PROGRAM PROGRAMME
EXCELLENCE
RED SEAL · SCEAU ROUGE

RED SEAL OCCUPATIONAL STANDARD

Steamfitter/Pipefitter

2015

INTERPROVINCIAL STANDARD
CANADA
NORME INTERPROVINCIALE

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Canada

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FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Red Seal Occupational Standard (RSOS) as the 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 analyses of occupations.

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

Trades and Apprenticeship Division
Labour Market Integration Directorate
Employment and Social Development Canada
140 Promenade du Portage, Phase IV, 5th Floor
Gatineau, Quebec K1A 0J9
Email: redseal-sceaurouge@hrsdc-rhdcc.gc.ca

STRUCTURE OF THE OCCUPATIONAL STANDARD

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

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

Essential Skills Summary: An overview of how each of the 9 essential skills is applied in this trade

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

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

Task Matrix, Examination Weightings and Recommended Training Levels: a chart which outlines graphically the blocks, tasks and sub tasks of this standard, their respective exam weightings, and the recommended level of apprenticeship technical training

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

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

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

Essential Skills: The most relevant essential skills for this sub-task

Skills:

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

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

Knowledge:

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

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

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

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

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

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

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Ron Perkin	British Columbia
Al Philips	British Columbia
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This standard was prepared by the Labour Market Integration Directorate of ESDC. The coordinating, facilitating and processing of this analysis were undertaken by employees of the standards development team of the Trades and Apprenticeship Division and of Apprenticeship New Brunswick. The host jurisdiction of British Columbia also participated in the development of this standard.

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 whose occupational title has been identified by some provinces and territories of Canada under the following names:

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
Pipefitter - Heating System Installer Specialty (Construction)					■								
Steamfitter						■							
Steamfitter – Pipefitter							■		■				
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, assemble and install metal, plastic and fiberglass pipes, valves and fittings. As well, they must be able to join and secure pipe sections of related equipment. They check systems for leaks. Steamfitters/Pipefitters also do general maintenance work including 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 and brazing equipment to join pipes and fabricate sections of piping systems.

Areas of specialization in this trade include maintenance, quality control, rigging, fabrication and installation of various types of systems and specialty piping.

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. 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. The work can also be physically demanding. In aspects of layout, work organization, project planning and supervisory tasks, steamfitters/pipefitters may also make use of many digital tools and applications.

With experience, steamfitters/pipefitters may advance to positions such as foreman, contractor, owner, superintendent and instructor.

ESSENTIAL SKILLS SUMMARY

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

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

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

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

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

The application of these skills may be described throughout this document within the skills and knowledge which support each sub-task of the trade. The most important essential skills for each sub-task have also been identified. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at www.red-seal.ca.

READING

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 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 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 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 SKILLS

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.

WORKING WITH OTHERS

Steamfitters/Pipefitters liaise with supervisors, colleagues and other trades to coordinate multiple tasks. They may work with trades such as welders, 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, building information modeling 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.

TRENDS IN THE STEAMFITTER/PIPEFITTER TRADE

Steam systems are being installed less frequently in office and commercial facilities. However, these systems are still prevalent in facilities utilizing central heating plants such as hospitals and college/university campuses.

Steamfitters/Pipefitters work in many sectors including pipelines, nuclear energy, mining, petro-chemical, natural gas, sawmills, offshore oil and gas, shipbuilding, automotive, pulp and paper, and commercial and institutional. In some jurisdictions, steamfitting/pipefitting work is increasing in certain sectors, such as gas plants and shipbuilding. Due to changing demands on the industry and an aging workforce, there may be a requirement for more steamfitter/pipefitters in Canada.

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. New materials are becoming economically feasible, driving changes in structural design, especially in industrial and institutional sectors. 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.

Renewable energy systems such as geo-exchange, geothermal, solar, radiant, refrigeration, heat recovery 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.

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

Steamfitters/Pipefitters are expected to obtain and maintain a high level of safety knowledge and training. 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 flame-free pipe press-connection technology, which increases efficiency and safety.

There is an ongoing trend towards the use of computers for reports, schedules, ordering material, completion of forms, rendering drawings (computer-aided design or CAD), system analysis and service, and control of heating/cooling systems. The use of digital equipment for the trade such as smart phones, laser and digital layout equipment such as total station and GPS technology is increasingly important for trade activities.

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

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 fork-lifts and scissor lifts are becoming essential for operating these pieces of equipment. Hoisting and rigging certification is becoming increasingly necessary in some jurisdictions.

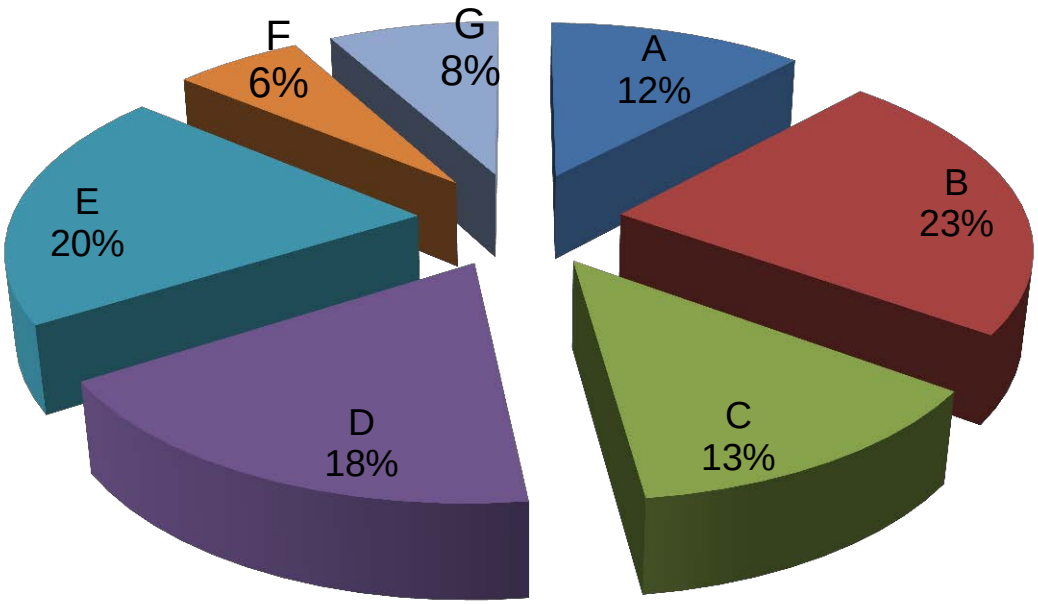
With regulations becoming more stringent, steamfitters/pipefitters may be held liable for their actions when performing rigging, hoisting, lifting and positioning activities. It is the responsibility of steamfitters/pipefitters to be aware of changes in regulations.

