine location and placement of ***high pressure steam and condensate equipment*** and ***controls***	location and placement of ***high pressure steam and condensate equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping

D-12.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.01.07P	determine ***installation method***	***installation method*** used to set ***high pressure steam and condensate equipment*** and ***controls*** in place is determined according to size, weight and location
D-12.01.08P	install ***high pressure steam and condensate equipment***	***high pressure steam and condensate equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

high pressure steam and condensate equipment include: boilers, boiler trim, expansion joints, pumps, heat transfer equipment, steam traps, valves, flash tanks, superheaters, reheaters, de-aerators, desuperheaters, condensers, water treatment equipment, economizers

controls include: flow devices, level devices, temperature devices, pressure devices

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: pipe wrenches, welding equipment, electrical cutting tools

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, spring hangers

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-12.01.01L	demonstrate knowledge of ***high pressure steam and condensate systems***, their characteristics, applications and operation	identify ***high pressure steam and condensate systems***, and describe their characteristics, applications and operation
		identify ***high pressure steam and condensate equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use

		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***high pressure steam and condensate systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***high pressure steam and condensate systems***, and describe their purpose and operation
		identify types of ***fuel*** used in ***high pressure steam and condensate systems***
		identify ***sources of heat*** used in ***high pressure steam and condensate systems***
		identify ***sources of cooling*** used in ***high pressure steam and condensate systems***
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
D-12.01.02L	demonstrate knowledge of procedures to install ***high pressure steam and condensate equipment***	identify ***tools and equipment*** used to install ***high pressure steam and condensate equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***high pressure steam and condensate equipment***
		describe procedures to install ***high pressure steam and condensate equipment***, ***controls***, ***supports*** and ***fasteners***
D-12.01.03L	demonstrate knowledge of regulatory requirements to install ***high pressure steam and condensate equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***high pressure steam and condensate equipment***

Range of Variables

high pressure steam and condensate systems include: condensing/non-condensing plant, generating plant, process

high pressure steam and condensate equipment includes: boilers, boiler trim, expansion joints, pumps, heat transfer equipment, steam traps, valves, flash tanks, superheaters, reheaters, de-aerators, desuperheaters, condensers, water treatment equipment, economizers

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, spring hangers

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

fuel includes: fuel oil, gas, coal, biomass, wood

sources of heat include: oil, gas, wood, steam, geothermal, solar, nuclear

sources of cooling include: ground source, cooling towers, chillers, refrigeration, heat exchangers

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, unit heaters, radiant panels, heat exchangers

tools and equipment include: pipe wrenches, welding equipment, electrical cutting tools

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

D-12.02 Installs piping for high pressure steam and condensate systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-12.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
D-12.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
D-12.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
D-12.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
D-12.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***

D-12.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints, spring cans

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-12.02.01L	demonstrate knowledge of ***properties of steam***	explain ***properties of steam***
		describe use of steam tables to identify relationship between pressure and temperature

D-12.02.02L	demonstrate knowledge of ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***high pressure steam and condensate systems,*** and describe their characteristics, applications and operation
		identify piping configurations, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***high pressure steam and condensate systems***
		explain effects of trapped air in piping for ***high pressure steam and condensate systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***high pressure steam and condensate systems***
		identify systems that require grade or pitch of piping
D-12.02.03L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***
		describe procedures to install ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***
		describe procedures to bend ***piping*** for ***high pressure steam and condensate systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***

		identify calculations for determining grade
D-12.02.04L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***high pressure steam and condensate systems***

Range of Variables

properties of steam include: pressure, temperature, latent heat, sensible heat, total heat, superheat, volume

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE

piping components include: valves, fittings, flexible connectors and hoses, strainers

high pressure steam and condensate systems include: condensing/non-condensing plant, generating plant, process

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

D-12.03 Tests high pressure steam and condensate systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
D-12.03.01P	perform visual pre-check inspection of ***high pressure steam and condensate systems***	visual pre-check inspection of ***high pressure steam and condensate systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
D-12.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
D-12.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
D-12.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***

D-12.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
D-12.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
D-12.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
D-12.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
D-12.03.09P	perform ***test*** on ***high pressure steam and condensate systems***	***test medium*** is introduced to ***high pressure steam and condensate systems*** and results of ***test*** are documented for purpose of obtaining sign-off
D-12.03.10P	remove ***test medium*** from ***high pressure steam and condensate systems***	***test medium*** is removed from ***high pressure steam and condensate systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
D-12.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
D-12.03.12P	reinstate ***high pressure steam and condensate systems***	***isolation components*** and ***testing equipment and components*** are removed and high pressure steam and condensate system components are reinstalled according to ***drawings*** and specifications
D-12.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

high pressure steam and condensate systems include: condensing/non-condensing plant, generating plant, process

tests include: hydrostatic, pneumatic

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, air, inert gas

method includes: pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces, double block and bleed

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-12.03.01L	demonstrate knowledge of ***high pressure steam and condensate systems***, their characteristics, applications and operation	identify ***high pressure steam and condensate systems***, their characteristics, applications and operation
D-12.03.02L	demonstrate knowledge of testing of ***high pressure steam and condensate system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***high pressure steam and condensate system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***high pressure steam and condensate system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***high pressure steam and condensate systems***
		explain effects of trapped air in piping for ***high pressure steam and condensate systems*** and describe procedures to prevent it

D-12.03.03L	demonstrate knowledge of procedures to test ***high pressure steam and condensate systems***	identify ***tools and equipment*** used to test ***high pressure steam and condensate systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***high pressure steam and condensate systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***high pressure steam and condensate systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***high pressure steam and condensate systems***
		describe procedures to reinstate ***high pressure steam and condensate systems***
		identify documentation to be completed following ***high pressure steam and condensate system*** testing
		describe ***confirmation of zero energy state*** procedures
D-12.03.04L	demonstrate knowledge of regulatory requirements to test ***high pressure steam and condensate systems***	identify ***jurisdictional regulations*** pertaining to testing of ***high pressure steam and condensate systems***

Range of Variables

high pressure steam and condensate systems include: condensing/non-condensing plant, generating plant, process

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, air, inert gas

method includes: pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces, double block and bleed

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

D-12.04 Maintains, troubleshoots and repairs high pressure steam and condensate systems

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

Skills

	Performance Criteria	Evidence of Attainment
D-12.04.01P	determine ***high pressure steam and condensate system*** issues that require investigation	***high pressure steam and condensate system*** issues requiring investigation are determined by consulting with system owner/operator
D-12.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
D-12.04.03P	troubleshoot ***high pressure steam and condensate system***	perform ***testing and inspection*** of ***high pressure steam and condensate system*** to determine equipment or components in ***condition for repair or replacement***
D-12.04.04P	lock out and tag out ***high pressure steam and condensate systems***	***high pressure steam and condensate systems*** are locked and tagged out to prevent activation during repair or maintenance
D-12.04.05P	install ***isolation components*** and ensure ***high pressure steam and condensate system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***high pressure steam and condensate systems***
D-12.04.06P	disassemble ***high pressure steam and condensate system***, repair or replace faulty equipment or components and reassemble ***high pressure steam and condensate system***	equipment and components are removed, repaired or replaced and ***high pressure steam and condensate system*** are reassembled without damage to other components or surrounding area
D-12.04.07P	reinstate ***high pressure steam and condensate system*** to operating condition	***high pressure steam and condensate system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
D-12.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***high pressure steam and condensate equipment*** is free of contaminants and operating efficiently

D-12.04.09P	perform ***test*** on ***high pressure steam and condensate systems***	***test medium*** is introduced to ***high pressure steam and condensate systems*** and results of ***test*** are documented for purpose of obtaining sign-off
D-12.04.10P	remove ***test medium*** from ***high pressure steam and condensate systems***	***test medium*** is removed from ***high pressure steam and condensate systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
D-12.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
D-12.04.12P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

high pressure steam and condensate systems include: condensing/non-condensing plant, generating plant, process

tools and equipment include: pipe wrenches, heat detecting equipment, stethoscopes

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces, double block and bleed

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance includes: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

high pressure steam and condensate equipment includes: boilers, boiler trim, expansion joints, pumps, heat transfer equipment, steam traps, valves, flash tanks, superheaters, reheaters, de-aerators, desuperheaters, condensers, water treatment equipment, economizers

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, air, inert gas

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
D-12.04.01L	demonstrate knowledge of ***high pressure steam and condensate systems***, their characteristics, applications and operation	identify ***high pressure steam and condensate systems***, their characteristics, applications and operation
D-12.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***high pressure steam and condensate systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***high pressure steam and condensate systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***high pressure steam and condensate systems***
		explain effects of trapped air in piping for ***high pressure steam and condensate systems*** and describe procedures to prevent it
D-12.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***high pressure steam and condensate systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***high pressure steam and condensate systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***high pressure steam and condensate systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***high pressure steam and condensate systems***
		describe procedures to repair ***high pressure steam and condensate systems***
		describe ***maintenance*** procedures for ***high pressure steam and condensate systems***

		identify documentation to be completed following ***high pressure steam and condensate system*** repair or maintenance
D-12.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***high pressure steam and condensate systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***high pressure steam and condensate systems***

Range of Variables

high pressure steam and condensate systems include: condensing/non-condensing plant, generating plant, process

isolation components include: blinds, spades, plugs and caps, temporary spool pieces, double block and bleed

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: pipe wrenches, heat detecting equipment, stethoscopes

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Major Work Activity E

Installs, tests, maintains, troubleshoots and repairs heating, cooling and process piping systems

Task E-13 Installs, tests, maintains, troubleshoots and repairs hydronic systems

Task Descriptor

This refers to the installation of “comfort” heating and cooling systems, and systems that are used for process heating and cooling, including high temperature and low temperature hot water heating systems, chilled water cooling systems and cooling towers.

Steamfitters/Pipefitters are responsible for the maintenance of piping, components and equipment. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material as needed.

E-13.01 Installs equipment for hydronic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-13.01.01P	select ***hydronic system equipment*** and ***controls***	***hydronic system equipment*** and ***controls*** are selected according to application, type of ***hydronic system, drawings***, specifications and ***jurisdictional regulations***
E-13.01.02P	size ***hydronic system equipment*** and ***controls***	***hydronic system equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
E-13.01.03P	determine high points and low points for ***hydronic system equipment*** and ***controls***	high points and low points for ***hydronic system equipment*** and ***controls*** are identified according to ***drawings***

E-13.01.04P	determine location and placement of ***hydronic system equipment*** and ***controls***	location and placement of ***hydronic system equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-13.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.01.07P	determine ***installation method***	***installation method*** used to set ***hydronic equipment*** and ***controls*** in place is determined according to size, weight and location
E-13.01.08P	install ***hydronic system equipment***	***hydronic system equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

hydronic system equipment includes: boilers, tanks, heat exchangers, pumps, isolators, valves, chemical feeders

controls include: flow devices, level devices, temperature devices, pressure devices

hydronic systems include: heating, cooling

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-13.01.01L	demonstrate knowledge of ***hydronic systems***, their characteristics, applications and operation	identify ***hydronic systems***, and describe their characteristics, applications and operation
		identify ***hydronic equipment***, and describe their characteristics, applications and operation

		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***hydronic systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***hydronic systems***, and describe their purpose and operation
		identify ***sources of heat*** used in ***hydronic systems***
		identify ***sources of cooling*** used in ***hydronic systems***
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
E-13.01.02L	demonstrate knowledge of procedures to install ***hydronic equipment***	identify ***tools and equipment*** used to install ***hydronic equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards and describe safe work practices pertaining to installing ***hydronic equipment***
		describe procedures to install ***hydronic equipment***, ***controls***, ***supports*** and ***fasteners***
E-13.01.03L	demonstrate knowledge of regulatory requirements to install ***hydronic equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***hydronic equipment***

Range of Variables

hydronic systems include: heating, cooling

hydronic equipment includes: boilers, tanks, heat exchangers, pumps, isolators, valves, chemical feeders

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sources of heat include: oil, gas, wood, steam, geothermal, solar

sources of cooling include: ground source, cooling towers, chillers, refrigeration, heat exchangers

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, unit heaters, radiant panels, heat exchangers

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-13.02 Installs piping for hydronic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-13.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-13.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
E-13.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-13.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-13.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***

E-13.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
E-13.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, copper, plastic, stainless steel, HDPE, PEX

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

tools and equipment include: see Appendix B

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

joining methods include: flanging, grooving, threading, welding, soldering, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-13.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***hydronic systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***hydronic systems,*** and describe their characteristics, applications and operation
		identify ***piping configurations***, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications

		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***hydronic systems***
		explain effects of trapped air in piping for ***hydronic systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***hydronic systems***
		identify systems that require grade or pitch of piping
E-13.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***hydronic systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***hydronic systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***hydronic systems***
		describe procedures to install ***piping*** and ***piping components*** for ***hydronic systems***
		describe procedures to ***protect piping*** and ***piping components*** for ***hydronic systems***
		describe procedures to bend ***piping*** for ***hydronic systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***hydronic systems***
		identify calculations for determining grade
E-13.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***hydronic systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***hydronic systems***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, PEX
piping components include: valves, fittings, flexible connectors and hoses, strainers
hydronic systems include: heating, cooling
piping configurations include: one pipe, two pipe, three pipe, four pipe, primary/secondary zoning
drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural
considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction
tools and equipment include: see Appendix B
protect includes: protection from mechanical damage, seismic activity, environmental conditions
jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-13.03 Tests hydronic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-13.03.01P	perform visual pre-check inspection of ***hydronic systems***	visual pre-check inspection of ***hydronic systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-13.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***
E-13.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-13.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-13.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-13.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
E-13.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures

E-13.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-13.03.09P	perform ***test*** on ***hydronic systems***	***test medium*** is introduced to ***hydronic systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-13.03.10P	remove ***test medium*** from ***hydronic systems***	***test medium*** is removed from ***hydronic systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-13.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
E-13.03.12P	reinstate ***hydronic systems***	***isolation components*** and ***testing equipment and components*** are removed and hydronic system components are reinstalled according to ***drawings*** and specifications
E-13.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

hydronic systems include: heating, cooling

tests include: hydrostatic, pneumatic

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-13.03.01L	demonstrate knowledge of ***hydronic systems***, their characteristics, applications and operation	identify ***hydronic systems***, their characteristics, applications and operation
E-13.03.02L	demonstrate knowledge of testing of ***hydronic system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***hydronic system*** and, describe their characteristics and applications

		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***hydronic system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***hydronic systems***
		explain effects of trapped air in piping for ***hydronic systems*** and describe procedures to prevent it
E-13.03.03L	demonstrate knowledge of procedures to test ***hydronic systems***	identify ***tools and equipment*** used to test ***hydronic systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***hydronic systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***hydronic systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***hydronic systems***
		describe procedures to reinstate ***hydronic systems***
		identify documentation to be completed following ***hydronic system*** testing
		describe ***confirmation of zero energy state*** procedures
E-13.03.04L	demonstrate knowledge of regulatory requirements to test ***hydronic systems***	identify ***jurisdictional regulations*** pertaining to testing of ***hydronic systems***

Range of Variables

hydronic systems include: heating, cooling

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

tools and equipment include: see Appendix B

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-13.04 Maintains, troubleshoots and repairs hydronic systems

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

Skills

	Performance Criteria	Evidence of Attainment
E-13.04.01P	determine ***hydronic system*** issues that require investigation	***hydronic system*** issues requiring investigation are determined by consulting with system owner/operator
E-13.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-13.04.03P	troubleshoot ***hydronic system***	perform ***testing and inspection*** of ***hydronic system*** to determine equipment or components in ***condition for repair or replacement***
E-13.04.04P	lock out and tag out ***hydronic systems***	***hydronic systems*** are locked and tagged out to prevent activation during repair or maintenance
E-13.04.05P	install ***isolation components*** and ensure ***hydronic system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***hydronic systems***
E-13.04.06P	disassemble ***hydronic system***, repair or replace faulty equipment or components and reassemble system	equipment and components are removed, repaired or replaced and ***hydronic system*** is reassembled without damage to other components or surrounding area
E-13.04.07P	reinstate ***hydronic system*** to operating condition	***hydronic system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
E-13.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***hydronic equipment*** is free of contaminants and operating efficiently
E-13.04.09P	perform ***test*** on ***hydronic systems***	***test medium*** is introduced to ***hydronic systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-13.04.10P	remove ***test medium*** from ***hydronic systems***	***test medium*** is removed from ***hydronic systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***

E-13.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
E-13.04.12P	complete documentation	documentation is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

hydronic systems include: heating, cooling

tools and equipment include: see Appendix B

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

hydronic equipment includes: boilers, tanks, heat exchangers, pumps, tanks, isolators, chemical feeders

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-13.04.01L	demonstrate knowledge of ***hydronic systems***, their characteristics, applications and operation	identify ***hydronic systems***, their characteristics, applications and operation
E-13.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***hydronic systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***hydronic systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***hydronic systems***
		explain effects of trapped air in piping for ***hydronic systems*** and describe procedures to prevent it

E-13.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***hydronic systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***hydronic systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***hydronic systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***hydronic systems***
		describe procedures to repair ***hydronic systems***
		describe ***maintenance*** procedures for ***hydronic systems***
		identify documentation to be completed following ***hydronic system*** repair or maintenance
E-13.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***hydronic systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***hydronic systems***

Range of Variables

hydronic systems include: heating, cooling

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task E-14 Installs, tests, maintains, troubleshoots and repairs process piping systems

Task Descriptor

Steamfitters/Pipefitters install process piping systems, which are used in specific industry processes, including gas and oil refining, pulp production, mining, food processing and chemical production. These industry processes dictate the use of a wide variety of piping materials and joining methods.

Steamfitters/Pipefitters are responsible for the maintenance of piping, components and equipment. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are responsible for diagnosing, locating and repairing or replacing equipment and material as needed.