LANGUAGE REQUIREMENTS

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

PIE CHART

OF RED SEAL EXAMINATION WEIGHTINGS



MWA A	PERFORMS COMMON OCCUPATIONAL SKILLS	12%
MWA B	PERFORMS LAYOUT, FABRICATION AND PIPING INSTALLATION	23%
MWA C	PERFORMS RIGGING, HOISTING, LIFTING AND POSITIONING	13%
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	20%
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 ad sub-tasks within each Major Work Activity, the breakdown of questions assigned to the Tasks, and the recommended training levels for each sub-task. Interprovincial examinations typically have between 100 and 150 questions.

STEAMFITTER/PIPEFITTER

TASK MATRIX AND WEIGHTINGS

A - PERFORMS COMMON OCCUPATIONAL SKILLS — 12%

Task A-1 Performs safety-related functions. 31%	A-1.01 Maintains safe work environment.	A-1.02 Selects, inspects and uses personal protective equipment (PPE) and safety equipment.	A-1.03 Follows lock-out procedures.
Task A-2 Uses and maintains tools and equipment. 32%	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 equipment.	
Task A-3 Organizes job. 37%	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 preliminary quality control functions.	

B – PERFORMS LAYOUT, FABRICATION AND PIPING INSTALLATION 23%

Task B-4 **Performs fabrication.** **32%**	**B-4.01 Fabricates piping system components.**	**B-4.02 Fabricates brackets, supports, hangers, guides and anchors.**	
Task B-5 **Lays out, identifies and installs piping, tubing, fittings and related components.** **39%**	**B-5.01. Lays out, identifies and installs copper piping, tubing, fittings and related components.**	**B-5.02 Lays out, identifies and installs plastic piping, tubing, fittings and related components.**	**B-5.03 Lays out, identifies and installs carbon steel piping, tubing, fittings and related components.**
	B-5.04. Lays out, identifies and installs stainless steel piping, tubing, fittings and related components.	**B-5.05. Lays out, identifies and installs fibreglass piping, fittings and related components.**	**B-5.06. Lays out, identifies and installs specialty piping, fittings and related components.**
Task B-6 **Installs, maintains, troubleshoots, repairs and tests valves.** **19%**	**B-6.01 Installs valves.**	**B-6.02 Maintains, troubleshoots, repairs and tests valves.**	
Task B-7 **Installs, tests, maintains, troubleshoots and repairs heat tracing systems.** **10%**	**B-7.01. Installs steam tracing systems.**	**B-7.02. Maintains, troubleshoots, repairs and tests steam tracing systems.**	**B-7.03. Installs liquid-filled tracing systems.**
	B-7.04. Maintains, troubleshoots, repairs and tests liquid-filled tracing systems.		

C – PERFORMS RIGGING, HOISTING, LIFTING AND POSITIONING 13%

Task C-8 **Performs common rigging, hoisting, lifting and positioning.** **62%**	**C-8.01 Determines load.**	**C-8.02. Prepares lift plan(s).**	**C-8.03 Selects rigging, hoisting, lifting and positioning equipment.**
	C-8.04 Inspects rigging, hoisting, lifting and positioning equipment.	**C-8.05 Secures lift area.**	**C-8.06 Sets up rigging, hoisting, lifting and positioning equipment.**
	C-8.07 Performs lift and positioning.	**C-8.08 Maintains and stores rigging, hoisting, lifting and positioning equipment.**	
Task C-9 **Performs complex and critical rigging, hoisting, lifting and positioning.** **38%**	**C-9.01 Prepares lift plan for complex and critical rigging, hoisting, lifting and positioning.**	**C-9.02 Performs calculations for complex and critical rigging, hoisting, lifting and positioning.**	**C-9.03 Selects rigging, hoisting, lifting and positioning equipment for complex and critical lifts.**
	C-9.04 Sets up rigging, hoisting, lifting and positioning equipment for complex and critical lifts.	**C-9.05 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-10 **Installs, tests, maintains, troubleshoots and repairs low pressure steam and condensate systems.** **46%**	**D-10.01 Installs equipment for low pressure steam and condensate systems.**	**D-10.02 Installs piping for low pressure steam and condensate systems.**	**D-10.03 Tests low pressure steam and condensate systems.**
	D-10.04 Maintains, troubleshoots and repairs low pressure steam and condensate systems.		
Task D-11 **Installs, tests, maintains, troubleshoots and repairs high pressure steam and condensate systems.** **54%**	**D-11.01 Installs equipment for high pressure steam and condensate systems.**	**D-11.02 Installs piping for high pressure steam and condensate systems.**	**D-11.03 Tests high pressure steam and condensate systems.**
	D-11.04 Maintains, troubleshoots and repairs high pressure steam and condensate systems.		

E – INSTALLS, TESTS, MAINTAINS, TROUBLESHOOTS AND REPAIRS HEATING, COOLING AND PROCESS PIPING SYSTEMS

20%

Task E-12 **Installs, tests, maintains, troubleshoots and repairs hydronic systems.** **23%**	**E-12.01 Installs equipment for hydronic systems.**	**E-12.02 Installs piping for hydronic systems.**	**E-12.03 Tests hydronic systems.**
	E-12.04 Maintains, troubleshoots and repairs hydronic systems.		
Task E-13 **Installs, tests, maintains, troubleshoots and repairs process piping systems.** **23%**	**E-13.01 Installs equipment for process piping systems.**	**E-13.02 Installs piping for process piping systems.**	**E-13.03 Tests process piping systems.**
	E-13.04 Maintains, troubleshoots and repairs process piping systems.		
Task E-14 **Installs, tests, maintains, troubleshoots and repairs industrial water and waste treatment systems.** **9%**	**E-14.01 Installs equipment for industrial water and waste treatment systems.**	**E-14.02 Installs piping for industrial water and waste treatment systems.**	**E-14.03 Tests industrial water and waste treatment systems.**
	E-14.04 Maintains, troubleshoots and repairs industrial water and waste treatment systems.		
Task E-15 **Installs, tests, maintains, troubleshoots and repairs hydraulic systems.** **8%**	**E-15.01 Installs equipment for hydraulic systems**	**E-15.02 Installs piping, tubing and hoses for hydraulic systems.**	**E-15.03 Tests hydraulic systems.**
	E-15.04 Maintains, troubleshoots and repairs hydraulic systems.		
Task E-16 **Installs, tests, maintains, troubleshoots and repairs heating, ventilation, air conditioning and refrigeration (HVACR) systems.** **10%**	**E-16.01 Installs equipment for HVACR systems.**	**E-16.02 Installs hydronic piping and refrigeration tubing for HVACR systems.**	**E-16.03 Tests associated components of HVACR systems.**

	E-16.04 Maintains, troubleshoots and repairs associated components of HVACR systems.		
Task E-17 Installs, tests, maintains, troubleshoots and repairs fuel systems. 9%	E-17.01 Installs equipment for fuel systems.	E-17.02 Installs piping and tubing for fuel systems.	E-17.03 Tests fuel systems.
	E-17.04 Maintains, troubleshoots and repairs fuel systems.		
Task E-18 Installs, tests, maintains, troubleshoots and repairs medical gas systems. 8%	E-18.01 Installs equipment for medical gas systems.	E-18.02 Installs piping and tubing for medical gas systems.	E-18.03 Tests medical gas systems.
	E-18.04 Maintains, troubleshoots and repairs medical gas systems.		
Task E-19 Installs, tests, maintains, troubleshoots and repairs compressed air and pneumatic systems. 10%	E-19.01 Installs equipment for compressed air and pneumatic systems.	E-19.02 Installs piping and tubing for compressed air and pneumatic systems.	E-19.03 Tests compressed air and pneumatic systems.
	E-19.04 Maintains, troubleshoots and repairs compressed air and pneumatic systems.		
Task E-20 Installs and tests fire protection systems. (NOT COMMON CORE)	E-20.01 Installs equipment for fire protection systems. (NOT COMMON CORE)	E-20.02 Installs piping for fire protection systems. (NOT COMMON CORE)	E-20.03 Tests fire protection systems. (NOT COMMON CORE)

F – INSTALLS, TESTS, MAINTAINS, TROUBLESHOOTS AND REPAIRS RENEWABLE ENERGY SYSTEMS

6%

Task F-21 **Installs, tests, maintains, troubleshoots and repairs geo-exchange and geothermal systems.** **28%**	**F-21.01 Installs equipment for geo-exchange and geothermal systems.**	**F-21.02 Installs piping for geo-exchange and geo-thermal systems.**	**F-21.03 Tests geo-exchange and geothermal systems.**
	F-21.04 Maintains, troubleshoots and repairs geo-exchange and geothermal systems.		
Task F-22 **Installs, tests, maintains, troubleshoots and repairs solar heating systems.** **16%**	**F-22.01 Installs equipment for solar heating systems.**	**F-22.02 Installs piping for solar heating systems.**	**F-22.03 Tests solar heating systems.**
	F-22.04 Maintains, troubleshoots and repairs solar heating systems.		
Task F-23 **Installs, tests, maintains, troubleshoots and repairs heat recovery systems.** **56%**	**F-23.01 Installs equipment for heat recovery systems.**	**F-23.02 Installs piping for heat recovery systems.**	**F-23.03 Tests heat recovery systems.**
	F-23.04 Maintains, troubleshoots and repairs heat recovery systems.		

G – PERFORMS COMMISSIONING, START-UP AND TURNOVER

8%

Task G-24 **Prepares system for commissioning, start-up and turnover.** **59%**	**G-24.01 Flushes system.**	**G-24.02 Chemically treats system.**	**G-24.03 Pre-checks system for commissioning.**
	G-24.04 Selects and connects commissioning equipment.		
Task G-25 **Commissions systems.** **41%**	**G-25.01 Secures commissioning area.**	**G-25.02 Pressurizes system.**	**G-25.03 Inspects system.**
	G-25.04 Corrects faulty conditions.	**G-25.05 Participates in start-up and turnover procedures.**	

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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Safety must be paramount to the work activities including due consideration to the environment. All requirements of the manufacturer, client specifications and the authority having jurisdiction (AHJ) must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

A-1.01 Maintains safe work environment

Essential Skills Oral Communication, Thinking Skills, Reading

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.01.01P	participate in tool box meetings	documentation of participation in meetings is signed off
A-1.01.02P	plan pre-hazard assessments before performing each task	pre-hazard assessment plan is in place and task is completed without incident
A-1.01.03P	reference ***safety regulations***	regulations are being followed by workers on site

A-1.01.04P	handle and store hazardous materials	hazardous materials are handled according to WHMIS and controlled products regulations
A-1.01.05P	locate and interpret ***WHMIS materials***	directions on safety data sheets (SDS) are being followed (such as use of PPE and ventilation)
A-1.01.06P	recognize and report unsafe conditions and ***worksite hazards***	conditions are brought to the attention of safety advisors and documented
A-1.01.07P	address or correct the hazard by contacting the Health and Safety representative and supervisor immediately	hazard is mitigated or eliminated and information is documented and communicated to personnel
A-1.01.08P	communicate hazards to co-workers using various ***methods***	co-workers are aware of hazards
A-1.01.09P	keep workplace tidy and organized (housekeeping)	workplace is free of debris and clutter