E-14.01 Installs equipment for process piping systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-14.01.01P	select ***process piping equipment*** and ***controls***	***process piping equipment*** and ***controls*** are selected according to application, type of system***, drawings***, specifications and ***jurisdictional regulations***
E-14.01.02P	size ***process piping equipment*** and ***controls***	***process piping equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
E-14.01.03P	determine high points and low points for ***process piping equipment*** and ***controls***	high points and low points for ***process piping equipment*** and ***controls*** are identified according to ***drawings***
E-14.01.04P	determine location and placement of ***process piping equipment*** and ***controls***	location and placement of ***process piping equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-14.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.01.07P	determine ***installation method***	***installation method*** used to set ***process piping equipment*** and ***controls*** in place is determined according to size, weight and location

E-14.01.08P	install ***process piping equipment***	***process piping equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

process piping equipment includes: circulating pumps, tanks, pressure vessels, heat exchangers, transfer pumps, holding tanks, isolators, relief valves, isolation valves for equipment, strainers, filters

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing, solar

controls include: flow devices, level devices, temperature devices, pressure devices

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-14.01.01L	demonstrate knowledge of ***process piping systems***, their characteristics, applications and operation	identify ***process piping systems***, and describe their characteristics, applications and operation
		identify ***process piping equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***process piping systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***process piping systems***, and describe their purpose and operation
		identify types of ***fuel*** used in high pressure steam and condensate systems

		identify ***sources of heat*** used in ***process piping systems***
		identify ***sources of cooling*** used in ***process piping systems***
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
E-14.01.02L	demonstrate knowledge of procedures to install ***process piping equipment***	identify ***tools and equipment*** used to install ***process piping equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***process piping equipment***
		describe procedures to install ***process piping equipment***, ***controls***, ***supports*** and ***fasteners***
E-14.01.03L	demonstrate knowledge of regulatory requirements to install ***process piping equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***process piping equipment***

Range of Variables

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing, solar

process piping equipment includes: circulating pumps, tanks, pressure vessels, heat exchangers, transfer pumps, holding tanks, isolators, relief valves, isolation valves for equipment, strainers, filters

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

fuel includes: fuel oil, gas, coal, biomass

sources of heat include: oil, gas, wood, steam, geothermal, solar, nuclear

sources of cooling include: ground source, cooling towers, chillers, refrigeration, heat exchangers

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: plate, shell and tube exchangers

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-14.02 Installs piping for process piping systems

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

Skills

	Performance Criteria	Evidence of Attainment
E-14.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-14.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
E-14.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-14.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-14.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-14.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, specialty

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints, fusion

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-14.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***process piping systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***process piping systems,*** and describe their characteristics, applications and operation
		identify piping configurations, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***process piping systems***
		explain effects of trapped air in piping for ***process piping systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***process piping systems***

		identify systems that require grade or pitch of piping
E-14.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***process piping systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***process piping systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***process piping systems***
		describe procedures to install ***piping*** and ***piping components*** for ***process piping systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***process piping systems***
		describe procedures to bend ***piping*** for ***process piping systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***process piping systems***
		identify calculations for determining grade
E-14.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***process piping systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***process piping systems***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, specialty

piping components include: valves, fittings, flexible connectors and hoses, strainers

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing, solar

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-14.03 Tests process piping systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-14.03.01P	perform visual pre-check inspection of ***process piping systems***	visual pre-check inspection of ***process piping systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-14.03.02P	determine ***test***, ***testing equipment and components***, and test parameters	***tests***, ***testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-14.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-14.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-14.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-14.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
E-14.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
E-14.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-14.03.09P	perform ***test*** on ***process piping systems***	***test medium*** is introduced to ***process piping systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-14.03.10P	remove ***test medium*** from ***process piping systems***	***test medium*** is removed from ***process piping systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-14.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures

E-14.03.12P	reinstate ***process piping systems***	***isolation components*** and ***testing equipment and components*** are removed and process piping system components are reinstalled according to ***drawings*** and specifications
E-14.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing, solar

tests include: hydrostatic, pneumatic, vacuum

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, air, inert gas

method includes: using pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-14.03.01L	demonstrate knowledge of ***process piping systems***, their characteristics, applications and operation	identify ***process piping systems***, their characteristics, applications and operation
E-14.03.02L	demonstrate knowledge of testing of ***process piping system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***process piping system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***process piping system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***process piping systems***

		explain effects of trapped air in piping for ***process piping systems*** and describe procedures to prevent it
E-14.03.03L	demonstrate knowledge of procedures to test ***process piping systems***	identify ***tools and equipment*** used to test ***process piping systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***process piping systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***process piping systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***process piping systems***
		describe procedures to reinstate ***process piping systems***
		identify documentation to be completed following ***process piping system*** testing
		describe ***confirmation of zero energy state*** procedures
E-14.03.04L	demonstrate knowledge of regulatory requirements to test ***process piping systems***	identify ***jurisdictional regulations*** pertaining to testing of ***process piping systems***

Range of Variables

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing, solar

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix, air, inert gas

method includes: using pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-14.04 Maintains, troubleshoots and repairs process piping systems

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

Skills

	Performance Criteria	Evidence of Attainment
E-14.04.01P	determine ***process piping system*** issues that require investigation	***process piping system*** issues requiring investigation are determined by consulting with system owner/operator
E-14.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-14.04.03P	troubleshoot ***process piping system***	perform ***testing and inspection*** of ***process piping system*** to determine equipment or components in ***condition for repair or replacement***
E-14.04.04P	lock out and tag out ***process piping systems***	***process piping systems*** are locked and tagged out to prevent activation during repair or maintenance
E-14.04.05P	install ***isolation components*** and ensure ***process piping system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***process piping systems***
E-14.04.06P	disassemble ***process piping system***, repair or replace faulty equipment or components and reassemble ***process piping system***	equipment and components are removed, repaired or replaced and ***process piping system*** is reassembled without damage to other components or surrounding area
E-14.04.07P	reinstate ***process piping system*** to operating condition	***process piping system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
E-14.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***process piping equipment*** is free of contaminants and operating efficiently
E-14.04.09P	check quality of system medium	system medium quality is tested to determine if it is suitable for system using a test kit
E-14.04.10P	perform ***test*** on ***process piping system***	***test medium*** is introduced to ***process piping system*** and results of ***test*** are documented for purpose of obtaining sign-off

E-14.04.11P	remove ***test medium*** from ***process piping system***	***test medium*** is removed from ***process piping system*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-14.04.12P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
E-14.04.13P	treat system medium in ***process piping system***	system medium in ***process piping systems*** is treated with chemicals according to manufacturers' recommendations, owner/operator, system parameters and results of system medium quality test
E-14.04.14P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing, solar

tools and equipment include: see Appendix B

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

process piping equipment includes: pumps, tanks, pressure vessels, heat exchangers, isolators, valves, strainers, filters

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix, air, inert gas

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-14.04.01L	demonstrate knowledge of ***process piping systems***, their characteristics, applications and operation	identify ***process piping systems***, their characteristics, applications and operation
E-14.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***process piping systems***	identify types of ***isolation components***, and describe their characteristics and applications

		interpret information pertaining to troubleshooting, repairing and maintaining ***process piping systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***process piping systems***
		explain effects of trapped air in piping for ***process piping systems*** and describe procedures to prevent it
E-14.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***process piping systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***process piping systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***process piping systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***process piping systems***
		describe procedures to repair ***process piping systems***
		describe ***maintenance*** procedures for ***process piping systems***
		identify documentation to be completed following ***process piping system*** repair or maintenance
E-14.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***process piping systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***process piping systems***

Range of Variables

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing, solar

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task E-15 Installs, tests, maintains, troubleshoots and repairs industrial water and waste treatment systems

Task Descriptor

Industrial water and waste treatment systems remove biological or chemical waste products from water. The functions of these systems may be to treat sewage, agriculture or industrial waste water. Steamfitter/Pipefitters are responsible for installing, maintaining and repairing the piping, and associated components and equipment for these systems. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material as needed.

E-15.01 Installs equipment for industrial water and waste treatment systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-15.01.01P	select ***industrial water and waste equipment*** and ***controls***	***industrial water and waste equipment*** and ***controls*** are selected according to application, type of system***, drawings***, specifications and ***jurisdictional regulations***
E-15.01.02P	size ***industrial water and waste equipment*** and ***controls***	***industrial water and waste equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
E-15.01.03P	determine high points and low points for ***industrial water and waste equipment*** and ***controls***	high points and low points for ***industrial water and waste equipment*** and ***controls*** are identified according to ***drawings***
E-15.01.04P	determine location and placement of ***industrial water and waste equipment*** and ***controls***	location and placement of ***industrial water and waste equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-15.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-15.01.07P	determine ***installation method***	***installation method*** used to set ***industrial water and waste equipment*** and ***controls*** in place is determined according to size, weight and location
E-15.01.08P	install ***industrial water and waste equipment***	***industrial water and waste equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

industrial water and waste equipment includes: pumps, tanks, valves, filters, strainers, separators, skimmers, aerators, water treatment equipment, clarifiers

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-15.01.01L	demonstrate knowledge of ***industrial water and waste systems***, their characteristics, applications and operation	identify ***industrial water and waste systems***, and describe their characteristics, applications and operation
		identify ***industrial water and waste equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***industrial water and waste systems*** found on ***drawings*** and specifications

		identify types of piping components and accessories for ***industrial water and waste systems***, and describe their purpose and operation
E-15.01.02L	demonstrate knowledge of procedures to install ***industrial water and waste equipment***	identify ***tools and equipment*** used to install ***industrial water and waste equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***industrial water and waste equipment***
		describe procedures to install ***industrial water and waste equipment***, ***controls***, ***supports*** and ***fasteners***
E-15.01.03L	demonstrate knowledge of regulatory requirements to install ***industrial water and waste equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***industrial water and waste equipment***

Range of Variables

industrial water and waste systems include: water softeners, settling tanks, clarifiers, chemical injection, aeration

industrial water and waste equipment includes: pumps, tanks, valves, filters, strainers, separators, skimmers, aerators, water treatment equipment, clarifiers

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-15.02 Installs piping for industrial water and waste treatment systems

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

Skills

	Performance Criteria	Evidence of Attainment
E-15.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-15.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
E-15.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-15.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-15.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-15.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, copper, plastic, stainless steel, fibreglass, cast iron, ductile iron, concrete pressure pipe (CPP), regular concrete pipe, dual containment pipe, polyethylene piping (HCPE)

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints, fusion

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-15.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***industrial water and waste systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***industrial water and waste systems,*** and describe their characteristics, applications and operation
		identify ***piping configurations***, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***industrial water and waste systems***
		explain effects of trapped air in piping for ***industrial water and waste systems*** and describe procedures to prevent it

		identify ***considerations*** for selecting ***piping components*** for ***industrial water and waste systems***
		identify systems that require grade or pitch of piping
E-15.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***industrial water and waste systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***industrial water and waste systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***industrial water and waste systems***
		describe procedures to install ***piping*** and ***piping components*** for ***industrial water and waste systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***industrial water and waste systems***
		describe procedures to bend ***piping*** for ***industrial water and waste systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***industrial water and waste systems***
		identify calculations for determining grade
E-15.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***industrial water and waste systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***industrial water and waste systems***

Range of Variables

piping includes: carbon steel, copper, plastic, stainless steel, fibreglass, cast iron, ductile iron, CPP, regular concrete pipe, dual containment pipe, HCPE

piping components include: valves, fittings, flexible connectors and hoses, strainers

industrial water and waste systems include: water softeners, settling tanks, clarifiers, chemical injection, aeration

piping configurations include: gravity, pressurized

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-15.03 Tests industrial water and waste treatment systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-15.03.01P	perform visual pre-check inspection of ***industrial water and waste systems***	visual pre-check inspection of ***industrial water and waste systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-15.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-15.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-15.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-15.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-15.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
E-15.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
E-15.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-15.03.09P	perform ***test*** on ***industrial water and waste systems***	***test medium*** is introduced to ***industrial water and waste systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-15.03.10P	remove ***test medium*** from ***industrial water and waste systems***	***test medium*** is removed from ***industrial water and waste systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***

E-15.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
E-15.03.12P	reinstate ***industrial water and waste systems***	***isolation components*** and ***testing equipment and components*** are removed and industrial water and waste system components are reinstalled according to ***drawings*** and specifications
E-15.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

industrial water and waste systems include: water softeners, settling tanks, clarifiers, chemical injection

tests include: hydrostatic, pneumatic, aeration

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-15.03.01L	demonstrate knowledge of ***industrial water and waste systems***, their characteristics, applications and operation	identify ***industrial water and waste systems***, their characteristics, applications and operation
E-15.03.02L	demonstrate knowledge of testing of ***industrial water and waste equipment system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***industrial water and waste equipment system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***industrial water and waste equipment system*** testing found on ***drawings*** and specifications

		explain effect of elevation and temperature on pressure when testing ***industrial water and waste systems***
		explain effects of trapped air in piping for ***industrial water and waste systems*** and describe procedures to prevent it
E-15.03.03L	demonstrate knowledge of procedures to test ***industrial water and waste systems***	identify ***tools and equipment*** used to test ***industrial water and waste systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***industrial water and waste systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***industrial water and waste systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***industrial water and waste systems***
		describe procedures to reinstate ***industrial water and waste systems***
		identify documentation to be completed following ***industrial water and waste equipment system*** testing
		describe ***confirmation of zero energy state*** procedures
E-15.03.04L	demonstrate knowledge of regulatory requirements to test ***industrial water and waste systems***	identify ***jurisdictional regulations*** pertaining to testing of ***industrial water and waste systems***

Range of Variables

industrial water and waste systems include: water softeners, settling tanks, clarifiers, chemical injection, aeration

industrial water and waste equipment and components include: pumps, tanks, valves, filters, strainers, separators, skimmers, aerators, water treatment equipment, clarifiers

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tests include: hydrostatic, pneumatic, aeration

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

tools and equipment include: see Appendix B

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-15.04 Maintains, troubleshoots and repairs industrial water and waste treatment systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-15.04.01P	determine ***industrial water and waste system*** issues that require investigation	***industrial water and waste system*** issues requiring investigation are determined by consulting with system owner/operator
E-15.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-15.04.03P	troubleshoot ***industrial water and waste system***	perform ***testing and inspection*** of ***industrial water and waste system*** to determine equipment or components in ***condition for repair or replacement***
E-15.04.04P	lock-out and tag-out ***industrial water and waste systems***	***industrial water and waste systems*** are locked and tagged out to prevent activation during repair or maintenance
E-15.04.05P	install ***isolation components*** and ensure ***industrial water and waste system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***industrial water and waste systems***

E-15.04.06P	disassemble ***industrial water and waste system***, repair or replace faulty ***equipment or components*** and reassemble ***industrial water and waste system***	***equipment and components*** are removed, repaired or replaced and ***industrial water and waste system*** reassembled without damage to other components or surrounding area
E-15.04.07P	reinstate ***industrial water and waste system*** to operating condition	***industrial water and waste system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
E-15.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***industrial water and waste equipment*** is free of contaminants and operating efficiently
E-15.04.09P	perform ***test*** on ***industrial water and waste systems***	***test medium*** is introduced to ***industrial water and waste systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-15.04.10P	remove ***test medium*** from ***industrial water and waste systems***	***test medium*** is removed from ***industrial water and waste systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-15.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
E-15.04.12P	treat system medium in ***industrial water and waste systems***	system medium in ***industrial water and waste systems*** is treated with chemicals according to manufacturers' recommendations and ***jurisdictional regulations***
E-15.04.13P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

industrial water and waste systems include: water softeners, settling tanks, clarifiers, chemical injection, aeration

tools and equipment include: see Appendix B

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

industrial water and waste equipment and components include: pumps, tanks, valves, filters, strainers, separators, skimmers, aerators, water treatment equipment, clarifiers

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-15.04.01L	demonstrate knowledge of ***industrial water and waste systems***, their characteristics, applications and operation	identify ***industrial water and waste systems***, their characteristics, applications and operation
E-15.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***industrial water and waste systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***industrial water and waste systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***industrial water and waste systems***
		explain effects of trapped air in piping for ***industrial water and waste systems*** and describe procedures to prevent it
E-15.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***industrial water and waste systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***industrial water and waste systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***industrial water and waste systems***

		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***industrial water and waste systems***
		describe procedures to repair ***industrial water and waste systems***
		describe ***maintenance*** procedures for ***industrial water and waste systems***
		identify documentation to be completed following ***industrial water and waste equipment and components*** repair or maintenance
E-15.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***industrial water and waste systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***industrial water and waste systems***

Range of Variables

industrial water and waste systems include: water softeners, settling tanks, clarifiers, chemical injection, aeration

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

industrial water and waste equipment and components include: pumps, tanks, valves, filters, strainers, separators, skimmers, aerators, water treatment equipment, clarifiers

Task E-16 Installs, tests, maintains, troubleshoots and repairs hydraulic systems

Task Descriptor

Hydraulic systems are used to drive hydraulic motors and actuators in a variety of commercial, industrial and manufacturing processes.

Steamfitters/Pipefitters are responsible for the maintenance of piping, components and equipment. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material as needed.

E-16.01 Installs equipment for hydraulic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-16.01.01P	select ***hydraulic equipment*** and ***controls***	***hydraulic equipment*** and ***controls*** are selected according to application, type of system, ***drawings***, specifications and ***jurisdictional regulations***
E-16.01.02P	determine high points and low points for ***hydraulic equipment*** and ***controls***	high points and low points for ***hydraulic equipment*** and ***controls*** are identified according to ***drawings***
E-16.01.03P	determine location and placement of ***hydraulic equipment*** and ***controls***	location and placement of ***hydraulic equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.01.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-16.01.05P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.01.06P	determine ***installation method***	***installation method*** used to set ***hydraulic equipment*** and ***controls*** in place is determined according to size, weight and location
E-16.01.07P	install ***hydraulic equipment***	***hydraulic equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-16.01.08P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.01.09P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

hydraulic equipment includes: reservoir tanks, pumps, motors, fittings, valves, cylinders, pistons, actuators, accumulators, fluid coolers, fluid heaters, strainers, filters

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

hydraulic systems include: open loop, closed loop

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-16.01.01L	demonstrate knowledge of ***hydraulic systems***, their characteristics, ***applications*** and operation	identify ***hydraulic systems***, and describe their characteristics, ***applications*** and operation
		identify ***hydraulic equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***hydraulic systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***hydraulic systems***, and describe their purpose and operation
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation

E-16.01.02L	demonstrate knowledge of procedures to install ***hydraulic equipment***	identify ***tools and equipment*** used to install ***hydraulic equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***hydraulic equipment***
		describe procedures to install ***hydraulic equipment***, ***controls***, ***supports*** and ***fasteners***
E-16.01.03L	demonstrate knowledge of regulatory requirements to install ***hydraulic equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***hydraulic equipment***

Range of Variables

hydraulic systems include: open loop, closed loop

applications include: to operate lifting devices, to operate motors, to operate valves

hydraulic equipment includes: reservoir tanks, pumps, motors, fittings, valves, cylinders, pistons, actuators, accumulators, fluid coolers, fluid heaters, strainers, filters

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, horizontal and vertical unit heaters, radiant panels, heat/plate exchangers

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-16.02 Installs piping and hoses for hydraulic systems

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

Skills

	Performance Criteria	Evidence of Attainment
E-16.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-16.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***

E-16.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-16.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-16.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping include: carbon steel, stainless steel, hydraulic hose, tube, tubing

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-16.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***hydraulic systems***, their characteristics, ***applications*** and operation	identify types of ***piping*** and ***piping components*** for ***hydraulic systems,*** and describe their characteristics, ***applications*** and operation
		identify ***piping configurations***, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***hydraulic systems***
		explain effects of trapped air in piping for ***hydraulic systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***hydraulic systems***
		identify systems that require grade or pitch of piping
E-16.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***hydraulic systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***hydraulic systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***hydraulic systems***

		describe procedures to install ***piping*** and ***piping components*** for ***hydraulic systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***hydraulic systems***
		describe procedures to bend ***piping*** for ***hydraulic systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***hydraulic systems***
E-16.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***hydraulic systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***hydraulic systems***

Range of Variables

piping include: carbon steel, stainless steel, hydraulic hose, tube, tubing

piping components include: valves, fittings, flexible connectors and hoses, strainers

hydraulic systems include: open loop, closed loop

applications include: to operate lifting devices, to operate motors, to operate valves

piping configurations include: pressurized, open tank

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-16.03 Tests hydraulic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-16.03.01P	perform visual pre-check inspection of ***hydraulic systems***	visual pre-check inspection of ***hydraulic systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-16.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-16.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-16.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-16.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-16.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
E-16.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
E-16.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-16.03.09P	perform ***test*** on ***hydraulic systems***	***test medium*** is introduced to ***hydraulic systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-16.03.10P	remove ***test medium*** from ***hydraulic systems***	***test medium*** is removed from ***hydraulic systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-16.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures

E-16.03.12P	reinstate ***hydraulic systems***	***isolation components*** and ***testing equipment and components*** are removed and hydraulic system components are reinstalled according to ***drawings*** and specifications
E-16.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

hydraulic systems include: open loop, closed loop

tests include: service, pneumatic

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: hydraulic fluid, compressed air, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-16.03.01L	demonstrate knowledge of ***hydraulic systems***, their characteristics, applications and operation	identify ***hydraulic systems***, their characteristics, applications and operation
E-16.03.02L	demonstrate knowledge of testing of ***hydraulic system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***hydraulic system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***hydraulic system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***hydraulic systems***
		explain effects of trapped air in piping for ***hydraulic systems*** and describe procedures to prevent it

E-16.03.03L	demonstrate knowledge of procedures to test ***hydraulic systems***	identify ***tools and equipment*** used to test ***hydraulic systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***hydraulic systems***
		identify types of ***testing equipment and components***, and describe their characteristics and applications
		describe procedures to test ***hydraulic systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***hydraulic systems***
		describe procedures to reinstate ***hydraulic systems***
		identify documentation to complete following ***hydraulic system*** testing
		describe ***confirmation of zero energy state*** procedures
E-16.03.04L	demonstrate knowledge of regulatory requirements to test ***hydraulic systems***	identify ***jurisdictional regulations*** pertaining to testing of ***hydraulic systems***

Range of Variables

hydraulic systems include: open loop, closed loop

tests include: service, pneumatic

test medium includes: hydraulic fluid, compressed air, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-16.04 Maintains, troubleshoots and repairs hydraulic systems

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

Skills

	Performance Criteria	Evidence of Attainment
E-16.04.01P	determine ***hydraulic system*** issues that require investigation	***hydraulic system*** issues requiring investigation are determined by consulting with system owner/operator
E-16.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-16.04.03P	troubleshoot ***hydraulic system***	perform ***testing and inspection*** of ***hydraulic system*** to determine equipment or components in ***condition for repair or replacement***
E-16.04.04P	lock out and tag out ***hydraulic systems***	***hydraulic systems*** are locked and tagged out to prevent activation during repair or maintenance
E-16.04.05P	install ***isolation components*** and ensure ***hydraulic system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***hydraulic systems***
E-16.04.06P	disassemble ***hydraulic system***, repair or replace faulty equipment or components and reassemble ***hydraulic system***	equipment and components are removed, repaired or replaced and ***hydraulic system*** is reassembled without damage to other components or surrounding area
E-16.04.07P	reinstate ***hydraulic system*** to operating condition	***hydraulic system*** is filled and pressurized, bled of air or contaminants, checked for leaks, particle tests performed, locks and tags removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
E-16.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***hydraulic equipment*** is free of contaminants and operating efficiently
E-16.04.09P	perform ***test*** on ***hydraulic system***	***test medium*** is introduced to ***hydraulic system*** and results of ***test*** are documented for purpose of obtaining sign-off
E-16.04.10P	remove ***test medium*** from ***hydraulic system***	***test medium*** is removed from ***hydraulic system*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***

E-16.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
E-16.04.12P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

hydraulic systems include: open loop, closed loop

tools and equipment include: see Appendix B

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

hydraulic equipment includes: reservoir tanks, pumps, motors, fittings, valves, cylinders, pistons, actuators, accumulators, fluid coolers, fluid heaters, strainers, filters

tests include: service, pneumatic

test medium includes: hydraulic fluid, compressed air, inert gases

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-16.04.01L	demonstrate knowledge of ***hydraulic systems***, their characteristics, applications and operation	identify ***hydraulic systems***, their characteristics, applications and operation
E-16.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***hydraulic systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***hydraulic systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***hydraulic systems***
		explain effects of trapped air in piping for ***hydraulic systems*** and describe procedures to prevent it

E-16.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***hydraulic systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***hydraulic systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***hydraulic systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***hydraulic systems***
		describe procedures to repair ***hydraulic systems***
		describe ***maintenance*** procedures for ***hydraulic systems***
		identify documentation to complete following ***hydraulic system*** repair or maintenance
E-16.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***hydraulic systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***hydraulic systems***

Range of Variables

hydraulic systems include: open loop, closed loop

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task E-17 Installs, tests, maintains, troubleshoots and repairs heating, ventilation, air conditioning and refrigeration (HVACR) systems

Task Descriptor

Steamfitters/Pipefitters install HVACR equipment and piping for applications such as food processing plants, recreational facilities, medical facilities, industrial manufacturing processes and liquefied natural gas plants. They may also work on the refrigeration units for co-gen systems in industrial applications. Additional certification may be required in certain jurisdictions.

Steamfitters/Pipefitters are responsible for the maintenance of piping, equipment and associated components. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are responsible for diagnosing, locating and repairing or replacing equipment and associated components.

E-17.01 Installs equipment for HVACR systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-17.01.01P	select ***HVACR equipment*** and ***controls***	***HVACR equipment*** and ***controls*** are selected according to application, type of system***, drawings***, specifications and ***jurisdictional regulations***
E-17.01.02P	size ***HVACR equipment*** and ***controls***	***HVACR equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
E-17.01.03P	determine high points and low points for ***HVACR equipment*** and ***controls***	high points and low points for ***HVACR equipment*** and ***controls*** are identified according to ***drawings***
E-17.01.04P	determine location and placement of ***HVACR equipment*** and ***controls***	location and placement of ***HVACR equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-17.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-17.01.07P	determine ***installation method***	***installation method*** used to set ***HVACR equipment*** and ***controls*** in place is determined according to size, weight and location
E-17.01.08P	install ***HVACR equipment***	***HVACR equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

HVACR equipment includes: compressors, condensers, heat pumps, chillers, evaporators, cooling towers, fin fans, liquid receivers, accumulators, humidifiers

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

HVACR systems include: chilled water, industrial cooling

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-17.01.01L	demonstrate knowledge of ***HVACR systems***, their characteristics, applications and operation	identify ***HVACR systems***, and describe their characteristics, applications and operation
		identify ***HVACR equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***HVACR systems*** found on ***drawings*** and specifications

		identify types of piping components and accessories for ***HVACR systems***, and describe their purpose and operation
		identify ***sources of heat*** used in ***HVACR systems***
		identify ***sources of cooling*** used in ***HVACR systems***
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
E-17.01.02L	demonstrate knowledge of procedures to install ***HVACR equipment***	identify ***tools and equipment*** used to install ***HVACR equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***HVACR equipment***
		describe procedures to install ***HVACR equipment***, ***controls***, ***supports*** and ***fasteners***
E-17.01.03L	demonstrate knowledge of regulatory requirements to install ***HVACR equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***HVACR equipment***

Range of Variables

HVACR systems include: chilled water, industrial cooling

HVACR equipment includes: compressors, condensers, heat pumps, chillers, evaporators, cooling towers, fin fans, liquid receivers, accumulators, humidifiers

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sources of heat include: oil, gas, wood, steam, geothermal, solar

sources of cooling include: ground source, cooling towers, chillers, refrigeration, plate exchangers

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, horizontal and vertical unit heaters, radiant panels, heat/plate exchangers

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-17.02 Installs piping for HVACR systems

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

Skills

	Performance Criteria	Evidence of Attainment
E-17.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-17.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
E-17.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-17.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-17.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-17.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, copper, alloys, tube, tubing, plastic tubing and piping, fibreglass piping

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-17.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***HVACR systems***, their characteristics, ***applications*** and operation	identify types of ***piping*** and ***piping components*** for ***HVACR systems,*** and describe their characteristics, ***applications*** and operation
		identify ***piping configurations***, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***HVACR systems***
		explain effects of trapped air in piping for ***HVACR systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***HVACR systems***

		identify systems that require grade or pitch of piping
		identify properties and characteristics of ***refrigerants***
E-17.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***HVACR systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***HVACR systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***HVACR systems***
		describe procedures to install ***piping*** and ***piping components*** for ***HVACR systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***HVACR systems***
		describe procedures to bend ***piping*** for ***HVACR systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***HVACR systems***
		identify calculations for determining grade
E-17.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***HVACR systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***HVACR systems***

Range of Variables

piping include: carbon steel, copper, alloys, tube, tubing, plastic tubing and piping, fibreglass piping

piping components include: valves, fittings, flexible connectors and hoses, strainers

HVACR systems include: chilled water, industrial cooling

applications include: residential cooling, industrial, commercial and institutional (ICI) cooling, process applications

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

piping configurations include: liquid line, gas line, grade, supply and return

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

refrigerants include: chlorofluorocarbons (CFCs), hydrofluorocarbons (HCFCs)

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-17.03 Tests HVACR systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-17.03.01P	perform visual pre-check inspection of ***HVACR systems***	visual pre-check inspection of ***HVACR systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-17.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-17.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-17.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-17.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-17.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
E-17.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
E-17.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-17.03.09P	perform ***test*** on ***HVACR systems***	***test medium*** is introduced to ***HVACR systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-17.03.10P	remove ***test medium*** from ***HVACR systems***	***test medium*** is removed from ***HVACR systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-17.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures

E-17.03.12P	reinstate ***HVACR systems***	***isolation components*** and ***testing equipment and components*** are removed and HVACR system components are reinstalled according to ***drawings*** and specifications
E-17.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

HVACR systems include: chilled water, industrial cooling

tests include: hydrostatic, pneumatic, vacuum

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-17.03.01L	demonstrate knowledge of ***HVACR systems***, their characteristics, applications and operation	identify ***HVACR systems***, their characteristics, applications and operation
E-17.03.02L	demonstrate knowledge of testing of ***HVACR system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***HVACR system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***HVACR system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***HVACR systems***
		explain effects of trapped air in piping for ***HVACR systems*** and describe procedures to prevent it

E-17.03.03L	demonstrate knowledge of procedures to test ***HVACR systems***	identify ***tools and equipment*** used to test ***HVACR systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***HVACR systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***HVACR systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***HVACR systems***
		describe procedures to reinstate ***HVACR systems***
		identify documentation to complete following ***HVACR system*** testing
		describe ***confirmation of zero energy state*** procedures
E-17.03.04L	demonstrate knowledge of regulatory requirements to test ***HVACR systems***	identify ***jurisdictional regulations*** pertaining to testing of ***HVACR systems***

Range of Variables

HVACR systems include: chilled water, industrial cooling

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

tools and equipment include: see Appendix B

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-17.04 Maintains, troubleshoots and repairs HVACR systems

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

Skills

	Performance Criteria	Evidence of Attainment
E-17.04.01P	determine ***HVACR system*** issues that require investigation	***HVACR system*** issues requiring investigation are determined by consulting with system owner/operator
E-17.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-17.04.03P	troubleshoot ***HVACR system***	perform ***testing and inspection*** of ***HVACR system*** to determine equipment or components in ***condition for repair or replacement***
E-17.04.04P	lock out and tag out ***HVACR systems***	***HVACR systems*** are locked and tagged out to prevent activation during repair or maintenance
E-17.04.05P	install ***isolation components*** and ensure ***HVACR system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***HVACR systems***
E-17.04.06P	disassemble ***HVACR system***, repair or replace faulty equipment or components and reassemble ***HVACR system***	equipment and components are removed, repaired or replaced and ***HVACR system*** is reassembled without damage to other components or surrounding area
E-17.04.07P	reinstate ***HVACR system*** to operating condition	***HVACR system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
E-17.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***HVACR equipment*** is free of contaminants and operating efficiently
E-17.04.09P	perform ***test*** on ***HVACR system***	***test medium*** is introduced to ***HVACR system*** and results of ***test*** are documented for purpose of obtaining sign-off
E-17.04.10P	remove ***test medium*** from ***HVACR system***	***test medium*** is removed from ***HVACR system*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***

E-17.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
E-17.04.12P	treat system medium in ***HVACR systems***	system medium in ***HVACR systems*** is treated with chemicals according to manufacturers' recommendations and ***jurisdictional regulations***
E-17.04.13P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

HVACR systems include: chilled water, industrial cooling

tools and equipment include: see Appendix B

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

HVACR equipment includes: compressors, condensers, heat pumps, chillers, evaporators, cooling towers, fin fans, liquid receivers, accumulators, humidifiers

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-17.04.01L	demonstrate knowledge of ***HVACR systems***, their characteristics, applications and operation	identify ***HVACR systems***, their characteristics, applications and operation
E-17.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***HVACR systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***HVACR systems*** found on ***drawings***, specifications and manufacturers' documentation

		explain effects of pressure on elevation when troubleshooting ***HVACR systems***
		explain effects of trapped air in piping for ***HVACR systems*** and describe procedures to prevent it
E-17.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***HVACR systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***HVACR systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***HVACR systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***HVACR systems***
		describe procedures to repair ***HVACR systems***
		describe ***maintenance*** procedures for ***HVACR systems***
		identify documentation to complete following ***HVACR system*** repair or maintenance
E-17.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***HVACR systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***HVACR systems***

Range of Variables

HVACR systems include: chilled water, industrial cooling

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task E-18 Installs, tests, maintains, troubleshoots and repairs fuel systems

Task Descriptor

Fuel systems supply required solid, liquid or vapour phase fuels to support combustion systems for heat, process, power generation and transportation. Steamfitter/Pipefitters install, maintain and repair piping, associated components and equipment for fuel systems throughout all aspects of industry including rail, storage tanks and marine tanker transportation systems. Additional certification may be required in certain jurisdictions.

Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material. Repairs are performed on an as-needed basis.

E-18.01 Installs equipment for fuel systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-18.01.01P	select ***fuel equipment*** and ***controls***	***fuel equipment*** and ***controls*** are selected according to application, type of system***, drawings***, specifications and ***jurisdictional regulations***
E-18.01.02P	size ***fuel equipment*** and ***controls***	***fuel equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
E-18.01.03P	determine high points and low points for ***fuel equipment*** and ***controls***	high points and low points for ***fuel equipment*** and ***controls*** are identified according to ***drawings***
E-18.01.04P	determine location and placement of ***fuel equipment*** and ***controls***	location and placement of ***fuel equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-18.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-18.01.07P	determine ***installation method***	***installation method*** used to set ***fuel equipment*** and ***controls*** in place is determined according to size, weight and location
E-18.01.08P	install ***fuel equipment***	***fuel equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

fuel equipment includes: expansion joints, pumps, heat transfer equipment, heat exchangers, tanks (may include rail or marine), vacuum breakers, valves and water separation equipment, blowers, flare stacks, flashback arrestors, scrubbers, vaporizers

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-18.01.01L	demonstrate knowledge of ***fuel systems***, their characteristics, applications and operation	identify ***fuel systems***, and describe their characteristics, applications and operation
		identify ***fuel equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***fuel systems*** found on ***drawings*** and specifications

		identify types of piping components and accessories for ***fuel systems***, and describe their purpose and operation
		identify ***sources of heat*** used in ***fuel systems***
		identify ***sources of cooling*** used in ***fuel systems***
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
E-18.01.02L	demonstrate knowledge of procedures to install ***fuel equipment***	identify ***tools and equipment*** used to install ***fuel equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***fuel equipment***
		describe procedures to install ***fuel equipment***, ***controls***, ***supports*** and ***fasteners***
E-18.01.03L	demonstrate knowledge of regulatory requirements to install ***fuel equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***fuel equipment***

Range of Variables

fuel systems include: natural gas, propane, diesel, fuel oil, black liquor, hydrocarbon derivatives, biofuels, bunker C (grade 4 oil or heavier), light oils, recovered biogases (sewer, landfill), hydrogen

fuel equipment includes: expansion joints, pumps, heat transfer equipment, heat exchangers, tanks (may include rail or marine), vacuum breakers, valves and water separation equipment, blowers, flare stacks, flashback arrestors, scrubbers, vaporizers

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sources of heat include: oil, gas, wood, steam, geothermal, solar

sources of cooling include: ground source, cooling towers, chillers, refrigeration, plate exchangers

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, horizontal and vertical unit heaters, radiant panels, heat/plate exchangers

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-18.02 Installs piping for fuel systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-18.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-18.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
E-18.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-18.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-18.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-18.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, copper, HDPE, stainless steel, protective-coated, tube, tubing, venting and exhaust, fibreglass

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints, fusion

piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-18.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***fuel systems***, their characteristics, ***applications*** and operation	identify types of ***piping*** and ***piping components*** for ***fuel systems,*** and describe their characteristics, ***applications*** and operation
		identify piping configurations, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***fuel systems***
		explain effects of trapped air in piping for ***fuel systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***fuel systems***

		identify systems that require grade or pitch of piping
E-18.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***fuel systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***fuel systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***fuel systems***
		describe procedures to install ***piping*** and ***piping components*** for ***fuel systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***fuel systems***
		describe procedures to bend ***piping*** for ***fuel systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***fuel systems***
		identify calculations for determining grade
E-18.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***fuel systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***fuel systems***

Range of Variables

piping includes: carbon steel, copper, HDPE, stainless steel, protective-coated, tube, tubing, venting and exhaust, fibreglass

piping components include: valves, fittings, flexible connectors and hoses, strainers

fuel systems include: natural gas, propane, diesel, fuel oil, black liquor, hydrocarbon derivatives, biofuels, bunker C (grade 4 oil or heavier), light oils, recovered biogases (sewer, landfill), hydrogen

applications include: residential heating, ICI heating, process

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-18.03 Tests fuel systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-18.03.01P	perform visual pre-check inspection of ***fuel systems***	visual pre-check inspection of ***fuel systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-18.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-18.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-18.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-18.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-18.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
E-18.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
E-18.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-18.03.09P	perform ***test*** on ***fuel systems***	***test medium*** is introduced to ***fuel systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-18.03.10P	remove ***test medium*** from ***fuel systems***	***test medium*** is removed from ***fuel systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-18.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures

E-18.03.12P	reinstate ***fuel systems***	***isolation components*** and ***testing equipment and components*** are removed and fuel system components are reinstalled according to ***drawings*** and specifications
E-18.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

fuel systems include: natural gas, propane, diesel, fuel oil, black liquor, hydrocarbon derivatives, biofuels, bunker C (grade 4 oil or heavier), light oils, recovered biogases (sewer, landfill), hydrogen

tests include: hydrostatic, pneumatic, NDE

testing equipment and components include: blind flanges, calibrated pressure gauges, test pumps, isolation valves, recorders, testing trees/headers, regulators, test medium, gas detection meters, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, air, inert gases, fuels

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-18.03.01L	demonstrate knowledge of ***fuel systems***, their characteristics, applications and operation	identify ***fuel systems***, their characteristics, applications and operation
E-18.03.02L	demonstrate knowledge of testing of ***fuel system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***fuel system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***fuel system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***fuel systems***

		explain effects of trapped air in piping for ***fuel systems*** and describe procedures to prevent it
E-18.03.03L	demonstrate knowledge of procedures to test ***fuel systems***	identify ***tools and equipment*** used to test ***fuel systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***fuel systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***fuel systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***fuel systems***
		describe procedures to reinstate ***fuel systems***
		identify documentation to complete following ***fuel system*** testing
		describe ***confirmation of zero energy state*** procedures
E-18.03.04L	demonstrate knowledge of regulatory requirements to test ***fuel systems***	identify ***jurisdictional regulations*** pertaining to testing of ***fuel systems***

Range of Variables

fuel systems include: natural gas, propane, diesel, fuel oil, black liquor, hydrocarbon derivatives, biofuels, bunker C (grade 4 oil or heavier), light oils, recovered biogases (sewer, landfill), hydrogen

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix, air, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators compressors, test medium, relief devices

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-18.04 Maintains, troubleshoots and repairs fuel systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-18.04.01P	determine ***fuel system*** issues that require investigation	***fuel system*** issues requiring investigation are determined by consulting with system owner/operator
E-18.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-18.04.03P	troubleshoot ***fuel system***	perform ***testing and inspection*** of ***fuel system*** to determine equipment or components in ***condition for repair or replacement***
E-18.04.04P	lock out and tag out ***fuel systems***	***fuel systems*** are locked and tagged out to prevent activation during repair or maintenance
E-18.04.05P	install ***isolation components*** and ensure ***fuel system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***fuel systems***
E-18.04.06P	disassemble ***fuel system***, repair or replace faulty equipment or components and reassemble ***fuel system***	equipment and components are removed, repaired or replaced and ***fuel system*** is reassembled without damage to other components or surrounding area
E-18.04.07P	reinstate ***fuel system*** to operating condition	***fuel system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
E-18.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***fuel equipment*** is free of contaminants and operating efficiently
E-18.04.09P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations and ***jurisdictional regulations***

E-18.04.10P	treat system medium in ***fuel systems***	system medium in ***fuel systems*** is treated with chemicals according to manufacturers' recommendations and ***jurisdictional regulations***
E-18.04.11P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

fuel systems include: natural gas, propane, diesel, fuel oil, black liquor, hydrocarbon derivatives, biofuels, bunker C (grade 4 oil or heavier), light oils, recovered biogases (sewer, landfill), hydrogen

tools and equipment include: see Appendix B

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

fuel equipment includes: expansion joints, pumps, heat transfer equipment, heat exchangers, tanks (may include rail or marine), vacuum breakers, valves and water separation equipment, blowers, flare stacks, flashback arrestors, scrubbers, vaporizers

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-18.04.01L	demonstrate knowledge of ***fuel systems***, their characteristics, applications and operation	identify ***fuel systems***, their characteristics, applications and operation
E-18.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***fuel systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***fuel systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***fuel systems***
		explain effects of trapped air in piping for ***fuel systems*** and describe procedures to prevent it

E-18.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***fuel systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***fuel systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***fuel systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***fuel systems***
		describe procedures to repair ***fuel systems***
		describe ***maintenance*** procedures for ***fuel systems***
		identify documentation to complete following ***fuel system*** repair or maintenance
E-18.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***fuel systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***fuel systems***

Range of Variables

fuel systems include: natural gas, propane, diesel, fuel oil, black liquor, hydrocarbon derivatives, biofuels, bunker C (grade 4 oil or heavier), light oils, recovered biogases (sewer, landfill), hydrogen

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task E-19 Installs, tests, maintains, troubleshoots and repairs medical gas systems

Task Descriptor

Medical gas piping systems are addressed separately due to their unique installation methods and applications. Additional certification may be required in certain jurisdictions. Medical gas systems are almost exclusively installed in health care facilities, dental clinics, veterinary clinics and laboratories. Medical gas piping systems supply piped gases, such as oxygen, nitrous oxide, nitrogen, carbon dioxide and medical air, to various parts of the facility.