RANGE OF VARIABLES

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

methods for communicating hazards to co-workers include: verbally, safety meetings, sirens, warning lights, flagging off the area, putting up signage

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-1.01.01K	demonstrate knowledge of safe work practices	identify ***hazards*** and describe safe work practices
A-1.01.02K	demonstrate knowledge of regulatory requirements pertaining to workplace safety	identify and describe local and jurisdictional laws and requirements
		identify and describe company or jurisdictional procedures for emergency response

RANGE OF VARIABLES

work site hazards include: poor housekeeping, overhead hazards, confined space hazards, hot work hazards, asbestos, noise hazards, environmental hazards, vibration hazards, air quality

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

Essential Skills	Document Use, Thinking Skills, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.02.01P	select ***PPE*** and safety equipment for task	***PPE*** and safety equipment selected meets application requirements including fit, specific work hazards and conditions
A-1.02.02P	maintain PPE and ***safety equipment*** by cleaning and ensuring it is in good condition	PPE and ***safety equipment*** is in safe working condition
A-1.02.03P	identify and replace worn, damaged or defective PPE and safety equipment	PPE and safety equipment are tagged and removed from service
A-1.02.04P	store PPE and safety equipment	PPE and safety equipment is organized and stored to prevent damage and theft
A-1.02.05P	complete ***training and certification*** for use of PPE and safety equipment	certifications are achieved to meet jurisdictional and site-specific guidelines
A-1.02.06P	inspect for function, expiration date and fit of PPE and safety equipment	all equipment deficiencies are identified, tagged and removed from service
A-1.02.07P	connect, tie or hook fall-protection and fall-arrest equipment	connection is performed in a manner that restricts user's free fall movement
A-1.02.08P	ensure fall-protection and fall-arrest equipment is re-certified	certification of equipment meets jurisdictional codes and regulations
A-1.02.09P	use PPE and safety equipment	PPE and safety equipment is being used in accordance with jurisdictional and manufacturers' guidelines

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

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

training and certification requirements include: first aid, confined space, fall arrest

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-1.02.01K	demonstrate knowledge of ***PPE*** and ***safety equipment***, its applications, maintenance and procedures for use	identify types of ***PPE*** and safety equipment and describe their applications, limitations and procedures for use
		describe procedures used to care for, maintain and store PPE and ***safety equipment***
A-1.02.02K	demonstrate knowledge of regulatory requirements pertaining to PPE and safety equipment	identify training required by jurisdictional codes and regulations, and site-specific regulations
		identify regulations and safety documentation pertaining to the use of PPE and safety equipment

RANGE OF VARIABLES

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

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

A-1.03 Follows lock-out procedures

Essential Skills Document Use, Reading, Thinking Skills

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.03.01P	determine lock-out requirements for ***system components***	requirements for lock-out are met according to local AHJ and site-specific guidelines
A-1.03.02P	obtain and install designated ***lock-out equipment***	***lock-out equipment*** is placed in correct location based on documentation from owner's representative
A-1.03.03P	complete required ***documentation*** for lock-outs	***documentation*** for lock-out is signed off by involved personnel
A-1.03.04P	apply ***isolation methods*** to system being locked out	system is at a zero-energy state
A-1.03.05P	remove lock-out equipment	***procedural guidelines*** for lock-out removal are followed

RANGE OF VARIABLES

system components that require lock-out include: pumps, valves, electrical panels

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

lock-out documentation includes: lock-out and tag-out 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

procedural guidelines include: tag-in and tag-out, sign-in and sign-out

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-1.03.01K	demonstrate knowledge of applications and procedures for ***locking out equipment***	identify situations that require lock-out
		describe procedures for locking out equipment and piping
		identify safety regulations pertaining to locking out electrical equipment, piping equipment and piping

RANGE OF VARIABLES

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

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. Ladders and work platforms are often required to access job locations. Steamfitters/Pipefitters use various tools and equipment to assemble piping systems. Steamfitter/Pipefitter tasks include welding, soldering, bolting, grooving, threading, fusion and crimping. 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. They must be knowledgeable in setting up the welding, soldering, brazing and oxy-fuel equipment, in welding practices, pipe preparation and cure times.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

Steamfitters/Pipefitters also work closely with quality control specifications in welding tasks. At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

A-2.01 Uses common tools and equipment

Essential Skills Thinking Skills, Document Use, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.01.01P	clean, lubricate and sharpen ***tools and equipment***	tools are in safe working condition
A-2.01.02P	perform visual inspection before using tools and equipment	any ***deficiencies or defects*** are identified
A-2.01.03P	***identify*** and replace worn, damaged or defective tools and equipment	tool is tagged and removed from service
A-2.01.04P	inspect and store tools and equipment	tools and equipment are organized and stored to prevent damage and theft
A-2.01.05P	follow scheduled maintenance procedures for tools and equipment	documentation is completed for maintenance of tools

RANGE OF VARIABLES

tools and equipment (for a list, see appendix A)
deficiencies or defects include: worn, misused, bent, broken, damaged and inoperable tools
identification markings include: tape, colour codes, markings, tags

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.01.01K	demonstrate knowledge of tools and equipment, their applications, maintenance 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
		describe the procedures used to inspect, maintain and store tools and equipment
		demonstrate proper use of tools and equipment

RANGE OF VARIABLES

hand tools include: pipe wrenches, combination wrenches, spacers, wedges, squares, levels
power tools include: electrical, pneumatic, hydraulic
measuring tools include: measuring tape, ruler, manometer

A-2.02 Uses access equipment

Essential Skills Document Use, Thinking Skills, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.02.01P	select ***ladders***	***ladder*** selected meets application requirements
A-2.02.02P	select ***aerial work platforms***	***aerial work platform*** selected meets application requirements
A-2.02.03P	perform visual inspection of ladders and work platforms prior to and during use	safety documentation is completed with required signatures

A-2.02.04P	secure ladders and work platforms	ladders and work platforms are secured according to safety codes, jurisdictional guidelines and site-specific requirements
A-2.02.05P	identify, tag and replace worn, damaged or defective ladders and work platforms	ladders and work platforms are tagged and removed from service
A-2.02.06P	store ladders and work platforms	ladders and work platforms are organized and stored to prevent damage and theft
A-2.02.07P	check certification dates for work platforms	documentation demonstrates that work platforms' certifications are current
A-2.02.08P	obtain motorized aerial work platform training	training meets company policy and jurisdictional requirements