Steamfitters/Pipefitters are responsible for the installation and maintenance of piping, associated components and equipment for these systems. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material. Repairs are performed on an as-needed basis.

E-19.01 Installs equipment for medical gas systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-19.01.01P	select ***medical gas equipment*** and ***controls***	***medical gas equipment*** and ***controls*** are selected according to application, type of system***, drawings***, specifications and ***jurisdictional regulations***
E-19.01.02P	size ***medical gas equipment*** and ***controls***	***medical gas equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
E-19.01.03P	determine high points and low points for ***medical gas equipment*** and ***controls***	high points and low points for ***medical gas equipment*** and ***controls*** are identified according to ***drawings***
E-19.01.04P	determine location and placement of ***medical gas equipment*** and ***controls***	location and placement of ***medical gas equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-19.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-19.01.07P	determine ***installation method***	***installation method*** used to set ***medical gas equipment*** and ***controls*** in place is determined according to size, weight and location
E-19.01.08P	install ***medical gas equipment***	***medical gas equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

medical gas equipment includes: valve boxes, terminal boxes, compressors, regulators, pumps, cryogenic tanks, valves, gauges, alarms

controls include: flow devices, level devices, temperature devices, pressure devices

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-19.01.01L	demonstrate knowledge of ***medical gas systems***, their characteristics, ***applications*** and operation	identify ***medical gas systems***, and describe their characteristics, ***applications*** and operation
		identify ***medical gas equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***medical gas systems*** found on ***drawings*** and specifications
		identify ***medical gas connection systems***

		identify types of piping components and accessories for ***medical gas systems***, and describe their purpose and operation
		identify sources of heat used in ***medical gas systems***
		identify ***sources of cooling*** used in ***medical gas systems***
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
E-19.01.02L	demonstrate knowledge of procedures to install ***medical gas equipment***	identify ***tools and equipment*** used to install ***medical gas equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***medical gas equipment***
		describe procedures to install ***medical gas equipment***, ***controls***, ***supports*** and ***fasteners***
E-19.01.03L	demonstrate knowledge of regulatory requirements to install ***medical gas equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***medical gas equipment***

Range of Variables

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases, nitrous oxide/anesthetic, medical air

applications include: hospitals, dental clinics, veterinary clinics, laboratories

medical gas equipment includes: valve boxes, terminal boxes, compressors, regulators, pumps, cryogenic tanks, valves, gauges, alarms

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

medical gas connection systems include: diameter index safety system (DISS), pin indexing system

sources of cooling include: refrigeration, plate exchangers

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, horizontal and vertical unit heaters, radiant panels, heat/plate exchangers

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-19.02 Installs piping for medical gas systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-19.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-19.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
E-19.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-19.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.07P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.08P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.09P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.10P	assemble and install ***piping***	***piping*** is assembled and installed using ***filler metal*** and ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***

E-19.02.11P	purge and charge piping	piping are purged and charged ensuring system remains a closed system to prevent environmental contamination according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.12P	install emergency shut-off valves	emergency shut-off valves are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.13P	label system	entire system is labelled to clearly identify gas products in each line according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.02.14P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping include: copper certified for medical gas service, carbon steel, stainless steel, tube, tubing

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

filler metal includes: American Welding Society (AWS) BCuP-3, BCuP-5 and Bag series brazing rods

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-19.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***medical gas systems***, their characteristics, ***applications*** and operation	identify types of ***piping*** and ***piping components*** for ***medical gas systems,*** and describe their characteristics, ***applications*** and operation
		identify piping configurations, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***medical gas systems***

		explain effects of trapped air in piping for ***medical gas systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***medical gas systems***
		identify systems that require grade or pitch of piping
		identify ***medical gas connection systems***
E-19.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***medical gas systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***medical gas systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***medical gas systems***
		describe procedures to install ***piping*** and ***piping components*** for ***medical gas systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***medical gas systems***
		describe procedures to bend ***piping*** for ***medical gas systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***medical gas systems***
		identify calculations for determining grade
E-19.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***medical gas systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***medical gas systems***

Range of Variables

piping include: copper certified for medical gas service, carbon steel, stainless steel, tube, tubing

piping components include: valves, fittings, flexible connectors and hoses, strainers

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases, nitrous oxide/anesthetic, medical air

applications include: hospitals, dental clinics, veterinary clinics, laboratories

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

medical gas connection systems include: DISS, pin indexing system

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-19.03 Tests medical gas systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-19.03.01P	perform visual pre-check inspection of ***medical gas systems***	visual pre-check inspection of ***medical gas systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-19.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-19.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-19.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-19.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-19.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing

E-19.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
E-19.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-19.03.09P	perform ***test*** on ***medical gas systems***	***test medium*** is introduced to ***medical gas systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-19.03.10P	remove ***test medium*** from ***medical gas systems***	***test medium*** is removed from ***medical gas systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-19.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
E-19.03.12P	reinstate ***medical gas systems***	***isolation components*** and ***testing equipment and components*** are removed and medical gas system components are reinstalled according to ***drawings*** and specifications
E-19.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases, nitrous oxide/anesthetic, medical air

tests include: particulate test, purification test, cross-connection test, destructive test, operational test

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: nitrogen, system gases

method includes: compressors, compressed gas cylinders

isolation components include: valves, plugs and caps

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-19.03.01L	demonstrate knowledge of ***medical gas systems***, their characteristics, applications and operation	identify ***medical gas systems***, their characteristics, applications and operation
E-19.03.02L	demonstrate knowledge of testing of ***medical gas system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***medical gas system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***medical gas system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***medical gas systems***
		explain effects of trapped air in piping for ***medical gas systems*** and describe procedures to prevent it
		identify ***medical gas connection systems***
E-19.03.03L	demonstrate knowledge of procedures to test ***medical gas systems***	identify ***tools and equipment*** used to test ***medical gas systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***medical gas systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***medical gas systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***medical gas systems***
		describe procedures to reinstate ***medical gas systems***
		identify documentation to complete following ***medical gas system*** testing

		describe ***confirmation of zero energy state*** procedures
E-19.03.04L	demonstrate knowledge of regulatory requirements to test ***medical gas systems***	identify ***jurisdictional regulations*** pertaining to testing of ***medical gas systems***

Range of Variables

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases, nitrous oxide/anesthetic, medical air

tests include: particulate test, purification test, cross-connection test, destructive test, operational test

test medium includes: nitrogen, system gases

method includes: compressors, compressed gas cylinders

isolation components include valves, plugs and caps

drawings include: engineered, mechanical, electrical, architectural, manufacturer

medical gas connection systems include: DISS, pin indexing system

tools and equipment include: see Appendix B

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, compressors, test medium, relief devices

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-19.04 Maintains, troubleshoots and repairs medical gas systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-19.04.01P	determine ***medical gas system*** issues that require investigation	***medical gas system*** issues requiring investigation are determined by consulting with system owner/operator
E-19.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-19.04.03P	troubleshoot ***medical gas system***	perform ***testing and inspection*** of ***medical gas system*** to determine equipment or components in ***condition for repair or replacement***
E-19.04.04P	lock out and tag out ***medical gas systems***	***medical gas systems*** are locked and tagged out to prevent activation during repair or maintenance
E-19.04.05P	install ***isolation components*** and ensure ***medical gas system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***medical gas systems***

E-19.04.06P	disassemble ***medical gas system***, repair or replace faulty equipment or components and reassemble ***medical gas system***	equipment and components are removed, repaired or replaced and ***medical gas system*** is reassembled without damage to other components or surrounding area
E-19.04.07P	reinstate ***medical gas system*** to operating condition	***medical gas system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
E-19.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***medical gas equipment*** is free of contaminants and operating efficiently
E-19.04.09P	perform ***test*** on ***medical gas systems***	***test medium*** is introduced to ***medical gas systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-19.04.10P	remove ***test medium*** from ***medical gas systems***	***test medium*** is removed from ***medical gas systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-19.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
E-19.04.12P	treat system medium in ***medical gas systems***	system medium in ***medical gas systems*** is treated with chemicals according to manufacturers' recommendations and ***jurisdictional regulations***
E-19.04.13P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases, nitrous oxide/anesthetic, medical air

tools and equipment include: see Appendix B

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

medical gas equipment includes: valve boxes, terminal boxes, compressors, regulators, pumps, cryogenic tanks, valves, gauges, alarms

tests include: particulate test, purification test, cross-connection test, destructive test, operational test

test medium includes: nitrogen, system gases

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-19.04.01L	demonstrate knowledge of ***medical gas systems***, their characteristics, applications and operation	identify ***medical gas systems***, their characteristics, applications and operation
E-19.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***medical gas systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***medical gas systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***medical gas systems***
		explain effects of trapped air in piping for ***medical gas systems*** and describe procedures to prevent it
		identify ***medical gas connection systems***
E-19.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***medical gas systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***medical gas systems***, and describe their applications and procedures for use

		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***medical gas systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***medical gas systems***
		describe procedures to repair ***medical gas systems***
		describe ***maintenance*** procedures for ***medical gas systems***
		identify documentation to complete following ***medical gas system*** repair or maintenance
E-19.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***medical gas systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***medical gas systems***

Range of Variables

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases, nitrous oxide/anesthetic, medical air

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

medical gas connection systems include: DISS, pin indexing system

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task E-20 Installs, tests, maintains, troubleshoots and repairs compressed air and pneumatic systems

Task Descriptor

Compressed air and pneumatic systems refer to instrument air, utility air and process air piping used in ICI settings.

Steamfitters/Pipefitters install, test and maintain piping, components and equipment. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material as needed.

E-20.01 Installs equipment for compressed air and pneumatic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-20.01.01P	select ***compressed air and pneumatic equipment*** and ***controls***	***compressed air and pneumatic equipment*** and ***controls*** are selected according to application, type of system***,*** ***drawings***, specifications and ***jurisdictional regulations***
E-20.01.02P	size ***compressed air and pneumatic equipment*** and ***controls***	***compressed air and pneumatic equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
E-20.01.03P	determine high points and low points for ***compressed air and pneumatic equipment*** and ***controls***	high points and low points for ***compressed air and pneumatic equipment*** and ***controls*** are identified according to ***drawings***
E-20.01.04P	determine location and placement of ***compressed air and pneumatic equipment*** and ***controls***	location and placement of ***compressed air and pneumatic equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-20.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-20.01.07P	determine ***installation method***	***installation method*** used to set ***compressed air and pneumatic equipment*** and ***controls*** in place is determined according to size, weight and location
E-20.01.08P	install ***compressed air and pneumatic equipment***	***compressed air and pneumatic equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

compressed air and pneumatic equipment includes: compressors (piston, screw type, rotary, axial, reciprocating, vane), heat transfer equipment, receiver tanks, valves, dryers, separators, filters, lubricators, compressed gas cylinders, tanks, liquid drainers

compressed air and pneumatic systems include: compressed air, compressed gases

controls include: flow devices, level devices, temperature devices, pressure devices

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-20.01.01L	demonstrate knowledge of ***compressed air and pneumatic systems***, their characteristics, applications and operation	identify ***compressed air and pneumatic systems***, and describe their characteristics, applications and operation
		identify ***compressed air and pneumatic equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation

		interpret information pertaining to ***compressed air and pneumatic systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***compressed air and pneumatic systems***, and describe their purpose and operation
		identify ***sources of heat*** found in ***compressed air and pneumatic systems***
		identify ***sources of cooling*** used in ***compressed air and pneumatic systems***
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
E-20.01.02L	demonstrate knowledge of procedures to install ***compressed air and pneumatic equipment***	identify ***tools and equipment*** used to install ***compressed air and pneumatic equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***compressed air and pneumatic equipment***
		describe procedures to install ***compressed air and pneumatic equipment***, ***controls***, ***supports*** and ***fasteners***
E-20.01.03L	demonstrate knowledge of regulatory requirements to install ***compressed air and pneumatic equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***compressed air and pneumatic equipment***

Range of Variables

compressed air and pneumatic systems include: compressed air, compressed gases

compressed air and pneumatic equipment includes: compressors (piston, screw type, rotary, axial, reciprocating, vane), heat transfer equipment, receiver tanks, valves, dryers, separators, filters, lubricators, compressed gas cylinders, tanks, liquid drainers

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sources of heat include: oil, gas, wood, steam, geothermal, solar

sources of cooling include: ground source, cooling towers, chillers, refrigeration, plate exchangers

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: heat/plate exchangers, pipe coils

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-20.02 Installs piping for compressed air and pneumatic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-20.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-20.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
E-20.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-20.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-20.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***

E-20.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and jurisd***ictional regulations***
E-20.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, copper, plastic (approved for use on compressed air and pneumatic systems), galvanized, stainless steel, tube, tubing

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-20.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***, their characteristics, ***applications*** and operation	identify types of ***piping*** and ***piping components*** for ***compressed air and pneumatic systems,*** and describe their characteristics, ***applications*** and operation
		identify piping configurations, and describe their characteristics, applications and operation

		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***compressed air and pneumatic systems***
		explain effects of trapped air in piping for ***compressed air and pneumatic systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***compressed air and pneumatic systems***
		identify systems that require grade or pitch of piping
E-20.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***
		describe procedures to install ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***
		describe procedures to bend ***piping*** for ***compressed air and pneumatic systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***
		identify calculations for determining grade
E-20.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***compressed air and pneumatic systems***

Range of Variables

piping includes: carbon steel, copper, plastic (approved for use on compressed air and pneumatic systems), galvanized, stainless steel, tube, tubing

piping components include: valves, fittings, flexible connectors and hoses, strainers

compressed air and pneumatic systems include: compressed air, compressed gases

applications include: instrument air, utility air, process air, inert gases used in ICI settings

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-20.03 Tests compressed air and pneumatic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-20.03.01P	perform visual pre-check inspection of ***compressed air and pneumatic systems***	visual pre-check inspection of ***compressed air and pneumatic systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-20.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-20.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-20.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-20.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-20.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing

E-20.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
E-20.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-20.03.09P	perform ***test*** on ***compressed air and pneumatic systems***	***test medium*** is introduced to ***compressed air and pneumatic systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-20.03.10P	remove ***test medium*** from ***compressed air and pneumatic systems***	***test medium*** is removed from ***compressed air and pneumatic systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-20.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
E-20.03.12P	reinstate ***compressed air and pneumatic systems***	***isolation components*** and ***testing equipment and components*** are removed and compressed air and pneumatic system components are reinstalled according to ***drawings*** and specifications
E-20.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

compressed air and pneumatic systems include: compressed air, compressed gases

tests include: hydrostatic, pneumatic

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, air, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-20.03.01L	demonstrate knowledge of ***compressed air and pneumatic systems***, their characteristics, applications and operation	identify ***compressed air and pneumatic systems***, their characteristics, applications and operation
E-20.03.02L	demonstrate knowledge of testing of ***compressed air and pneumatic system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***compressed air and pneumatic system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***compressed air and pneumatic system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***compressed air and pneumatic systems***
		explain effects of trapped air in piping for ***compressed air and pneumatic systems*** and describe procedures to prevent it
E-20.03.03L	demonstrate knowledge of procedures to test ***compressed air and pneumatic systems***	identify ***tools and equipment*** used to test ***compressed air and pneumatic systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***compressed air and pneumatic systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***compressed air and pneumatic systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***compressed air and pneumatic systems***
		describe procedures to reinstate ***compressed air and pneumatic systems***

		identify documentation to complete following ***compressed air and pneumatic system*** testing
		describe ***confirmation of zero energy state*** procedures
E-20.03.04L	demonstrate knowledge of regulatory requirements to test ***compressed air and pneumatic systems***	identify ***jurisdictional regulations*** pertaining to testing of ***compressed air and pneumatic systems***

Range of Variables

compressed air and pneumatic systems include: compressed air, compressed gases
tests include: hydrostatic, pneumatic
test medium includes: water, air, inert gases
method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders
isolation components include: blinds, spades, plugs and caps, temporary spool pieces
drawings include: engineered, mechanical, electrical, architectural, manufacturer
tools and equipment include: see Appendix B
testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices
confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable
jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-20.04 Maintains, troubleshoots and repairs compressed air and pneumatic systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-20.04.01P	determine ***compressed air and pneumatic system*** issues that require investigation	***compressed air and pneumatic system*** issues requiring investigation are determined by consulting with system owner/operator
E-20.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-20.04.03P	troubleshoot ***compressed air and pneumatic system***	perform ***testing and inspection*** of ***compressed air and pneumatic system*** to determine equipment or components in ***condition for repair or replacement***
E-20.04.04P	lock out and tag out ***compressed air and pneumatic systems***	***compressed air and pneumatic systems*** are locked and tagged out to prevent activation during repair or maintenance

E-20.04.05P	install ***isolation components*** and ensure ***compressed air and pneumatic system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***compressed air and pneumatic systems***
E-20.04.06P	disassemble ***compressed air and pneumatic system***, repair or replace faulty equipment or components and reassemble ***compressed air and pneumatic system***	equipment and components are removed, repaired or replaced and ***compressed air and pneumatic system*** is reassembled without damage to other components or surrounding area
E-20.04.07P	reinstate ***compressed air and pneumatic system*** to operating condition	***compressed air and pneumatic system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
E-20.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***compressed air and pneumatic equipment*** is free of contaminants and operating efficiently
E-20.04.09P	perform ***test*** on ***compressed air and pneumatic systems***	***test medium*** is introduced to ***compressed air and pneumatic systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-20.04.10P	remove ***test medium*** from ***compressed air and pneumatic systems***	***test medium*** is removed from ***compressed air and pneumatic systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
E-20.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
E-20.04.12P	treat system medium in ***compressed air and pneumatic systems***	system medium in ***compressed air and pneumatic systems*** is treated with chemicals according to manufacturers' recommendations and ***jurisdictional regulations***
E-20.04.13P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

compressed air and pneumatic systems include: compressed air, compressed gases

tools and equipment include: see Appendix B

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

compressed air and pneumatic equipment includes: compressors (piston, screw type, rotary, axial, reciprocating, vane), heat transfer equipment, receiver tanks, valves, dryers, separators, filters, lubricators, compressed gas cylinders, tanks, liquid drainers

tests include: hydrostatic, pneumatic

test medium includes: water, air, inert gases

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-20.04.01L	demonstrate knowledge of ***compressed air and pneumatic systems***, their characteristics, applications and operation	identify ***compressed air and pneumatic systems***, their characteristics, applications and operation
E-20.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***compressed air and pneumatic systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***compressed air and pneumatic systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***compressed air and pneumatic systems***
		explain effects of trapped air in piping for ***compressed air and pneumatic systems*** and describe procedures to prevent it
E-20.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***compressed air and pneumatic systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***compressed air and pneumatic systems***, and describe their applications and procedures for use

		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***compressed air and pneumatic systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***compressed air and pneumatic systems***
		describe procedures to repair ***compressed air and pneumatic systems***
		describe ***maintenance*** procedures for ***compressed air and pneumatic systems***
		identify documentation to complete following ***compressed air and pneumatic system*** repair or maintenance
E-20.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***compressed air and pneumatic systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***compressed air and pneumatic systems***

Range of Variables

compressed air and pneumatic systems include: compressed air, compressed gases

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task E-21 Installs and tests fire protection systems - Not Common Core

Task Descriptor

Fire protection systems include fire sprinkler systems (wet, dry, pre-action and deluge), gaseous agents and wet and dry chemical agents. These systems protect buildings from the spread of fire.

In some jurisdictions in Canada, work on fire protection systems can only be performed by a certified and trained sprinkler fitter or apprentice. While steamfitters/pipefitters may possess similar skills required to install piping for fire protection systems, their installation and testing requires the application of specific codes and regulations.

Steamfitters/Pipefitters may do work associated with the installation and testing of piping, associated components and equipment for these systems. Maintenance, troubleshooting and repairs are done by sprinkler fitters.

E-21.01 Installs equipment for fire protection systems - Not Common Core

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-21.01.01P	select ***fire protection equipment*** and ***controls***	***fire protection equipment*** and ***controls*** are selected according to application, type of system, ***drawings***, specifications and ***jurisdictional regulations***
E-21.01.02P	size ***fire protection equipment*** and ***controls***	***fire protection equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
E-21.01.03P	determine high points and low points for ***fire protection equipment*** and ***controls***	high points and low points for ***fire protection equipment*** and ***controls*** are identified according to ***drawings***
E-21.01.04P	determine location and placement of ***fire protection equipment*** and ***controls***	location and placement of ***fire protection equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
E-21.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

E-21.01.07P	determine ***installation method***	***installation method*** used to set ***fire protection equipment*** and ***controls*** in place is determined according to size, weight and location
E-21.01.08P	install ***fire protection equipment***	***fire protection equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

fire protection equipment includes: water supply systems, tanks, valves, drains, connections, backflow preventers, detection devices, nozzles

controls include: flow devices, level devices, temperature devices, pressure devices

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-21.01.01L	demonstrate knowledge of ***fire protection systems***, their characteristics, applications and operation	identify ***fire protection systems***, and describe their characteristics, applications and operation
		identify ***fire protection equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***fire protection systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***fire protection systems***, and describe their purpose and operation

		explain ***principles of heat transfer***
E-21.01.02L	demonstrate knowledge of procedures to install ***fire protection equipment***	identify ***tools and equipment*** used to install ***fire protection equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***fire protection equipment***
		describe procedures to install ***fire protection equipment***, ***controls***, ***supports*** and ***fasteners***
E-21.01.03L	demonstrate knowledge of regulatory requirements to install ***fire protection equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***fire protection equipment***

Range of Variables

fire protection systems include: standpipes, hose cabinets, wet systems, dry systems, pre-action systems, deluge systems

fire protection equipment includes: water supply systems, tanks, valves, drains, connections, backflow preventers, detection devices, nozzles

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

principles of heat transfer include: radiation, conduction, convection

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-21.02 Installs piping for fire protection systems- Not Common Core

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

Skills

	Performance Criteria	Evidence of Attainment
E-21.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
E-21.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***

E-21.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
E-21.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
E-21.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, copper, plastic, galvanized, copper-nickel, titanium, stainless steel, tube, tubing

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-21.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***fire protection systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***fire protection systems,*** and describe their characteristics, applications and operation
		identify piping configurations, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***fire protection systems***
		explain effects of trapped air in piping for ***fire protection systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***fire protection systems***
		identify systems that require grade or pitch of piping
E-21.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***fire protection systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***fire protection systems***, and describe their applications and procedures for use

		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***fire protection systems***
		describe procedures to install ***piping*** and ***piping components*** for ***fire protection systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***fire protection systems***
		describe procedures to bend ***piping*** for ***fire protection systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***fire protection systems***
		identify calculations for determining grade
E-21.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***fire protection systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***fire protection systems***

Range of Variables

piping includes: carbon steel, copper, plastic, galvanized, copper-nickel, titanium, stainless steel, tube, tubing

piping components include: valves, fittings, flexible connectors and hoses, strainers

fire protection systems include: standpipes, hose cabinets, wet systems, dry systems, pre-action systems, deluge systems

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

E-21.03 Tests fire protection systems- Not Common Core

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
E-21.03.01P	perform visual pre-check inspection of ***fire protection systems***	visual pre-check inspection of ***fire protection systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
E-21.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
E-21.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
E-21.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
E-21.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
E-21.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
E-21.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
E-21.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
E-21.03.09P	perform ***test*** on ***fire protection systems***	***test medium*** is introduced to ***fire protection systems*** and results of ***test*** are documented for purpose of obtaining sign-off
E-21.03.10P	remove ***test medium*** from ***fire protection systems***	***test medium*** is removed from ***fire protection systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***

E-21.03.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
E-21.03.12P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
E-21.03.13P	reinstate ***fire protection systems***	***isolation components*** and ***testing equipment and components*** are removed and fire protection system components are reinstalled according to ***drawings*** and specifications
E-21.03.14P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

fire protection systems include: standpipes, hose cabinets, wet systems, dry systems, pre-action systems, deluge systems

tests include: hydrostatic, pneumatic

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

test medium includes: water, glycol, water/glycol mix, compressed air, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

tools and equipment include: see Appendix B

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
E-21.03.01L	demonstrate knowledge of ***fire protection systems***, their characteristics, applications and operation	identify ***fire protection systems***, their characteristics, applications and operation
E-21.03.02L	demonstrate knowledge of testing of ***fire protection system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***fire protection system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications

		interpret information pertaining to ***fire protection system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***fire protection systems***
		explain effects of trapped air in piping for ***fire protection systems*** and describe procedures to prevent it
E-21.03.03L	demonstrate knowledge of procedures to test ***fire protection systems***	identify ***tools and equipment*** used to test ***fire protection systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***fire protection systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***fire protection systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***fire protection systems***
		describe procedures to reinstate ***fire protection systems***
		identify documentation to complete following ***fire protection system*** testing
		describe ***confirmation of zero energy state*** procedures
E-21.03.04L	demonstrate knowledge of regulatory requirements to test ***fire protection systems***	identify ***jurisdictional regulations*** pertaining to testing of ***fire protection systems***

Range of Variables

fire protection systems include: standpipes, hose cabinets, wet systems, dry systems, pre-action systems, deluge systems

tests include: hydrostatic, pneumatic

test medium includes: water, glycol, water/glycol mix, compressed air, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, isolation valves, recorders, testing trees/headers, regulators, relief devices

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Major Work Activity F

Installs, tests, maintains, troubleshoots and repairs renewable energy systems

Task F-22 Installs, tests, maintains, troubleshoots and repairs geo-exchange and geothermal systems

Task Descriptor

Geo-exchange and geothermal systems transfer heat from either ground source or deep earth by means of conduction, convection and radiation by use of closed or open loop systems.

Steamfitters/Pipefitters are responsible for the installation and maintenance of piping, associated components and equipment for these systems. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material as needed.

F-22.01 Installs equipment for geo-exchange and geothermal systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-22.01.01P	select ***geo-exchange and geothermal equipment*** and ***controls***	***geo-exchange and geothermal equipment*** and ***controls*** are selected according to application, type of system***,*** ***drawings***, specifications and ***jurisdictional regulations***
F-22.01.02P	size ***geo-exchange and geothermal equipment*** and ***controls***	***geo-exchange and geothermal equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
F-22.01.03P	determine high points and low points for ***geo-exchange and geothermal equipment*** and ***controls***	high points and low points for ***geo-exchange and geothermal equipment*** and ***controls*** are identified according to ***drawings***

F-22.01.04P	determine location and placement of ***geo-exchange and geothermal equipment*** and ***controls***	location and placement of ***geo-exchange and geothermal equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
F-22.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.01.07P	determine ***installation method***	***installation method*** used to set ***geo-exchange and geothermal equipment*** and ***controls*** in place is determined according to size, weight and location
F-22.01.08P	install ***geo-exchange and geothermal equipment***	***geo-exchange and geothermal equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

geo-exchange and geothermal equipment includes: expansion joints, pumps, heat exchangers, steam traps, tanks, valves, water treatment equipment

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-22.01.01L	demonstrate knowledge of ***geo-exchange and geothermal systems***, their characteristics, applications and operation	identify ***geo-exchange and geothermal systems***, and describe their characteristics, applications and operation
		identify ***geo-exchange and geothermal equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***geo-exchange and geothermal systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***geo-exchange and geothermal systems***, and describe their purpose and operation
		identify compression refrigeration components, and describe their cycle, characteristics and applications
		identify piping configurations for earth loops
		identify purpose and functionality of reversing valve within heat pump
		identify difference in operation of direct exchange (DX) system
		identify ***sources of heat*** used in ***geo-exchange and geothermal systems***
		identify ***sources of cooling*** used in ***geo-exchange and geothermal systems***
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
F-22.01.02L	demonstrate knowledge of procedures to install ***geo-exchange and geothermal equipment***	identify ***tools and equipment*** used to install ***geo-exchange and geothermal equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***geo-exchange and geothermal equipment***

		describe procedures to install ***geo-exchange and geothermal equipment***, ***controls***, ***supports*** and ***fasteners***
F-22.01.03L	demonstrate knowledge of regulatory requirements to install ***geo-exchange and geothermal equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***geo-exchange and geothermal equipment***

Range of Variables

geo-exchange and geothermal systems include: domestic hot water heating, hydronic heating and cooling, radiant heating, ground source heat pumps, water source heat pumps, open loop, closed loop, horizontal loop and vertical loop, DX systems

geo-exchange and geothermal equipment includes: expansion joints, pumps, heat exchangers, steam traps, tanks, valves, water treatment equipment

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sources of heat include: ground source, water source

sources of cooling include: ground source, water source

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: earth loops, heat exchangers

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-22.02 Installs piping for geo-exchange and geo-thermal systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-22.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
F-22.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
F-22.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***

F-22.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
F-22.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, plastic

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints, fusion

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-22.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***, and describe their characteristics, applications and operation
		identify ***piping configurations***, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***geo-exchange and geothermal systems***
		explain effects of trapped air in piping for ***geo-exchange and geothermal systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***geo-exchange and geothermal systems***
		identify systems that require grade or pitch of piping
F-22.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***
		describe procedures to install ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***
		describe procedures to bend ***piping*** for ***geo-exchange and geothermal systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***

		identify calculations for determining grade
F-22.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***geo-exchange and geothermal systems***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, plastic

piping components include: fittings, dielectric fittings, hangers, brackets, sleeves, anchors, guides, valves, strainers, expansion joints, expansion loops, circuit balancing, valves, pumps

geo-exchange and geothermal systems include: domestic hot water heating, hydronic heating and cooling, radiant heating, ground source heat pumps, water source heat pumps, open loop, closed loop, horizontal loop and vertical loop, DX systems

piping configurations include: domestic hot water heating, hydronic heating and cooling, radiant heating, open loop, closed loop

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-22.03 Tests geo-exchange and geothermal systems

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

Skills

	Performance Criteria	Evidence of Attainment
F-22.03.01P	perform visual pre-check inspection of ***geo-exchange and geothermal systems***	visual pre-check inspection of ***geo-exchange and geothermal systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
F-22.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-22.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
F-22.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***

F-22.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
F-22.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
F-22.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
F-22.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
F-22.03.09P	perform ***test*** on ***geo-exchange and geothermal systems***	***test medium*** is introduced to ***geo-exchange and geothermal systems*** and results of ***test*** are documented for purpose of obtaining sign-off
F-22.03.10P	remove ***test medium*** from ***geo-exchange and geothermal systems***	***test medium*** is removed from ***geo-exchange and geothermal systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
F-22.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures
F-22.03.12P	reinstate ***geo-exchange and geothermal systems***	***isolation components*** and ***testing equipment and components*** are removed and geo-exchange and geothermal system components are reinstalled according to ***drawings*** and specifications
F-22.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

geo-exchange and geothermal systems include: domestic hot water heating, hydronic heating and cooling, radiant heating, ground source heat pumps, water source heat pumps, open loop, closed loop, horizontal loop and vertical loop, DX systems

tests include: hydrostatic and pneumatic

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, air, inert gas

method includes: using pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperative

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-22.03.01L	demonstrate knowledge of ***geo-exchange and geothermal systems***, their characteristics, applications and operation	identify ***geo-exchange and geothermal systems***, their characteristics, applications and operation
F-22.03.02L	demonstrate knowledge of testing of ***geo-exchange and geothermal system***	identify types of ***tests***, and describe their characteristics and applications
		identify ***test medium*** used in testing of ***geo-exchange and geothermal system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***geo-exchange and geothermal system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***geo-exchange and geothermal systems***
		explain effects of trapped air in piping for ***geo-exchange and geothermal systems*** and describe procedures to prevent it
F-22.03.03L	demonstrate knowledge of procedures to test ***geo-exchange and geothermal systems***	identify ***tools and equipment*** used to test ***geo-exchange and geothermal systems***, and describe their applications and procedures for use

		identify hazards, and describe safe work practices pertaining to testing ***geo-exchange and geothermal systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***geo-exchange and geothermal systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***geo-exchange and geothermal systems***
		describe procedures to reinstate ***geo-exchange and geothermal systems***
		identify documentation to complete following ***geo-exchange and geothermal system*** testing
		describe ***confirmation of zero energy state*** procedures
F-22.03.04L	demonstrate knowledge of regulatory requirements to test ***geo-exchange and geothermal systems***	identify ***jurisdictional regulations*** pertaining to testing of ***geo-exchange and geothermal systems***

Range of Variables

geo-exchange and geothermal systems include: domestic hot water heating, hydronic heating and cooling, radiant heating, ground source heat pumps, water source heat pumps, open loop, closed loop, horizontal loop and vertical loop, DX systems

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, air, inert gas

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-22.04 Maintains, troubleshoots and repairs geo-exchange and geothermal systems

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

Skills

	Performance Criteria	Evidence of Attainment
F-22.04.01P	determine ***geo-exchange and geothermal system*** issues that require investigation	***geo-exchange and geothermal system*** issues requiring investigation are determined by consulting with system owner/operator
F-22.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
F-22.04.03P	troubleshoot ***geo-exchange and geothermal system***	of ***geo-exchange and geothermal system*** is ***tested and inspected*** to determine equipment or components in ***condition for repair or replacement***
F-22.04.04P	lock out and tag out ***geo-exchange and geothermal systems***	***geo-exchange and geothermal systems*** are locked and tagged out to prevent activation during repair or maintenance
F-22.04.05P	install ***isolation components*** and ensure ***geo-exchange and geothermal system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***geo-exchange and geothermal systems***
F-22.04.06P	disassemble ***geo-exchange and geothermal system***, repair or replace faulty equipment or components and reassemble ***geo-exchange and geothermal system***	equipment and components are removed, repaired or replaced and ***geo-exchange and geothermal system*** is reassembled without damage to other components or surrounding area
F-22.04.07P	reinstate ***geo-exchange and geothermal system*** to operating condition	***geo-exchange and geothermal system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
F-22.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***geo-exchange and geothermal equipment*** is free of contaminants and operating efficiently
F-22.04.09P	perform ***test*** on ***geo-exchange and geothermal systems***	***test medium*** is introduced to ***geo-exchange and geothermal systems*** and results of ***test*** are documented for purpose of obtaining sign-off

F-22.04.10P	remove ***test medium*** from ***geo-exchange and geothermal systems***	***test medium*** is removed from ***geo-exchange and geothermal systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
F-22.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
F-22.04.12P	treat system medium in ***geo-exchange and geothermal systems***	system medium in ***geo-exchange and geothermal systems*** is treated with chemicals according to manufacturers' recommendations, owner/operator, system parameters and results of system medium quality test
F-22.04.13P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

geo-exchange and geothermal systems include: domestic hot water heating, hydronic heating and cooling, radiant heating, ground source heat pumps, water source heat pumps, open loop, closed loop, horizontal loop and vertical loop, DX systems

tools and equipment include: see Appendix B

test and inspect includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

geo-exchange and geothermal equipment includes: expansion joints, pumps, heat exchangers, steam traps, tanks, valves, water treatment equipment

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, air, inert gas

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-22.04.01L	demonstrate knowledge of ***geo-exchange and geothermal systems***, their characteristics, applications and operation	identify ***geo-exchange and geothermal systems***, their characteristics, applications and operation
F-22.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***geo-exchange and geothermal systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***geo-exchange and geothermal systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***geo-exchange and geothermal systems***
		explain effects of trapped air in piping for ***geo-exchange and geothermal systems*** and describe procedures to prevent it
F-22.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***geo-exchange and geothermal systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***geo-exchange and geothermal systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***geo-exchange and geothermal systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***geo-exchange and geothermal systems***
		describe procedures to repair ***geo-exchange and geothermal systems***
		describe ***maintenance*** procedures for ***geo-exchange and geothermal systems***
		identify documentation to complete following ***geo-exchange and geothermal system*** repair or maintenance
F-22.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***geo-exchange and geothermal systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***geo-exchange and geothermal systems***

Range of Variables

geo-exchange and geothermal systems include: domestic hot water heating, hydronic heating and cooling, radiant heating, ground source heat pumps, water source heat pumps, open loop, closed loop, horizontal loop and vertical loop, DX systems

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task F-23 Installs, tests, maintains, troubleshoots and repairs solar heating systems

Task Descriptor

Solar heating systems harness energy from the sun and deliver it through means such as conduction, convection and radiation to its intended destination. They encompass environmentally sound practices and technologies to generate energy. These systems create heating, cooling and electricity. Steamfitters/Pipefitters install these systems in residential and ICI settings.

Steamfitters/Pipefitters are responsible for the installation and maintenance of piping, associated components and equipment for these systems. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material as needed.

F-23.01 Installs equipment for solar heating systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-23.01.01P	select ***solar heating equipment*** and ***controls***	***solar heating equipment*** and ***controls*** are selected according to application, type of system, ***drawings***, specifications and ***jurisdictional regulations***
F-23.01.02P	size ***solar heating equipment*** and ***controls***	***solar heating equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
F-23.01.03P	determine high points and low points for ***solar heating equipment*** and ***controls***	high points and low points for ***solar heating equipment*** and ***controls*** are identified according to ***drawings***

F-23.01.04P	determine location and placement of ***solar heating equipment*** and ***controls***	location and placement of ***solar heating equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
F-23.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.01.07P	determine ***installation method***	***installation method*** used to set ***solar heating equipment*** and ***controls*** in place is determined according to size, weight and location
F-23.01.08P	install ***solar heating equipment***	***solar heating equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

solar heating equipment includes: solar collectors, indirect water heaters, heat dissipaters, controls, expansion joints, pumps, heat exchangers, tanks, valves

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-23.01.01L	demonstrate knowledge of ***solar heating systems***, their characteristics, applications and operation	identify ***solar heating systems***, and describe their characteristics, applications and operation
		identify ***solar heating equipment***, and describe their characteristics, applications and operation

		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***solar heating systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***solar heating systems***, and describe their purpose and operation
		identify equipment used for heat dissipation
		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
F-23.01.02L	demonstrate knowledge of procedures to install ***solar heating equipment***	identify ***tools and equipment*** used to install ***solar heating equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***solar heating equipment***
		describe procedures to install ***solar heating equipment***, ***controls***, ***supports*** and ***fasteners***
F-23.01.03L	demonstrate knowledge of regulatory requirements to install ***solar heating equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***solar heating equipment***

Range of Variables

solar heating systems include: domestic water heating, space heating, direct and indirect systems, closed loop systems

solar heating equipment includes: solar collectors, indirect water heaters, heat dissipaters, controls, expansion joints, pumps, heat exchangers, tanks, valves

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws***,*** epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: solar collectors, indirect water heaters, heat dissipaters, heat exchangers, tanks

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-23.02 Installs piping for solar heating systems

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

Skills

	Performance Criteria	Evidence of Attainment
F-23.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
F-23.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
F-23.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
F-23.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
F-23.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

F-23.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, plastic

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints, fusion

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-23.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***solar heating systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***solar heating systems,*** and describe their characteristics, applications and operation
		identify ***piping configurations***, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***solar heating systems***
		explain effects of trapped air in piping for ***solar heating systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***solar heating systems***

		identify systems that require grade or pitch of piping
F-23.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***solar heating systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***solar heating systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***solar heating systems***
		describe procedures to install ***piping*** and ***piping components*** for ***solar heating systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***solar heating systems***
		describe procedures to bend ***piping*** for ***solar heating systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***solar heating systems***
		identify calculations for determining grade
F-23.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***solar heating systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***solar heating systems***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, plastic

piping components include: fittings, dielectric fittings, hangers, brackets, sleeves, anchors, guides, valves, strainers, expansion joints, expansion loops

solar heating systems include: domestic water heating, space heating, direct and indirect systems, closed loop systems

piping configurations include: open system, closed system

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction, weight, loading

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-23.03 Tests solar heating systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-23.03.01P	perform visual pre-check inspection of ***solar heating systems***	visual pre-check inspection of ***solar heating systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
F-23.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-23.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
F-23.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
F-23.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
F-23.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
F-23.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
F-23.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
F-23.03.09P	perform ***test*** on ***solar heating systems***	***test medium*** is introduced to ***solar heating systems*** and results of ***test*** are documented for purpose of obtaining sign-off
F-23.03.10P	remove ***test medium*** from ***solar heating systems***	***test medium*** is removed from ***solar heating systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
F-23.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures

F-23.03.12P	reinstate ***solar heating systems***	***isolation components*** and ***testing equipment and components*** are removed and solar heating system components are reinstalled according to ***drawings*** and specifications
F-23.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

solar heating systems include: domestic water heating, space heating, direct and indirect systems, closed loop systems

tests include: hydrostatic, pneumatic

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, water/glycol mix, air, inert gas

method includes: using pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-23.03.01L	demonstrate knowledge of ***solar heating systems***, their characteristics, applications and operation	identify ***solar heating systems***, their characteristics, applications and operation
F-23.03.02L	demonstrate knowledge of testing of ***solar heating system***	identify types of ***tests,*** and describe their characteristics and applications
		identify ***test medium*** used in testing of ***solar heating system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***solar heating system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***solar heating systems***

		explain effects of trapped air in piping for ***solar heating systems*** and describe procedures to prevent it
F-23.03.03L	demonstrate knowledge of procedures to test ***solar heating systems***	identify ***tools and equipment*** used to test ***solar heating systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***solar heating systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***solar heating systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***solar heating systems***
		describe procedures to reinstate ***solar heating systems***
		identify documentation to complete following ***solar heating system*** testing
		describe ***confirmation of zero energy state*** procedures
F-23.03.04L	demonstrate knowledge of regulatory requirements to test ***solar heating systems***	identify ***jurisdictional regulations*** pertaining to testing of ***solar heating systems***

Range of Variables

solar heating systems include: domestic water heating, space heating, direct and indirect systems, closed loop systems

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, air, inert gas

method includes: using pumps, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-23.04 Maintains, troubleshoots and repairs solar heating systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-23.04.01P	determine ***solar heating system*** issues that require investigation	***solar heating system*** issues requiring investigation are determined by consulting with system owner/operator
F-23.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
F-23.04.03P	troubleshoot ***solar heating system***	***solar heating system*** is ***tested and inspected*** to determine equipment or components in ***condition for repair or replacement***
F-23.04.04P	lock out and tag out ***solar heating systems***	***solar heating systems*** are locked and tagged out to prevent activation during repair or ***maintenance***
F-23.04.05P	install ***isolation components*** and ensure ***solar heating system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***solar heating systems***
F-23.04.06P	disassemble ***solar heating system***, repair or replace faulty equipment or components and reassemble ***solar heating system***	equipment and components are removed, repaired or replaced and ***solar heating system*** is reassembled without damage to other components or surrounding area
F-23.04.07P	reinstate ***solar heating system*** to operating condition	***solar heating system*** is filled and pressurized, bled of air or contaminants, checked for leaks, locks and tags removed and system is returned to normal operating condition after ***maintenance*** or repair is completed
F-23.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***solar heating equipment*** is free of contaminants and operating efficiently
F-23.04.09P	perform ***test*** on ***solar heating systems***	***test medium*** is introduced to ***solar heating systems*** and results of ***test*** are documented for purpose of obtaining sign-off
F-23.04.10P	remove ***test medium*** from ***solar heating systems***	***test medium*** is removed from ***solar heating systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***

F-23.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
F-23.04.12P	treat system medium in ***solar heating systems***	system medium in ***solar heating systems*** is treated with chemicals according to manufacturers' recommendations, owner/operator, system parameters and results of system medium quality test
F-23.04.13P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

solar heating systems include: domestic water heating, space heating, direct and indirect systems, closed loop systems

tools and equipment include: see Appendix B

test and inspect includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

solar heating equipment includes: solar collectors, indirect water heaters, heat dissipaters, controls, expansion joints, pumps, heat exchangers, tanks, valves

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, air, inert gas

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-23.04.01L	demonstrate knowledge of ***solar heating systems***, their characteristics, applications and operation	identify ***solar heating systems***, their characteristics, applications and operation
	demonstrate knowledge of troubleshooting, repairing and maintaining ***solar heating systems***	identify types of ***isolation components***, and describe their characteristics and applications

		interpret information pertaining to troubleshooting, repairing and maintaining ***solar heating systems*** found on ***drawings***, specifications and manufacturers' documentation
		explain effects of pressure on elevation when troubleshooting ***solar heating systems***
		explain effects of trapped air in piping for ***solar heating systems*** and describe procedures to prevent it
F-23.04.02L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***solar heating systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***solar heating systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***solar heating systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***solar heating systems***
		describe procedures to repair ***solar heating systems***
		describe ***maintenance*** procedures for ***solar heating systems***
		identify documentation to complete following ***solar heating system*** repair or maintenance
F-23.04.03L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***solar heating systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***solar heating systems***

Range of Variables

solar heating systems include: domestic water heating, space heating, direct and indirect systems, closed loop systems

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Task F-24 Installs, tests, maintains, troubleshoots and repairs heat recovery systems

Task Descriptor

Heat recovery systems transfer heat from various sources of heat such as refrigerant gas, exhaust steam, flash steam, waste water, cooling water, heat recovery ventilators (HRV) and gland seals. Steamfitter/Pipefitters install, test, maintain, troubleshoot and repair heat recovery systems.

Steamfitters/Pipefitters are responsible for the installation and maintenance of piping, associated components and equipment for these systems. Maintenance is done on a regular schedule or on an emergency basis to ensure the integrity of the piping system. Steamfitters/Pipefitters are also responsible for diagnosing, locating and repairing or replacing equipment and material as needed.

F-24.01 Installs equipment for heat recovery systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-24.01.01P	select ***heat recovery equipment*** and ***controls***	***heat recovery equipment*** and ***controls*** are selected according to application, type of system***, drawings***, specifications and ***jurisdictional regulations***
F-24.01.02P	size ***heat recovery equipment*** and ***controls***	***heat recovery equipment*** and ***controls*** are sized according to ***sizing methods***, ***drawings***, specifications and ***jurisdictional regulations***
F-24.01.03P	determine high points and low points for ***heat recovery equipment*** and ***controls***	high points and low points for ***heat recovery equipment*** and ***controls*** are identified according to ***drawings***
F-24.01.04P	determine location and placement of ***heat recovery equipment*** and ***controls***	location and placement of ***heat recovery equipment*** and ***controls*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.01.05P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of piping
F-24.01.06P	install ***supports*** and ***fasteners***	***supports*** and ***fasteners*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.01.07P	determine ***installation method***	***installation method*** used to set ***heat recovery equipment*** and ***controls*** in place is determined according to size, weight and location

F-24.01.08P	install ***heat recovery equipment***	***heat recovery equipment*** is installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.01.09P	install ***controls***	***controls*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.01.10P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

heat recovery equipment includes: expansion joints, pumps, heat exchangers, tanks, valves

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

sizing methods include: performing calculations based on load and demand, determining measurements, consulting manufacturer/supplier documentation

tools and equipment include: see Appendix B

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, inserts, beam clamps, nuts, bolts, screws, epoxy

installation method includes: manual, mechanical (cranes, chain falls, tuggers, rollers, come-alongs, cable grip hoists, hydraulic jacks)

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-24.01.01L	demonstrate knowledge of ***heat recovery systems***, their characteristics, applications and operation	identify ***heat recovery systems***, and describe their characteristics, applications and operation
		identify ***heat recovery equipment***, and describe their characteristics, applications and operation
		identify ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify ***controls***, and describe their purpose and operation
		interpret information pertaining to ***heat recovery systems*** found on ***drawings*** and specifications
		identify types of piping components and accessories for ***heat recovery systems***, and describe their purpose and operation
		identify ***sources of heat*** used in ***heat recovery systems***
		identify ***sources of cooling*** used in ***heat recovery systems***

		explain ***principles of heat transfer***
		identify types of ***heat transfer equipment***, and describe their characteristics, applications and operation
F-24.01.02L	demonstrate knowledge of procedures to install ***heat recovery equipment***	identify ***tools and equipment*** used to install ***heat recovery equipment***, ***controls***, ***supports*** and ***fasteners***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to installing ***heat recovery equipment***
		describe procedures to install ***heat recovery equipment***, ***controls***, ***supports*** and ***fasteners***
F-24.01.03L	demonstrate knowledge of regulatory requirements to install ***heat recovery equipment***	identify ***jurisdictional regulations*** pertaining to installation of ***heat recovery equipment***

Range of Variables

heat recovery systems include: domestic water heating, process water heating, heating and cooling

heat recovery equipment includes: expansion joints, pumps, heat exchangers, tanks, valves

supports include: brackets, stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds, seismic restraints, anchors, guides

fasteners include: anchors, expansion type inserts, beam clamps, nuts, bolts, screws, epoxy

controls include: flow devices, level devices, temperature devices, pressure devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

sources of heat include: refrigerant gases, steam, waste water, cooling water, heat recovery ventilators (HRV), gland seals

sources of cooling include: ground source, cooling towers, chillers, refrigeration, heat exchangers

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, unit heaters, radiant panels, heat exchangers

tools and equipment include: see Appendix B

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-24.02 Installs piping for heat recovery systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-24.02.01P	determine route and location of ***piping*** system	route and location of ***piping*** system are determined according to ***drawings***, or modified to avoid ***obstructions*** and ***conflicts***
F-24.02.02P	determine high points and low points of ***piping*** system	high points and low points of ***piping*** system are identified according to ***drawings***
F-24.02.03P	select and size ***piping***	***piping*** is selected and sized according to manufacturers' recommendations, ***drawings***, specifications and ***jurisdictional regulations***
F-24.02.04P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job, type of system and size of ***piping***
F-24.02.05P	clean and prepare fittings and joints	fittings and joints are cleaned and prepared according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.02.06P	determine ***joining method***	***joining methods*** are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.02.07P	bend ***piping***	***piping*** is bent according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.02.08P	determine grade or pitch of ***piping***	grade or pitch of ***piping*** is determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.02.09P	install ***piping supports***	***piping supports*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.02.10P	install ***piping restraints***	***piping restraints*** are installed according to ***drawings***, specifications and ***jurisdictional regulations***

F-24.02.11P	assemble and install ***piping***	***piping*** is assembled and installed using ***joining methods*** to allow for insulation of ***piping***, including sleeving and proper spacing, and making ***allowances for contraction and expansion*** according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.02.12P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, plastic

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

obstructions include: structural components (beams, walls), other mechanical and electrical systems

conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

joining methods include: flanging, bonding, grooving, threading, welding, soldering, brazing, mechanical joints, fusion

piping supports include: rollers, hangers, clamps, brackets, stands

piping restraints include: wires, clamps, pipe, brackets, anchors, guides

allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-24.02.01L	demonstrate knowledge of ***piping*** and ***piping components*** for ***heat recovery systems***, their characteristics, applications and operation	identify types of ***piping*** and ***piping components*** for ***heat recovery systems,*** and describe their characteristics, applications and operation
		identify piping configurations, and describe their characteristics, applications and operation
		interpret information pertaining to ***piping*** found on ***drawings*** and specifications
		explain effects of electrolysis when connecting dissimilar metals on ***piping*** and ***piping components***
		explain effects of expansion and contraction on ***piping*** for ***heat recovery systems***
		explain effects of trapped air in piping for ***heat recovery systems*** and describe procedures to prevent it
		identify ***considerations*** for selecting ***piping components*** for ***heat recovery systems***

		identify systems that require grade or pitch of piping
F-24.02.02L	demonstrate knowledge of procedures to assemble and install ***piping*** and ***piping components*** for ***heat recovery systems***	identify ***tools and equipment*** used to assemble and install ***piping*** and ***piping components*** for ***heat recovery systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to assembling and installing ***piping*** and ***piping components*** for ***heat recovery systems***
		describe procedures to install ***piping*** and ***piping components*** for ***heat recovery systems***
		describe procedures to protect ***piping*** and ***piping components*** for ***heat recovery systems***
		describe procedures to bend ***piping*** for ***heat recovery systems***
		identify documentation to be completed following assembly and installation of ***piping*** and ***piping components*** for ***heat recovery systems***
		identify calculations for determining grade
F-24.02.03L	demonstrate knowledge of regulatory requirements for installation of ***piping*** and ***piping components*** for ***heat recovery systems***	identify ***jurisdictional regulations*** pertaining to installation of ***piping*** and ***piping components*** for ***heat recovery systems***

Range of Variables

piping includes: carbon steel, alloy steel, copper, stainless steel, HDPE, plastic

piping components include: fittings, dielectric fittings, hangers, brackets, sleeves, anchors, guides, valves, strainers, expansion joints, expansion loops

heat recovery systems include: domestic water heating, process water heating, heating and cooling

drawings include: engineered, mechanical, electrical, architectural, manufacturer, structural

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

tools and equipment include: see Appendix B

protect includes: protection from mechanical damage, seismic activity, environmental conditions

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-24.03 Tests heat recovery systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-24.03.01P	perform visual pre-check inspection of ***heat recovery systems***	visual pre-check inspection of ***heat recovery systems*** is performed to check for possible obstructions and deficiencies, and punch list is completed to confirm components are installed
F-24.03.02P	determine ***test, testing equipment and components***, and test parameters	***tests, testing equipment and components***, and test parameters are determined according to ***drawings***, specifications and ***jurisdictional regulations***
F-24.03.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
F-24.03.04P	determine ***test medium*** and ***method*** of filling, draining or purging system	***test medium*** is determined according to ***test*** selected, and ***method*** of filling, draining or purging is determined according to ***test medium***
F-24.03.05P	assemble ***testing equipment and components***	***testing equipment and components*** are assembled and allow ***test*** to be completed
F-24.03.06P	lock out and tag out piping systems and their components	piping systems and their components are locked and tagged out to prevent activation during testing
F-24.03.07P	install ***isolation components***	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed according to LOTO procedures
F-24.03.08P	connect ***testing equipment and components***	***testing equipment and components*** are connected according to test procedures
F-24.03.09P	perform ***test*** on ***heat recovery systems***	***test medium*** is introduced to ***heat recovery systems*** and results of ***test*** are documented for purpose of obtaining sign-off
F-24.03.10P	remove ***test medium*** from ***heat recovery systems***	***test medium*** is removed from ***heat recovery systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***
F-24.03.11P	remove lock-out and tag-out from piping systems and their components	locks and tags are removed from piping systems and their components according to LOTO procedures

F-24.03.12P	reinstate ***heat recovery systems***	***isolation components*** and ***testing equipment and components*** are removed and heat recovery system components are reinstalled according to ***drawings*** and specifications
F-24.03.13P	complete documentation	documentation is completed according to ***drawings***, QA/QC specifications and ***jurisdictional regulations***, and final copies are distributed

Range of Variables

heat recovery systems include: domestic water heating, process water heating, heating and cooling

tests include: hydrostatic, pneumatic

testing equipment and components include: blinds, calibrated pressure gauges, pumps, valves, recorders, testing trees, testing headers, relief devices

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

tools and equipment include: see Appendix B

test medium includes: water, air, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-24.03.01L	demonstrate knowledge of ***heat recovery systems***, their characteristics, applications and operation	identify ***heat recovery systems***, their characteristics, applications and operation
F-24.03.02L	demonstrate knowledge of testing of ***heat recovery system***	identify types of ***tests***, and describe their characteristics and applications
		identify ***test medium*** used in testing of ***heat recovery system*** and, describe their characteristics and applications
		identify ***method*** of filling, draining or purging ***test medium***
		identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to ***heat recovery system*** testing found on ***drawings*** and specifications
		explain effect of elevation and temperature on pressure when testing ***heat recovery systems***
		explain effects of trapped air in piping for ***heat recovery systems*** and describe procedures to prevent it

F-24.03.03L	demonstrate knowledge of procedures to test ***heat recovery systems***	identify ***tools and equipment*** used to test ***heat recovery systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to testing ***heat recovery systems***
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		describe procedures to test ***heat recovery systems*** and ***equipment***
		describe procedures to remove ***test medium*** from ***heat recovery systems***
		describe procedures to reinstate ***heat recovery systems***
		identify documentation to complete following ***heat recovery system*** testing
		describe ***confirmation of zero energy state*** procedures
F-24.03.04L	demonstrate knowledge of regulatory requirements to test ***heat recovery systems***	identify ***jurisdictional regulations*** pertaining to testing of ***heat recovery systems***

Range of Variables

heat recovery systems include: domestic water heating, process water heating, heating and cooling

tests include: hydrostatic, pneumatic

test medium includes: water, air, inert gases

method includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

testing equipment and components include: blinds, calibrated pressure gauges***,*** pumps, valves, recorders, testing trees, testing headers, relief devices

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

F-24.04 Maintains, troubleshoots and repairs heat recovery systems

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
F-24.04.01P	determine ***heat recovery system*** issues that require investigation	***heat recovery system*** issues requiring investigation are determined by consulting with system owner/operator
F-24.04.02P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and type of system
F-24.04.03P	troubleshoot ***heat recovery system***	***heat recovery system*** is ***tested and inspected*** to determine equipment or components in ***condition for repair or replacement***
F-24.04.04P	lock out and tag out ***heat recovery systems***	***heat recovery systems*** are locked and tagged out to prevent activation during repair or maintenance
F-24.04.05P	install ***isolation components*** and ensure ***heat recovery system*** is in zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed before repair or ***maintenance*** of ***heat recovery systems***
F-24.04.06P	disassemble ***heat recovery system***, repair or replace faulty equipment or components and reassemble ***heat recovery system***	equipment and components are removed, repaired or replaced and ***heat recovery system*** is reassembled without damage to other components or surrounding area
F-24.04.07P	reinstate ***heat recovery system*** to operating condition	***heat recovery system*** is filled and pressurized, bled of air or contaminants, and checked for leaks, locks and tags are removed, and system is returned to normal operating condition after ***maintenance*** or repair is completed
F-24.04.08P	follow predetermined maintenance schedule	***maintenance*** is performed according to predetermined maintenance schedule, and ***heat recovery equipment*** is free of contaminants and operating efficiently
F-24.04.09P	perform ***test*** on ***heat recovery systems***	***test medium*** is introduced to ***heat recovery systems*** and results of ***test*** are documented for purpose of obtaining sign-off
F-24.04.10P	remove ***test medium*** from ***heat recovery systems***	***test medium*** is removed from ***heat recovery systems*** and either recycled or disposed of according to specifications and ***jurisdictional regulations***

F-24.04.11P	perform system medium quality test	system medium quality test is performed using a test kit and testing equipment according to manufacturers' recommendations, QA/QC requirements and ***jurisdictional regulations***
F-24.04.12P	treat system medium in ***heat recovery systems***	system medium in ***heat recovery systems*** is treated with chemicals according to manufacturers' recommendations, owner/operator, system parameters and results of system medium quality test
F-24.04.13P	complete ***documentation***	***documentation*** is completed according to manufacturers' recommendations, owner/operator, ***drawings***, QA/QC specifications and ***jurisdictional regulations***

Range of Variables

heat recovery systems include: domestic water heating, process water heating, heating and cooling

tools and equipment include: see Appendix B

test and inspect includes: sensory inspection, diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

confirmation of zero energy state include: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, and equipment is inoperable

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

heat recovery equipment includes: expansion joints, pumps, heat exchangers, tanks, valves

tests include: hydrostatic, pneumatic

test medium includes: water, air, inert gases

documentation includes: lock-out and tag-out, maintenance log, quality control reports

drawings include: engineered, mechanical, electrical, architectural, manufacturer

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

	Knowledge	
	Learning Outcomes	**Learning Objectives**
F-24.04.01L	demonstrate knowledge of ***heat recovery systems***, their characteristics, applications and operation	identify ***heat recovery systems***, their characteristics, applications and operation
F-24.04.02L	demonstrate knowledge of troubleshooting, repairing and maintaining ***heat recovery systems***	identify types of ***isolation components***, and describe their characteristics and applications
		interpret information pertaining to troubleshooting, repairing and maintaining ***heat recovery systems*** found on ***drawings***, specifications and manufacturers' documentation

		explain effects of pressure on elevation when troubleshooting ***heat recovery systems***
		explain effects of trapped air in piping for ***heat recovery systems*** and describe procedures to prevent it
F-24.04.03L	demonstrate knowledge of procedures to troubleshoot, repair and maintain ***heat recovery systems***	identify ***tools and equipment*** used to troubleshoot, repair and maintain ***heat recovery systems***, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to troubleshooting, repairing and maintaining ***heat recovery systems***
		identify types of measuring and testing equipment and components, and describe their characteristics and applications
		describe procedures to troubleshoot ***heat recovery systems***
		describe procedures to repair ***heat recovery systems***
		describe ***maintenance*** procedures for ***heat recovery systems***
		identify documentation to complete following ***heat recovery system*** repair or maintenance
F-24.04.04L	demonstrate knowledge of regulatory requirements to troubleshoot, repair and maintain ***heat recovery systems***	identify ***jurisdictional regulations*** pertaining to troubleshooting, repairing and maintaining of ***heat recovery systems***

Range of Variables

heat recovery systems include: domestic water heating, process water heating, heating and cooling

isolation components include: blinds, spades, plugs and caps, temporary spool pieces

drawings include: engineered, mechanical, electrical, architectural, manufacturer

tools and equipment include: see Appendix B

maintenance include: adding chemical and various additives, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

Major Work Activity G

Performs commissioning, start-up and turnover

Task G-25 Prepares system for commissioning, start-up and turnover

Task Descriptor

Steamfitters/Pipefitters must carefully pre-check and isolate the systems as necessary when performing commissioning and start-up procedures. This is done for protection of the system, the surrounding areas and safety of personnel. They must also select proper commissioning equipment, reference system specifications and procedures, and include any accessories required.