RANGE OF VARIABLES

ladders include: step ladders, extension ladders, platform ladders
aerial work platforms include: scaffolds, motorized work platforms

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.02.01K	demonstrate knowledge of ladders, scaffolding and motorized work platforms, their applications, limitations and procedures for use	identify hazards and describe safe work practices pertaining to ladders, scaffolding and motorized work platforms
		identify ***jurisdictional regulations and site specific requirements*** pertaining to ladders, scaffolding and motorized work platforms
		identify types of ***ladders*** and describe their characteristics and applications
		identify types of ***scaffolding*** and describe their characteristics and applications
		identify types of ***motorized work platforms*** and describe their characteristics and applications
		describe the procedures used to erect and dismantle ladders and scaffolding

RANGE OF VARIABLES

jurisdictional regulations and site specific requirements include: personnel training/certification, equipment certification requirements, proper use and limitations of equipment
ladders includes: step ladders, extension ladders, platform ladders
scaffolding includes: tube and clamp, swing stage, frame scaffolding
motorized work platforms include: scissor lift, articulated boom, personnel basket

A-2.03 Uses welding equipment

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.03.01P	assist in the selection of ***welding equipment***	***welding equipment*** is appropriate for application and materials
A-2.03.02P	handle ***welding consumables***	handling is performed according to quality control requirements
A-2.03.03P	match alloys to specific components to be welded	alloy selected matches quality control requirements
A-2.03.04P	assist in setting up machine	machine is set up according to application
A-2.03.05P	protect surrounding equipment and flammable materials while welding	flammable materials are protected or removed from vicinity of welding work, and equipment is protected
A-2.03.06P	perform tack welding	tack welds are performed within jurisdictional limitations
A-2.03.07P	assist in performing visual inspections in order to maintain welding equipment	all defects in welding equipment are identified
A-2.03.08P	assist in identifying, tagging and replacing worn, damaged or defective welding equipment	welding equipment is in safe and operable condition

RANGE OF VARIABLES

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

welding consumables include: welding rods, flux, grinding discs

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.03.01K	demonstrate knowledge of ***welding equipment***, applications and procedures	identify types of ***welding equipment***
		identify different ***welding processes*** and applications
		identify ***welding consumables***
		identify certification requirements for performing welding

	demonstrate use of welding equipment according to industry standards
	describe the procedures used to inspect, maintain and store welding equipment

RANGE OF VARIABLES

welding equipment includes: SMAW equipment, orbital welding machines and equipment, GTAW equipment, torches, GMAW equipment

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

welding consumables include: welding rods, flux, grinding discs

A-2.04 Uses soldering and brazing equipment

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.04.01P	select ***soldering and brazing equipment***	***soldering and brazing equipment*** is appropriate for application and materials
A-2.04.02P	set up soldering and brazing equipment	setup is performed according to application
A-2.04.03P	match alloys to specific components to be soldered or brazed	alloy selected matches quality control requirements
A-2.04.04P	select flux and solder according to application	flux and solder selected meets requirements of weld procedures and quality control requirements
A-2.04.05P	join piping fittings and components	standards for brazed or soldered materials are met through inspection by quality assurance and local AHJ
A-2.04.06P	purge piping and tubing	piping and tubing are purged ensuring system remains a closed system to prevent environmental contamination
A-2.04.07P	protect equipment and flammable materials while soldering and brazing	flammable materials are protected or removed from vicinity of soldering and brazing work, and equipment is protected
A-2.04.08P	maintain soldering and brazing equipment	soldering and brazing equipment is in safe and operable condition

A-2.04.09P	identify, tag and replace worn, damaged or defective soldering and brazing equipment	defects in soldering and brazing equipment are identified
A-2.04.10P	store soldering and brazing equipment	soldering and brazing equipment are organized and stored to prevent damage and theft
A-2.04.11P	store fuel cylinders according to specifications	fuel cylinders are stored in ventilated storage unit in an upright position

RANGE OF VARIABLES

soldering and brazing equipment include: oxy-acetylene and air-acetylene torches, attachments (strikers, methylacetylene-propadiene propane [MAPP] gas cylinder, torch heads)

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-2.04.01K	demonstrate knowledge of ***soldering and brazing equipment***, applications and procedures	identify types of ***soldering and brazing equipment***
		identify different soldering and brazing processes and applications
		identify ***purge procedures*** required for brazing
		identify ***soldering and brazing consumables***
		identify certification requirements for performing brazing
		demonstrate use of soldering and brazing equipment according to industry standards
		describe the procedures used to inspect, maintain and store soldering and brazing equipment

RANGE OF VARIABLES

soldering and brazing equipment includes: oxy-acetylene and air-acetylene torches, attachments (strikers, MAPP, gas cylinder and torch heads)

purge procedures include: dams, purge gas, pressures, flow rates

soldering and brazing consumables include: silver solder, flux, soft solder, brazing rod, sand cloth

A-2.05 Uses oxy-fuel equipment

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.05.01P	select oxy-fuel equipment	oxy-fuel equipment is appropriate for application and materials
A-2.05.02P	set up oxy-fuel gauges and torches	setup is performed according to safe work practices
A-2.05.03P	select tips according to application and fuel use	tips selected match material being cut or heated
A-2.05.04P	protect equipment and flammable materials while operating oxy-fuel equipment	flammable materials are protected or removed from vicinity of work, and equipment is protected
A-2.05.05P	identify, tag and replace worn, damaged or defective oxy-fuel equipment	defects in oxy-fuel equipment are identified and defective equipment is removed from service
A-2.05.06P	store oxy-fuel equipment	oxy-fuel equipment is stored in ventilated storage unit in an upright position

RANGE OF VARIABLES

oxy-fuel equipment includes: flashback arrestors, regulators

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.05.01K	demonstrate knowledge of oxy-fuel equipment, applications and procedures	identify ***oxy-fuel equipment components***
		demonstrate use of oxy-fuel equipment according to industry standards
		describe the procedures used to inspect, maintain and store oxy-fuel equipment

RANGE OF VARIABLES

oxy-fuel equipment components include: hoses, flashback arrestors

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 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, joining methods,-templates, which are used in the layout and fabrication of fittings such as mitres and branch connections.

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 preliminary quality control checks to ensure compliance with specifications and AHJ requirements.

INDUSTRY EXPECTED PERFORMANCE

These organizational tasks must be done to the satisfaction of the client, the project engineer and the AHJ. All health and safety standards must be respected and considered in planning activities.

Work should be done efficiently and at a high quality without material waste or environmental damage. At a journeyperson level of performance, tasks should be done independently and with minimal supervision.

A-3.01 Plans work

Essential Skills Thinking Skills, Oral Communication, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.01.01P	identify task and sequence of tasks	task planning is done with construction sequence in mind
A-3.01.02P	identify tools, piping, equipment and components required for task	required tools, piping, equipment and components are identified
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	work practices are tracked in productivity reports and work schedule
A-3.01.05P	verify that required permits are in place before commencing work	required documentation is filed according to site requirements
A-3.01.06P	adapt to changing ***environmental conditions***	work schedule includes a back-up plan to accommodate for unexpected conditions

A-3.01.07P	organize ***work area requirements***	work practices are tracked in productivity reports and work schedule
A-3.01.08P	expedite tools, material and spool pieces to installation location	required 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 may involve: installing temporary shelters, platforms and heaters, waste disposal, wash cars, lunch rooms, specific site safety requirements

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.01.01K	demonstrate knowledge of the procedures used to plan and organize work	identify ***sources of information*** relevant to work planning
		describe the ***considerations*** for determining job requirements
		describe the ***procedures used to plan work***
		describe the procedures used to organize and maintain inventory
A-3.01.02K	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: documentation, drawings, related professionals, clients

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

planning procedures include: scheduling, estimating

A-3.02 Generates drawings

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.02.01P	select and use ***layout and drafting tools and equipment***	drawing is clear and able to be interpreted for fabrication
A-3.02.02P	sketch types of ***drawings***	types of sketches generated meet requirements of the application
A-3.02.03P	apply ***trade-related symbols*** to sketches	symbols on sketches match the process and instrumentation drawings (P&ID)
A-3.02.04P	create as-built drawings to illustrate final installation	as-built drawing reflects actual installation
A-3.02.05P	determine location of piping and equipment	piping location matches the plan views
A-3.02.06P	determine dimensions using ***tools***	drawings reflect engineer's drawings
A-3.02.07P	illustrate three-dimensional visualization using orthographic and isometric drawings	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, compasses

drawings include: isometric, weld maps, spool drawings, schematics

trade-related symbols include: valves, socket welds, caps, tees, 90s, flanges, tie-ins, weld symbols, penetrations, equipment, supports

tools include: scale rules, calculators

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.02.01K	demonstrate knowledge of drawings and their applications	describe metric and imperial systems of measurement and the procedures used to perform conversions
		identify the types of ***drawings*** and describe their applications
		identify types of symbols and describe their characteristics and applications
		identify ***drawing projections*** and ***views***, and describe their applications

		describe the use of scales
A-3.02.02K	demonstrate knowledge of basic drawing and sketching techniques	demonstrate basic drawing and sketching techniques

RANGE OF VARIABLES

drawings include: civil/site, architectural, mechanical, structural, electrical, shop drawings, sketches
drawing projections include: orthographic, oblique, isometric, pictorial
drawing views include: plan, section, detail, elevation, cross section

A-3.03 Interprets drawings and specifications

Essential Skills	Document Use, Oral Communication, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.03.01P	verify accuracy of specifications by comparing to drawings in order to select material required for installation	material list is produced with material and equipment required for installation
A-3.03.02P	transfer ***information*** from specifications to drawings	required material and equipment is on drawing
A-3.03.03P	communicate discrepancies with authorities such as supervisor or engineer	change orders and revisions are documented
A-3.03.04P	identify drawing revisions	piping installation reflects revisions from engineer
A-3.03.05P	gather information from multiple ***drawings***	***drawings*** are verified to be correct or Request for Information (RFI) are completed
A-3.03.06P	determine dimensions using ***tools***	drawings reflect engineer's drawings
A-3.03.07P	reference spool drawings to identify scope of work, fabricate piping and components, and install systems	piping fits as designed
A-3.03.08P	identify types of piping systems, piping and equipment from drawings	interpretation of drawing type matches the actual installation
A-3.03.09P	relate line numbering systems to drawings	line numbers are correct on the drawing
A-3.03.10P	access drawings and specification information using ***digital tools and software*** for layout and installation (dimensional control)	***digital tools and software*** are used to identify location of piping and equipment in relation to the facility

RANGE OF VARIABLES

information includes: abbreviations, drafting symbols (lines, weld symbols, piping and fitting symbols, control symbols)

drawings include: structural, electrical, architectural, P&ID, schematic, civil, general arrangement drawings (GA)

tools include: scale rules, calculators

digital tools and software include: total station, auto-CAD, CAD

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.03.01K	demonstrate ability to interpret and extract information from types of ***drawings and specifications***	identify types of ***drawings and specifications*** and describe their applications
		identify symbols relating to drawings and describe their characteristics and applications
		interpret and extract information from drawings and specifications
A-3.03.02K	demonstrate knowledge of drawings and their applications	describe metric and imperial systems of measurement and the procedures used to perform conversions
		identify ***drawing projections*** and ***views*** and describe their applications
		describe the use of scales
A-3.03.03K	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

drawings and specifications include: P&ID, spool sheets, isometric drawings, revisions, vendor/shop civil/site, architectural, mechanical, structural, electrical, shop drawings, sketches

drawing projections include: orthographic, oblique, isometric, pictorial

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

digital tools and software includes: total station, auto-CAD, CAD, building information management (BIM)