G-25.01 Flushes system

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-25.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job
G-25.01.02P	set up pigging devices, launchers and receivers	pigging devices, launchers and receivers are set up for cleaning of pipe
G-25.01.03P	select ***medium***	***medium*** to flush piping system and equipment is selected according to piping system
G-25.01.04P	install temporary pipe	temporary pipe for delivering flushing ***medium*** is securely fastened to system
G-25.01.05P	follow flushing procedures	flushing procedures are carried out according to engineers' specifications
G-25.01.06P	drain ***medium*** from system	***medium*** is drained from system, and low point drains and high point vents are opened

G-25.01.07P	recover and dispose of ***medium***	***medium*** is disposed of according to jurisdictional environmental regulations and guidelines
G-25.01.08P	complete documentation	documentation is completed according to job specifications and witnessed by client or consultant engineer

Range of Variables

tools and equipment include: see Appendix B

medium includes: water, water/glycol mix, methanol, acid flush, compressed gas, steam, oil

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-25.01.01L	demonstrate knowledge of system flushing procedures	identify types of flushing ***medium*** and describe their applications
		identify ***sources of information*** pertaining to system flushing
		identify ***tools and equipment*** used to flush systems, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to system flushing
		describe ***procedures to perform system flushing***
G-25.01.02L	demonstrate knowledge of regulatory requirements to flush systems	identify ***jurisdictional regulations*** for chemical treatment and disposal of ***medium***

Range of Variables

medium includes: water, water/glycol mix, methanol, acid flush, compressed gas, steam, oil

sources of information include: manufacturers' and engineers' specifications, WHMIS information

tools and equipment include: see Appendix B

procedures to perform system flushing include: checking vents and drains, attaching hoses, filling system

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

G-25.02 Chemically treats system

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-25.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job
G-25.02.02P	identify which systems require chemical treatment	system to be treated is identified according to owner's request and project engineers' specifications
G-25.02.03P	follow ***chemical treatment requirements*** and ***procedures***	***chemical treatment requirements*** and ***procedures*** are followed according to chemical engineer guidelines
G-25.02.04P	obtain a sample of medium that will be chemically treated	sample of medium that will be chemically treated is bottled and labelled for testing
G-25.02.05P	install and disconnect temporary pipe	temporary pipe to introduce chemical into piping system is securely fastened to system, and disconnected
G-25.02.06P	introduce chemicals to system and circulate	chemicals are introduced to system and circulated according to levels of chemicals signed off by engineer
G-25.02.07P	drain medium from system	medium is drained from system, and low point drains and high point vents are opened
G-25.02.08P	recover and dispose of chemical treatment waste fluid	chemical treatment waste fluid is disposed of according to jurisdictional environmental regulations and guidelines
G-25.02.09P	complete documentation	documentation is completed according to site-specific requirements, jurisdictional environmental regulations and guidelines, and witnessed by client or consultant engineer

Range of Variables

tools and equipment include: see Appendix B
chemical treatment requirements include: cycling, length of time, pressure
chemical treatment procedures include: checking vents and drains, attaching hoses, filling system

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-25.02.01L	demonstrate knowledge of chemical treatment procedures	identify ***sources of information*** pertaining to chemical treatment
		identify ***tools and equipment*** to chemically treat systems, and describe their applications and procedures for use
		identify hazards, and describe safe work practices pertaining to chemical treatment
		describe ***chemical treatments requirements***
		describe ***chemical treatment procedures***
G-25.02.02L	demonstrate knowledge of regulatory requirements to chemically treat systems	identify ***jurisdictional regulations*** for disposal of chemical treatment

Range of Variables

sources of information include: manufacturers' and engineers' specifications, engineer, WHMIS information

tools and equipment include: see Appendix B

chemical treatment requirements include: cycling, length of time, pressure

chemical treatment procedures include: checking vents and drains, attaching hoses, filling system

jurisdictional regulations include: by-laws, standards, codes, ANSI, CSA, OH&S, ASME

G-25.03 Pre-checks system for commissioning

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-25.03.01P	***identify system*** to be commissioned according to engineered drawings	system to be commissioned is identified according to engineered drawings
G-25.03.02P	select and use ***tools and equipment*** for commissioning	***tools and equipment*** are selected and used according to commissioning task and situation
G-25.03.03P	perform visual inspection of system to be commissioned	visual inspection of system to be commissioned is performed to identify ***deficiencies*** that do not conform to P&ID, standard piping practices and engineering specifications

G-25.03.04P	complete pre-check list (punch list)	pre-check list (punch list) is completed for ***conditions*** and components are confirmed to be installed in system
G-25.03.05P	verify ***operating parameters***	***operating parameters*** are verified according to manufacturers' specifications for operation and design of system
G-25.03.06P	determine ***method*** for filling system	***method*** for filling system is determined according to size and type of system

Range of Variables

identify system includes: ensuring documentation indicates system to be commissioned matches engineered drawings and traces piping back to equipment

tools and equipment include: differential pressure gauges, probes, inline flowmeters, inline filters, temperature indicators

deficiencies include: obstructions, leaks, removal of test equipment, improperly installed equipment

conditions include: rotation of pumps and fans, support and anchor installation, flow direction of valves, installation and position of vents and drains

operating parameters include: temperature, direction of flow, power, operating pressures, controls, safeties

methods include: using hand pumps, centrifugal pumps, air compressor, gravity feed, energizing

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-25.03.01L	demonstrate knowledge of system commissioning procedures	identify ***sources of information*** pertaining to system commissioning
		identify ***tools and equipment*** relating to system commissioning, and describe their applications and procedures for use
		identify hazards, and describe ***safe work practices*** pertaining to system commissioning
		identify methods for charging systems to operating design pressure
		describe ***procedures to perform pre-checks***
		describe ***procedures to commission systems***

Range of Variables

sources of information include: manufacturers' and engineers' specifications, drawings

tools and equipment include: differential pressure gauges, probes, inline flowmeters, inline filters, temperature indicators

safe work practices include: system isolation, LOTO procedures, use of testing medium

procedures to perform pre-checks include: system isolation, check of equipment, piping for location and orientation, selection and connection of test equipment, system pressurization, system inspection and correction of leaks, documentation, removal of test equipment

procedures to commission systems include: flushing, chemical treating, start-up and documentation, reinstatement after testing

G-25.04 Selects and connects commissioning equipment

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-25.04.01P	identify design ***operating conditions***	***operating conditions*** are identified according to reference drawings, system specifications and equipment specifications
G-25.04.02P	select and use ***commissioning equipment***	***commissioning equipment*** is selected and used according to job and conditions
G-25.04.03P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and conditions
G-25.04.04P	perform basic check of ***commissioning equipment***	basic check of ***commissioning equipment*** is performed, and equipment is operational and calibrated
G-25.04.05P	reinstate ***system components***	punch list indicates ***system components*** that were removed for system testing are reinstated

Range of Variables

operating conditions include: temperature, pressure, flow rate

commissioning equipment includes: flow control meters, gauges, thermometers

tools and equipment include: pipe wrenches, combination wrenches, adjustable wrenches

system components include: pressure relief valves, gauges, control valves, thermometers, check valves, filters, probes, strainers, chemical pot feeders

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-25.04.01L	demonstrate knowledge of system commissioning procedures	identify ***sources of information*** pertaining to system commissioning
		identify ***commissioning equipment*** and ***tools and equipment*** relating to system commissioning, and describe their applications and procedures for use
		identify hazards, and describe safe work ***practices*** pertaining to system commissioning
		identify methods for charging systems to operating design pressure
		describe procedures to select and connect ***commissioning equipment***
		describe ***procedures to commission systems***

Range of Variables

sources of information include: manufacturers' and engineers' specifications, drawings
commissioning equipment includes: flow control meters, gauges, thermometers
tools and equipment include: pipe wrenches, combination wrenches, adjustable wrenches
safe work practices include: system isolation, LOTO procedures, use of testing medium
procedures to commission systems include: flushing, chemical treating, start-up and documentation, reinstatement after testing

Task G-26 Commissions systems

Task Descriptor

Commissioning systems involves bringing the piping systems online. This can be done in collaboration with owners' representatives or authority having jurisdiction (AHJ).

Steamfitters/pipefitters must commission a system to normal operational conditions to satisfy necessary codes, regulations, quality control standards, and contractual obligations. This encompasses making repairs and adjustments along the way and documenting all findings.

G-26.01 Secures commissioning area

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-26.01.01P	obtain ***approvals***	***approvals*** to work in commissioning area are obtained, and written documentation and permits are valid
G-26.01.02P	***communicate*** and coordinate scheduled commissioning with other trades	other trades are coordinated with and are given written documentation of scheduled commissioning
G-26.01.03P	secure test area and clear area of personnel	test area is secured and is cleared of unauthorized personnel after a walk-through inspection
G-26.01.04P	perform LOTO procedures	LOTO procedures are performed on system or equipment being commissioned according to company policies and procedures, and removal is documented

Range of Variables

approvals include: operating permits, AHJ permission

communicate includes: written, electronic, radio, cell phones

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-26.01.01L	demonstrate knowledge of system commissioning and its associated procedures	identify ***sources of information*** pertaining to system commissioning
		identify ***tools and equipment*** relating to system commissioning, and describe their applications and procedures for use
		identify hazards, and describe ***safe work practices*** pertaining to system commissioning

Range of Variables

sources of information include: manufacturers' and engineers' specifications, drawings, operating conditions

tools and equipment include: see Appendix B

safe work practices include: system re-energizing, LOTO procedures followed, safe handling of system medium, OH&S

G-26.02 Pressurizes system

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-26.02.01P	fill system and vent	drains are closed, air is removed and system is filled to high point vent
G-26.02.02P	increase pressure in a controlled manner to operating pressure	operating pressures are measured using ***pressure measuring devices***, and are in accordance with engineering specifications and jurisdictional regulations

Range of Variables

pressure measuring devices include: pressure transducers, gauges

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-26.02.01L	demonstrate knowledge of system commissioning and its associated procedures	identify ***sources of information*** pertaining to system commissioning
		identify ***tools and equipment*** relating to system commissioning, and describe their applications and procedures for use
		identify hazards, and describe ***safe work practices*** pertaining to system commissioning
		describe ***procedures to perform pressurization***
G-26.02.02L	demonstrate knowledge of regulatory requirements to perform pressurization	identify ***jurisdictional regulations*** pertaining to pressurization
		identify permits and approvals required to perform pressurization

Range of Variables

sources of information include: manufacturers' and engineers' specifications, drawings, operating conditions

tools and equipment include: see Appendix B

safe work practices include: system re-energizing, LOTO procedures followed, safe handling of system medium

procedures to perform pressurization include: filling, venting, increasing pressure in a controlled manner

jurisdictional regulations include: by-laws, standards, codes, OH&S, ASME

G-26.03 Inspects system

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-26.03.01P	perform visual inspection of system	visual inspection of system is performed, ***faulty conditions*** are identified, reported and documented
G-26.03.02P	detect ***defects*** in system	***defects*** are identified, reported and documented
G-26.03.03P	analyze ***defect***	***defect*** is analyzed and repairs required are identified, reported and documented

Range of Variables

faulty conditions include: leaks, freezing temperatures, overheating, improper pressure
defects include: faulty gaskets, loose packing nuts, missing or loose plugs, faulty valves

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-26.03.01L	demonstrate knowledge of system inspection and its associated procedures	identify piping and equipment in system being inspected
		describe ***faulty conditions*** and ***defects*** in system
		identify ***sources of information*** pertaining to system inspection
		identify ***tools and equipment*** relating to system inspection, and describe their applications and procedures for use
		identify hazards, and describe ***safe work practices*** pertaining to system inspection

Range of Variables

faulty conditions include: leaks, freezing temperatures, overheating, improper pressure
defects include: faulty gaskets, loose packing nuts, missing or loose plugs, faulty valves
sources of information include: manufacturers' and engineers' specifications, drawings, operating conditions
tools and equipment include: see Appendix B
safe work practices include: use of PPE (respirator, face shield), barricading, OH&S, company policies

G-26.04 Corrects faulty conditions

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-26.04.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job
G-26.04.02P	perform LOTO procedures prior to de-pressurizing	LOTO procedures are performed on system or equipment being worked on prior to de-pressurizing according to company policies and procedures, and removal is documented
G-26.04.03P	depressurize system	system is depressurized, vents and drains are opened and pressure instruments read zero

G-26.04.04P	repair leaks	leaks are repaired using ***procedures***
G-26.04.05P	remove and replace faulty ***components***	faulty ***components*** are removed, replaced and function according to engineers' specifications
G-26.04.06P	repair faulty ***joints***	faulty ***joints*** are repaired
G-26.04.07P	complete documentation	documentation of repairs performed is completed

Range of Variables

tools and equipment include: see Appendix B

procedures include: tightening and torquing flanges, cutting in unions, replacing pipe spools, changing gaskets

components include: valves, flanges, gaskets, fittings

joints include: welded, mechanical, fused, threaded

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-26.04.01L	demonstrate knowledge of repair and replacement procedures	identify piping and equipment in system being repaired
		identify ***sources of information*** pertaining to repair
		identify ***tools and equipment*** relating to repair and replacement, and describe their applications and procedures for use
		identify hazards, and describe ***safe work practices*** pertaining to repair
		describe procedures to perform repairs or replacements

Range of Variables

sources of information include: manufacturers' and engineers' specifications, drawings, operating conditions

tools and equipment include: see Appendix B

safe work practices include: acquiring permits, applying LOTO procedures, using PPE, OH&S, company policies

G-26.05 Participates in start-up and turnover procedures

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

	Skills	
	Performance Criteria	**Evidence of Attainment**
G-26.05.01P	select and use ***tools and equipment***	***tools and equipment*** are selected and used according to job and safe work practices
G-26.05.02P	follow start-up procedure list	start-up procedure list is followed and equipment operates according to design and functional performance requirements
G-26.05.03P	check equipment and trim function, and safety features	equipment and trim function, and safety features are performing according to manufacturers' specifications
G-26.05.04P	demonstrate system operation with owner's representative	system operation is demonstrated, and documentation is completed and signed off by owner's representative
G-26.05.05P	balance system	system is balanced by adjusting ***components*** according to operational requirements
G-26.05.06P	perform final ***maintenance*** of components at start-up	components are maintained according to manufacturers' and engineers' specifications, for optimal operation of equipment
G-26.05.07P	remove ***commissioning equipment***	***commissioning equipment*** is removed without damage, leakage or spillage
G-26.05.08P	remove commissioning signage and barricades	commissioning signage and barricades are removed once commissioning is completed
G-26.05.09P	place and review valve identification tags	valve tag list is completed and tags hung on valves at correct locations
G-26.05.10P	apply pipe markings to identify flow and medium	pipe markings indicate flow and medium
G-26.05.11P	complete ***turnover documentation***	***turnover documentation*** is completed according to contractual agreement

Range of Variables

tools and equipment include: balancing equipment, laptops, radios, analyzers

components include: flow control devices, pressure reducing valves, regulators, flow switches, level switches

maintenance includes: cleaning strainers, changing filters

commissioning equipment includes: balancing instruments, analyzers

turnover documentation includes: as-builts, weld mapping, non-destructive testing (NDT), NDE, testing records, sign-off sheets, mill test reports (MTR), CRN, valve mapping

	Knowledge	
	Learning Outcomes	**Learning Objectives**
G-26.05.01L	demonstrate knowledge of start-up and turnover procedures	identify ***sources of information*** pertaining to start-up
		identify piping and equipment in system being started up
		identify ***tools and equipment*** relating to start-up, and describe their applications and procedures for use
		identify hazards, and describe ***safe work practices*** pertaining to start-up
		describe ***start-up procedures***
		describe ***turnover documentation***

Range of Variables

sources of information include: manufacturers' and engineers' specifications, drawings, operating conditions

tools and equipment include: balancing equipment, laptops, radios, analyzers

safe work practices include: acquiring permits, applying LOTO procedures, using PPE, OH&S, company policies

start-up procedures include: organizing inspection date, notifying client, checking connections, verifying parameters, performing operational tests, making final adjustments

turnover documentation includes: as-builts, weld mapping, NDT, NDE, testing records, sign-off sheets, MTR, CRN, valve mapping

Appendix A Acronyms

ABS	acrylonitrile butadiene styrene
ACR	air-conditioning and refrigeration
AHJ	authority having jurisdiction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
BIM	Building Information Modelling
CAD	computer-aided design
CFC	chlorofluorocarbon
CNC	Computer Numeric Control
CPP	concrete pressure pipe
CPVC	chlorinated polyvinyl chloride
CRN	Canadian Registration Number
CSA	Canadian Standards Association
CWB	Canadian Welding Bureau
DISS	diameter index safety system
DWV	drain, waste and vent
DX	direct exchange
ERW	electric resistance welded
FLRA	field level risk assessments
FRP	fibreglass reinforced plastic
GA	general arrangement
GFRP	glass fibreglass reinforced plastic
GMAW	gas metal arc welding
GPS	global positioning system
GRE	glass reinforced epoxy
GTAW	gas tungsten arc welding
HCFC	hydrofluorocarbon
HCPE	polyethylene piping
HDPE	high-density polyethylene
HRV	heat recovery ventilators
HSS	hollow structural sections
HVACR	heating, ventilation and air conditioning and refrigeration
ICI	industrial, commercial and institutional
JSA	job safety analysis
LDPE	low density polyethylene
LEED	Leadership in Energy and Environmental Design

LOTO	lock-out and tag-out
LWCO	low water cut-offs
MAPP	methylacetylene-propadiene propane
MTR	mill test reports
NDE	non-destructive examination
NDT	non-destructive testing
NFPA	National Fire Protection Association
OH&S	Occupational Health and Safety
P&ID	process and instrumentation drawings
PE	polyethylene
PEX	cross-linked polyethylene
PMI	positive material identification
PP	polypropylene
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RFI	request for information
SAW	submerged arc-welded
SCBA	self-contained breathing apparatus
SDS	Safety Data Sheet
SMAW	shielded metal arc welding
SPA	safety plan of action
UL	United Laboratories
VR	virtual reality
WHMIS	Workplace Hazardous Materials Information System
WLL	working load limit