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

A-3.04 Develops piping templates

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.04.01P	identify required ***template***	***template*** used matches requirements of application
A-3.04.02P	plan development of template to meet requirements	template fabrication plan is appropriate to the task and situation
A-3.04.03P	determine measurements for coordinates on pipe in order to create the template	template matches the intended pipe size and orientation
A-3.04.04P	measure pipe and lay out coordinates on the pipe	fittings and markings on pipe are sufficient to build a template

RANGE OF VARIABLES

template includes: tee, wye, mitre

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.04.01K	demonstrate knowledge of the methods of template development and their associated procedures	interpret information pertaining to template development found on drawings
		identify ***tools and equipment relating to template development*** and describe their applications and procedures for use
		identify the ***methods used for template development***
		describe the procedures used to develop templates
		identify ***specifications for piping requirements*** used in template development

RANGE OF VARIABLES

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

methods used for template development include: standard template design, alternative template development methods

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

A-3.05 Performs quality control functions

Essential Skills Document Use, Reading, Thinking Skills

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.05.01P	use ***quality control documentation***, codes, specifications and engineered drawings	documentation completed matches actual specifications and installation (moaning)
A-3.05.02P	identify piping materials	installed material matches specifications and documentation
A-3.05.03P	perform ***QC testing procedures***	tests are performed to specification requirements
A-3.05.04P	reference weld procedures	tracer indicates welding procedures specifications (WPS) and consumables for the application
A-3.05.05P	document material for traceability and verify the types of piping within the system	tracer indicates WPS and material used in the system
A-3.05.06P	monitor pre- and post-heated, heat treated and stress relieved materials	***monitoring sensors*** confirm integrity of the weld meets specifications
A-3.05.07P	verify torque requirements	***documentation*** confirms that torque requirements meet QC specifications
A-3.05.08P	apply recommended ***coating*** to welded joints on piping	***coatings*** are applied to prevent weld degradation in accordance with specifications
A-3.05.09P	perform visual inspection of entire system	system documentation indicates that it is in compliance with specifications
A-3.05.10P	arrange for ***non-destructive examination (NDE)*** inspection of welded joints and piping	documentation received by third party indicates that examination was performed in compliance with specifications

RANGE OF VARIABLES

quality control (QC) documentation includes: manuals, mill test reports, Canadian Registration Numbers (CRN)

QC testing procedures include: vacuum, hydrostatic, pneumatic

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

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

coatings include: pickling, synthetic coatings

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
A-3.05.01K	demonstrate knowledge of quality control and its applications	identify hazards and safe work practices pertaining to quality control
		interpret information pertaining to quality control found on drawings and specifications
		identify tools and equipment relating to quality control
		identify methods of NDE
		identify methods of heat treatment and stress relief
A-3.05.02K	demonstrate knowledge of procedures used to complete quality control documentation	identify types of ***QC documentation*** and describe their applications

RANGE OF VARIABLES

QC documentation includes: manuals, torque sheets, bolt tensioning sequence, mill test reports, welders logs

MAJOR WORK ACTIVITY B
PERFORMS LAYOUT, FABRICATION AND PIPING INSTALLATION

TASK B-4 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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be adhered to. Work should be done efficiently and at a high quality without material waste or environmental damage. LEED guidelines should be followed where applicable. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-4.01 Fabricates piping system components

Essential Skills	Document Use, Thinking Skills, Reading, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-4.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected for ***piping system components*** to be fabricated
B-4.01.02P	check material list to ascertain ***material*** quantities and type	***materials*** are selected according to material list and item to be fabricated
B-4.01.03P	assemble piping system components using layout techniques, ***joining methods*** and ***fabrication techniques***	piping system components are assembled
B-4.01.04P	clean and protect piping system components using ***treating methods***	piping system components are cleaned and protected

B-4.01.05P	fit and position piping system components	piping system components are oriented, fitted and positioned according to ***fitting tolerance practices,*** and joining method for the application is used
B-4.01.06P	pre-heat or purge piping material and verify joining method using ***verification tools and equipment***	piping system components meet pressure testing, QA/QC control requirements and commissioning specifications for completed project
B-4.01.07P	perform ***post-weld activities***	***post-weld activities*** are performed according to QC welding procedures
B-4.01.08P	check completed work for conformity to specifications and requirements of field installation	completed work meets specifications and field installation requirements
B-4.01.09P	generate field required drawings where none exist	drawing is legible, clear, and reflects field requirements
B-4.01.10P	document weld mapping	weld mapping is documented according to QC procedures
B-4.01.11P	identify piping system components and cross reference to ***installation drawings***	piping system components cross referenced to ***installation drawings***
B-4.01.12P	test piping system components using ***testing methods***	tests completed according to ***testing*** procedures

RANGE OF VARIABLES

tools and equipment include: pipe stands, pipe vises, bevelling machines, levels, measuring tools and flange squares
piping system components include: pipe spools, fittings, valves
materials include: structural steel, pipe fittings, pipe
joining methods include: threading, grooving, crimping, gluing, welding, compression, fusion
fabrication techniques include: cutting, bending, bevelling
treating methods include: applying protective coatings, pickling, 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
testing methods include: hydrostatic, pneumatic

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-4.01.01K	demonstrate knowledge of the procedures used to fabricate ***piping system components***	identify ***tools and equipment*** relating to ***piping system component*** fabrication and describe their applications and procedures for use
		interpret information pertaining to piping system component fabrication found on drawings and specifications
		interpret ***codes and regulations*** pertaining to piping system component fabrication

	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/post-weld activities*** and describe their applications
	describe the procedures used to fabricate and assemble piping system components

RANGE OF VARIABLES

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

B-4.02 Fabricates brackets, supports, hangers, guides and anchors

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-4.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected for brackets, supports, hangers, guides and anchors to be fabricated
B-4.02.02P	check material list to ascertain ***material*** quantities and type	***materials*** are selected according to material list and item to be fabricated
B-4.02.03P	assemble materials and ***support components*** using ***joining methods*** and ***fabrication techniques***	support components meet QA/QC control requirements and commissioning specifications for completed project