Appendix B
Tools and Equipment / Outils et équipement

Hand Tools / Outils à main

bolt cutter	coupe-boulon
bolt die	taraudeur de boulons
bolt tap	boulon à filetage complet
calculator	calculatrice
centre punch	pointeau à centrer
chain pipe tongs	serre-tube à chaînes
clamps – C, adjustable	serre-joints – en C, ajustable
coil fin straightener	redresseur d'ailettes à serpentin
cold chisels	ciseaux à froid
contour markers	marqueurs de contour
digital devices (laptops, smart phones, tablets, computers)	dispositifs numériques – portables, téléphones intélligents, tablettes, ordinateursordinateur
drafting accessories	instruments de dessin technique
files	limes
flange alignment pins	chevilles d'alignement à brides
flange spreader (jacks)	séparateur de brides (vérins)
flaring tool	outil à évaser
freeze pack	contenant réfrigérant
gasket cutter	coupeur de joints
hacksaws – hand, portable band, large band	scies à métaux – à main, à ruban portative, à gros rubans
hammers – ball peen, chipping, sledge, soft-face	marteaux - à panne ronde, à buriner, masse, à frappe douce
hand beveller	outil à chanfreiner à main
hi-lo gauge	jauge de dénivellement
hole punch	poinçon à trous
levels – laser, standard, builders, digital (smart)	niveaux – à laser, standard, télescopiques, numériques (intelligents)
marking tool	outil de marquage
PEX tools	outils pour la tuyauterie en polyéthylène réticulé (PEX)
pin punch	chasse-goupille
pinch bars	barres-leviers
pipe/tube cutters	coupe-tuyau, coupe-tube
pipe reamer – spiral, fluted	alésoir à tuyau – hélicoïdal, à cannelure
pipe tap	taraud pour tube
pipe threader	fileteuse de tuyaux

pipe vises – chain and yokes, tri-stand and bench, power vise (power drive)	étaux pour les tubulures – à chaînes et à arceaux, à trois supports et d’établi, électriques
pliers	pinces
prying tool	levier
ratchet	rochet
screwdrivers	tournevis
shear	cisaille
shrink-fit device	dispositif d’ajustage par contraction
spacing tool	outil à espacer
strapping device	sangle de levage
swaging tool	outil à sertissage
tip cleaner	nettoyeur de buse
tube cleaner	nettoie-tube
tube bender	cintreuse
wheel and bearing pullers	arrache-roue et extracteur de roulements
wrap-around	ruban-gaine
wrenches – adjustable, chain, combination (open-/closed-end), hammer, hex-key, non-spark, pin, pipe, socket, torque	clés – ajustables, à chaînes, combinées (ouvertes et polygonales), marteaux, hexagonales, sans étincelles, à ergots, à tuyaux, à douilles, dynamométriques

Power Tools / Outils électriques

air compressor	compresseur d’air
bending machine	machine à cintrer
bevelling tools – electric drive, pneumatic, oxy-fuel	outils à chanfreiner – électriques, pneumatiques et oxygaz
bolt tensioner	dispositif de serrage des boulons
drills – electric, pneumatic, hammer, bench or stand press, mag	perceuses –électriques, pneumatiques, marteau perforateur, d’établi
facing tool	outil à dresser
generator	génératrice
grinders (electric or pneumatic) - angle, bench, die, pedestal	meuleuses – électriques ou pneumatiques, d’angle, d’établi, rectifieuses, sur colonne
grooving machine	rainureuse
hydraulic flange spreaders	séparateurs de brides hydrauliques
hydraulic jacks	crics hydrauliques
hydraulic torque wrench	clé hydraulique dynamométrique
hydrostatic pump	pompe hydrostatique
impact driver	outil de pose et de dépose à impact
portable end-prep milling – pneumatic, electric	fraiseuse portative pour fraisage combiné – pneumatique, électrique
powder-actuated tools	outils à charge explosive
press fit tools	outils d’assemblage par pression

saws – circular, cut-off, jig, sabre	scies – circulaires, à découper, sauteuses, à guichet
threading machine	fileteuse

Measuring and Testing Tools and Devices / Instruments et dispositifs de mesure et d'essai

ampere probe	détecteur de courant
calculator	calculatrice
callipers	compas d'épaisseur
centre finder	centreur
chart recorders	enregistreurs à tracé continu
compass	compas
dead weights	poids morts
feeler gauge	calibre d'épaisseur
gauges – temperature, pressure, liquid, vacuum, specialty	jauges – à température, à pression, à liquide, à vide, de spécialité
geometry set	instruments de dessin
holiday detector	détecteur de manques
hydrostatic test pump	pompe d'essai hydrostatique
infrared temperature sensor	capteur de température à rayons infrarouges
levels – laser, standard, builders (transit), digital (smart)	niveaux – à laser, standard, télescopiques (théodolite), numériques (intelligents)
manometer	manomètre
measuring tape	ruban à mersurer
micrometer	micromètre
multimeter	multimètre
plumb bob	fil à plomb
rulers	règles
scales	échelles
squares – standard 24-in., combination, flange straightedge	équerres – standard de 24 po, combinées, à brides, à bords droits
string line	cordeau
thermometer	thermomètre

Rigging and Hoisting Equipment/ Équipement de levage et de gréage

beam clamps	attaches de poutre
cable clips	serre-câbles
cable puller	dispositif de tirage de câbles
chain block	treuil à palan
chain fall	palan à chaîne
chain puller	extracteur à chaîne
come-alongs	palan à main

cranes	grues
D ring	anneau d’arrimage
equalizer beam	palonnier à un point d’ancrage
eye bolts	boulons à œil
forklift	chariot élévateur à fourche
grip hoist	treuil à mâchoires
hooks	crochets
jacks (hydraulic, ram and piston)	vérins - hydraulique, à coulisse et à pistons
plate clamp	pince à tôles
rope	corde
shackles	manille
slings (nylon, wire rope, wire mesh)	élingues -nylon, câble métallique, treillis métallique
snatch block	poulie coupée
softeners	protecteurs d’élingue
spreader bar	barre d’écartement
tag line	câble de retenue
tugger	treuil pneumatique

Welding, Soldering and Brazing Equipment / Équipement de soudage, de brasage tendre et de brasage

arc welders (electric, fuel)	soudeuses à arc (électrique, à carburant)
compressed gas cylinders (purge, shield, cutting)	bouteilles de gaz comprimé (de purge, de protection, de coupage)
flashback arrestor	intercepteur de rentrée de flamme
fusion welding equipment	matériel de soudage par fusion
hot air welding machine	soudeuse à l’air chaud
induction heater (pre-heat, post-heat)	appareil chauffant à induction (pré-chauffage, post-chauffage)
orbital welder	soudeuse orbitale
plasma cutters	coupeurs au plasma
propane tiger torches (preheating)	buses de lance-flamme au propane (préchauffage)
regulator	régulateur
torches (oxy-fuel cutting, heating and welding)	chalumeaux (coupage, chauffage et soudage à oxygaz)
welding machines (SMAW, GMAW, GTAW)	soudeuses (soudage à l’arc avec électrode enrobée, soudage à l’arc sous gaz avec fil plein, soudage à l’électrode de tungstène)

Ladders, Stands and Platforms / Échelles, trépieds à tuyaux et plates-formes

combination ladder	échelle transformable
extension ladder	échelle extensible
material lifts	monte-charges pour matériaux

motorized work platforms (electrical, hydraulic, pneumatic, winch (hand and power)) – scissor lift, articulated boom, personnel basket	plateformes élévatrices motorisées (électriques, hydrauliques, pneumatiques, treuils [manuels et électriques]) – plateformes élévatrices à ciseaux, flèches articulées et nacelles
scaffolding (staging)	échafaudage (plate-forme de travail)
pipe racks	râteliers à tuyaux
pipe stands – roller and V type	porte-tuyaux – sur rouleaux ou type en V
platform ladder	échelle plate-forme
step ladder	échelle graduée

Personal Protective Equipment (PPE) and Safety Equipment / Équipement de sécurité et de protection individuelle

air quality monitors	contrôles de la qualité de l’air
anti-vibration gloves	gants anti-vibrations
breathing apparatus	appareil respiratoire
chemical protective clothing	vêtements de protection contre les produits chimiques
coveralls (standard and fire retardant)	combinaison (standard et à l’épreuve du feu)
dust mask	masque antipoussière
ear protection	protecteurs d’oreilles
face shield	écran facial
fall arrest harness	harnais antichute
fire extinguisher	extincteur
first aid kit	trousse de premiers soins
fume extractor	extracteur de vapeurs
hard hat	casque protecteur
leather apron	tablier en cuir
leather gloves and sleeves	gants et manchons en cuir
respirator	respirateur
rubber gloves	gants de caoutchouc
safety boots	bottes de sécurité
safety glasses	lunettes de sécurité
safety vest/gauntlets	veste de sécurité/gants à crispin
welding goggles (shade 5) and flash goggles (shade 2)	lunettes de soudeur (teinte 5) et lunettes antiéblouissement de soudeur (teinte 2)
welding helmet	casque de soudure

Appendix C
Glossary / Glossaire

backflow preventer	a device or a method that prevents a reverse flow from the normal direction of flow in a piping system	**dispositif anti-refoulement**	dans une tuyauterie, dispositif ou méthode servant à empêcher le contenu de refouler
balancing valve	valve used to add artificial resistance where required to achieve design flow rate	**robinet d'équilibrage**	robinet utilisé afin d'ajouter de la résistance artificielle pour obtenir le débit voulu
blowdown	a connection at the bottom or lowest portion of a piping system or equipment to facilitate cleaning out or testing	**purge**	dispositif situé à la partie inférieure ou au point bas d'un tube de niveau, d'un interrupteur de bas niveau, d'un alimentateur automatique d'eau, d'une colonne d'eau en fonte, etc., qui facilite le nettoyage de l'équipement ou les essais sur ce dernier
boiler	equipment used to heat water or generate steam	**chaudière**	appareil destiné à chauffer l'eau ou à créer de la vapeur
boiler trim	the controls, equipment and accessories connected to a boiler for its safe and efficient operation	**organes internes de la chaudière**	contrôles, équipement et accessoires qui assurent le fonctionnement efficace et sécuritaire d'une chaudière
butt fusion	a joining method that requires ends of pipe to be joined by direct heat application on material such as steel or plastic	**fusion bout à bout**	méthode de raccordement qui consiste à lier les extrémités de tuyaux en appliquant une chaleur directement sur des matériaux comme de l'acier ou du plastique
chilled water cooling system	piping systems for cooling buildings, equipment or processes by circulating chilled water	**système à eau froide**	tuyauteries servant à refroidir les bâtiments, l'eéquipementou les procédés en faisant circuler de l'eau froide
computer-aided design (CAD)	computer aided design; used for drawing, altering and recalling views and details on a computer	**conception assistée par ordinateur (CAO)**	technique utilisée pour réaliser des dessins sur ordinateur, ainsi que pour modifier et mettre à jour des vues et des détails
condensate return system	a piping arrangement designated to return condensate to a steam generator	**système de retour d'eau condensée**	ensemble de tuyaux servant à retourner le condensat à une chaudière à vapeur
contour marker	a layout instrument used in the fabrication of pipe that will trace lines for the cutting of laterals, tees and, wyes	**marqueur de contour**	instrument utilisé dans la fabrication des tuyaux pour tracer des lignes de coupe sur des embranchements latéraux, en T ou en Y

control valve	a valve which controls the flow of a liquid or gas automatically as directed by an electrical or pneumatic signal or a capillary tube	**soupape de contrôle**	soupape qui règle automatiquement le débit d'un liquide ou d'un gaz en réponse à un signal électrique ou pneumatique, ou au niveau d'un liquide dans un tube capillaire
controller	a device with a sensing element which takes measurements and adjusts the setting of a preselected component accordingly	**contrôleur**	dispositif muni d'un capteur qui prend des mesures et modifie en conséquence le réglage d'une pièce présélectionnée
converter	a piece of equipment used to heat or cool water and other liquids by means of steam, high temperature hot water, or chilled water without the two mediums coming in contact with each other (e.g. heat exchanger; indirect heater)	**convertisseur**	pièce d'équipement servant à réchauffer ou à refroidir l'eau, ou un autre liquide, au moyen de vapeur, d'eau chaude à haute température ou d'eau glacée, et évitant que les contenus ne viennent en contact (échangeur thermique, réchauffeur indirect).
de-aerator	a device used to remove temporary hardness and unwanted gases (such as oxygen and carbon dioxide) from the make-up water	**dégazeur**	appareil destiné à et éliminer la dureté temporaire et les gaz indésirables (comme l'oxygène et le bioxyde de carbone) dissous dans l'eau d'appoint
desuperheater	a device which uses water as a cooling medium to lower the temperature of the superheated steam	**désurchauffeur**	appareil qui utilise l'eau comme fluide de refroidissement pour abaisser la température de la vapeur surchauffée
direct return	a two-pipe hydronic system in which the first unit supplied has the shortest return to the boiler	**installation à retour direct**	installation de chauffage à eau chaudehydronique à deux tuyaux dans laquelle l'eau d'alimentation du premier corps de chauffe emprunte le retour le plus court pour revenir à la chaudière
double-block-and-bleed	a valving system wherein a full flow valve is located on piping between two shut-off valves in series for the purpose of bleeding to the atmosphere excess pressure between valves	**arrêt et purge double**	ensemble de soupapes dans lequel on retrouve un purgeur d'incondensables à débit maximal situé sur la tuyauterie entre les deux robinets d'arrêt d'urgence en série pour purger les excès de pression dans l'atmosphère entre les soupapes
dry return	a condensate return line which is located above the water line of the boiler and carries condensate and air	**retour sec**	canalisation de retour située au-dessus de la ligne d'eau de la chaudière, et qui distibue le condensat et l'air
equalizer beam	used to equalize the load during lifts. It is connected to a crane hook and the load.	**palonnier à un point d'ancrage**	utilisé pour équilibrer une charge durant le levage. Il est rattaché à un crochet de charge et à la charge.

expansion joint	a mechanical device to take up or to compensate for the expansion and contraction of a pipe line due to temperature change	**joint de dilatation**	un dispositif mécanique permettant de rattraper ou de compenser la dilatation et la contraction d'une canalisation dues à un changement de température
expansion loop	a piping configuration to take up or to compensate for the expansion and contraction of a pipe line due to temperature change	**boucle de dilatation**	une configuration de tuyaux qui permet la dilatation et la contraction d'une conduite lors des changements de température
feed water	water that is fed into a system	**eau d'alimentation**	eau qui entre dans un système
flashback	unintentional burning of the fuel and flow-reversal in oxy-fuel equipment. It occurs in the line carrying the lower pressure and will occur upstream of the mixer, and may include the hose and regulator.	**retour de flamme**	combustion non intentionnelle du carburant et débit renversé dans l'équipement d'oxygaz. Se produit dans le conduit basse pression et au-delà du diffuseur, peut atteindre le tuyau flexible et le détenteur
heat exchanger	a device for transferring heat from one fluid to another without mixing the two fluids	**échangeurs thermiquede chaleurs**	appareil destiné à réchauffer ou refroidir un fluide, au moyen d'un autre fluide, sans que ces fluides ne se mélangent
heat transfer unit	a device used to transfer heat from a fluid to a space via conduction, convection or radiation	**corps de chauffeappareil de transfert de chaleur**	appareil destiné à transférer la chaleur d'un liquide dans une chambre par la conduction, la convection ou la radiation
high temperature hot-water system	a system which has hot water above 350˚F (180˚C)	**système de chauffage à eau chaude à haute température**	système dans lequel l'eau est portée à une température supérieure à 350˚F (180˚C)180 °C (350 °F)
HVACR system	heating, ventilation, air-conditioning and refrigeration system	**sSystème de CVCR**	système de chauffage, de ventilation, de climatisation et de réfrigération
indicator	an instrument that shows a measurement, but makes no permanent record, e.g. pressure gauge	**indicateur**	appareil qui présente une mesure, mais qui ne l'enregistre pas; il peut s'agir, par exemple, d'un manomètre
isolator	a device used to isolate equipment from its piping for testing or flushing purposes; isolators are also used to give separation from its support to prevent the transmission of noise, vibration, or static electricity	**isolateur**	dispositif servant à isoler l'équipement des tuyaux à des fins d'essai et de purge; les isolateurs servent également à isoler le tuyau du support afin d'éviter la transmission des bruits et des vibrations ou d'électricité statique
low water cut off (LWCO)	a device which shuts off the automatic fuel control valve when the water falls below a safe level	**interrupteur de bas niveau d'eau**	dispositif servant à fermer la soupape de contrôle automatique de combustible dès que l'eau descend sous un niveau minimal admissible dans la chaudière

make-up water	water supplied to a system that replaces system fluid that has been lost through evaporation, leakage, etc.	**eau d’appoint**	eau fournie à un système pour remplacer le manque de liquide perdu à cause de l’évaporation, de fuites, etc.
pin indexing	a fail-safe design by which end connections for specific medical gases can only be connected to other ends intended for use with the same gas (DISS)	**raccord à ergots de sécurité (*pin indexing*)**	conception à sûreté intégrée qui assure que les connecteurs d’extrémité pour des gaz particuliers se raccordent uniquement à des connecteurs dont le contenu du système est le même gaz; par exemple, un équipement qui doit être utilisé pour l’oxygène ne peut être physiquement branché à un équipement transportant de l’oxyde nitreux
piping circuit	the piping path from a heat exchanger to a heat transfer unit and back to the heat exchanger	**réseau**	tuyauterie parcourue par le fluide caloporteur de l’échangeur thermique au corps de chauffe, puis de ce dernier à l’échangeur
post heating	use of a heat source to heat an area after a process such as welding takes place	**post-chauffage**	utilisation d’une source de chaleur pour chauffer la matière après avoir procédé, par exemple, à une opération de soudage
preheating	use of a heat source to heat an area before a process such as welding takes place	**préchauffage**	utilisation d’une source de chaleur pour chauffer la matière avant de procéder, par exemple, à une opération de soudage
relief devices	a protection device that will open automatically to prevent over pressuring of a system	**soupape de sûreté**	dispositif de sécurité qui s’ouvre automatiquement pour éviter que la pression ou la température n’atteignent le stade critique
resin	a bonding agent used in the fibreglass process; used because of its resistance to acids and alkalines	**résine**	agent liant utilisé dans le traitement de la fibre de verre en raison de sa résistance aux acides et aux alcalins
saturated steam	steam which is at the same temperature as the boiling water from which it was formed (dry saturated; wet saturated)	**vapeur saturée**	vapeur dont la température est identique à celle de l’eau bouillante de laquelle elle provient (vapeur saturée sèche; vapeur saturée humide)
single-seated control valve	a control valve with a single seat and a single plug or disc	**robinet à simple siège**	robinet comportant un siège et un seul bouchon ou disque
solvent fusion	a method of connecting plastic pipes and fittings by the use of a solvent which dissolves the surface of the pipes and fittings to join them	**soudage par solvant**	assemblage de tuyaux de plastique à l’aide d’un solvant qui dissout la surface du tuyau et qui forme un joint permanent par évaporation

spool sheets	detail views of a piping system identifying specific piping and pieces to be fabricated	**schémas de raccordement**	vues détaillées d'un système de tuyauterie identifiant les pièces et les tuyaux particuliers qui doivent être fabriqués
spreader bar/beam	used to support long, hard-to-handle loads. These bars eliminate load tipping, sliding or bending. They connect by using slings from the beam to the crane hook.	**barre d'écartement et palonnier**	utilisés pour supporter des charges de grande taille qui sont difficiles à manipuler. Ces barres évitent que la charge ne bascule, ne glisse ou ne plie. On les attache à partir du palonnier jusqu'au crochet de charge avec des élingues
spreaders	a set of chokers or slings of equal length used to lift a load	**répartiteurs de charge**	ensemble d'étrangleurs ou d'élingues de même longueur utilisé pour lever une charge
steam separator	a device used to remove entrained moisture present in steam	**séparateur de vapeur**	dispositif destiné à éliminer les gouttelettes d'eau contenues dans la vapeur
steam tracing	a pipe or tube which is placed along or coiled around pipe, vessels and pumps and is filled with steam to maintain a minimal temperature in the primary pipe's medium	**traçage à la vapeur**	tuyau ou tube placé le long ou enroulé autour d'un tuyau, den vaisseaux ou de pompes dans lequel passe de la vapeur pour contrôler la température du contenu du tuyau principal
steam trap	an automatic device which allows the passage of air and condensate but prevents the passage of steam	**purgeur de vapeur**	appareil qui évacue de manière automatique l'air et les condensats, tout en restant étanche à la vapeur
straightening vanes	device used to take the turbulence out of liquids and gases flowing in pipes so measuring instruments can get an accurate reading	**redresseur à aubes**	dispositif ayant pour but d'instaurer l'écoulement parallèle d'un liquide ou d'un gaz dans une conduite; pour permettre aux instruments de mesure d'obtenir des résultats précis
superheated steam	saturated steam with the addition of sensible heat; an increase in temperature of saturated steam without an increase in pressure	**vapeur surchauffée**	vapeur saturée à laquelle s'ajoute une chaleur sensible; sa température a été augmentée, sans augmenter sa pression
superheater	a device used to heat dry or wet-saturated steam and increase the temperature without increasing the pressure of the steam	**surchauffeur**	dispositif servant à chauffer la vapeur saturée sèche ou humide et à accroître sa température, sans augmenter sa pression
vacuum	a pressure below atmospheric	**à vide**	une pression plus faible que la pression atmosphérique
wrap-around	a pipe marking and measuring tool used on round surfaces during layout	**ruban-gaine**	instrument de traçage et de mesure utilisé sur les surfaces rondes pendant le positionnement