B-4.02.04P	apply ***pipe protection***	pipe is protected from wear on the support
B-4.02.05P	fit and position materials and support components	materials and support components are oriented, fitted and positioned according to dimensions of insulation and calculated expansion, and joining method for the application is used
B-4.02.06P	pre-heat materials and support components, and verify joining method using ***verification tools and equipment***	pipe protection materials and support components meet QA/QC control requirements and commissioning specifications for project
B-4.02.07P	perform ***post-weld activities***	***post-weld activities*** are performed according to QC welding procedures
B-4.02.08P	check completed work for conformity to specifications and requirements of field installation	completed work meets specifications and field installation requirements
B-4.02.09P	generate field required bracket and support drawings where none exist	drawings are legible, clear and reflect field requirements
B-4.02.10P	document weld mapping	weld mapping is documented according to QC procedures
B-4.02.11P	identify brackets, supports, hangers, guides, anchors and fittings and cross reference to ***installation drawings***	brackets, supports, hangers, guides, anchors and fittings are cross referenced to ***installation drawings***
B-4.02.12P	inspect joining methods	***inspections*** are completed according to inspection 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
support components include: anchors, shoes, trunions, dummy legs, guides
joining methods include: bolt-on, inserting, welding
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 includes: stress relieving, controlled cooling
installation drawings include: GA, orthographic, isometric
inspections are NDE

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-4.02.01K	demonstrate knowledge of the procedures used to fabricate brackets, supports, hangers, guides and anchors	interpret information pertaining to brackets, supports, hangers, guides and anchors fabrication found on drawings and specifications
		interpret ***codes and regulations*** pertaining to brackets, supports, hangers, guides and anchors fabrication
		identify ***fabrication tools and equipment*** relating to brackets, supports, hangers, guides and anchors fabrication and describe their applications and procedures for use
		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
		describe the procedures used to fabricate and assemble brackets, supports, hangers, guides and anchors

RANGE OF VARIABLES

codes and regulations include: ASME B31, Canadian Welding Bureau (CWB)

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

joining methods include: bolt-on, inserting, welding

fabrication techniques include: cutting, bending, bevelling

post-weld activities include: stress relieving, controlled cooling

TASK B-5 LAYS OUT, IDENTIFIES AND INSTALLS PIPPING, 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. Testing of these systems follows strict guidelines predetermined by industry.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. These codes and standards include American Society of Testing and Materials (ASTM), Canadian Standards Association (CSA), and American Petroleum Institute (API). All health and safety standards must be adhered to. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-5.01 Lays out, identifies and installs copper tube, tubing, fittings and related components

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-5.01.01P	select and use ***tools and equipment***	***tools and equipment*** selected according to types of ***tube and tubing*** and task
B-5.01.02P	select and inspect tube and tubing material	tube and tubing is selected according to drawings and has visible ASTM incised markings
B-5.01.03P	prepare material list	material list is cross referenced against packing list and drawings
B-5.01.04P	take field measurements	field measurements taken are complete and accurate
B-5.01.05P	measure, calculate and mark tube and tubing	tube and tubing is laid out according to drawings
B-5.01.06P	cut and ream tube and tubing	tube and tubing is cut using ***cutting and reaming tools and equipment*** according to the type and size of tubing
B-5.01.07P	bend tube and tubing	tube and tubing is assembled to the required dimensions using ***bending tools and equipment***

B-5.01.08P	prepare, assemble and join tube and tubing using ***preparation*** and ***joining methods***	tube and tubing ***joining*** and ***preparation methods*** are performed to produce a leak-free joint
B-5.01.09P	Install tube, tubing, expansion joints, swing joints, expansion loops and ***related components***	tube and tubing is installed according to drawings, is supported, is at the correct elevation and coordinates, and incised markings are clearly visible where practical
B-5.01.10P	generate field required bracket and support drawings where none exist	drawings are legible, clear and reflect field requirements
B-5.01.11P	perform mapping of joints	mapping is documented according to QC procedures
B-5.01.12P	itemize tube, tubing, fittings and related components and cross reference to drawings	tube, tubing, fittings and related components are matched to the drawings
B-5.01.13P	torque flanged joints	flanged joints hold required pressure and are documented
B-5.01.14P	anneal tube and tubing	tube and tubing is pliable and is not kinked
B-5.01.15P	test tube, tubing**,** fittings and related components using ***testing methods***	tests are completed according to testing requirements

RANGE OF VARIABLES

tools and equipment include: tube cutters, tube benders, reamers, soldering, brazing, flaring, grooving equipment

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

cutting and reaming tools and equipment include: tubing cutters, hack saws, reamers, power cutting tools

bending tools and equipment include: hand benders, hydraulic benders

preparation methods include: reaming and sanding

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

related components include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

testing methods include: hydrostatic, pneumatic

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-5.01.01K	demonstrate knowledge of ***copper tube and tubing***, fittings and ***related components***	identify ***tools and equipment*** relating to ***copper tube and tubing***, fittings and their ***components*** and describe their applications and procedures for use
		interpret ***codes and regulations*** pertaining to copper tube and tubing
		interpret information pertaining to copper tubing found on drawings and specifications

		describe the identification systems and ***methods of identification*** for copper tube and tubing
		identify types of ***fittings*** used with copper tube and tubing and describe their purpose and applications
		identify copper tube and tubing related components and describe their purpose and applications
B-5.01.02K	demonstrate knowledge of the procedures used to measure and size copper tube and tubing and related components	explain the ***systems of measurement*** for copper tube and tubing
		identify the systems and criteria used in referencing, selecting and ordering copper tube and tubing
		describe the ***procedures*** used to measure copper tube and tubing and fittings
B-5.01.03K	demonstrate knowledge of the procedures used to cut, bend and join copper tube and tubing and related components	identify the methods used to cut copper tube, and tubing, and describe their associated procedures and ***cutting and reaming tools and equipment***
		demonstrate ***joining methods*** for copper tube and tubing
		describe the procedures and ***bending tools and equipment*** used to bend copper tube and tubing
		describe the procedures used to install and test copper tube, tubing, fittings and related components

RANGE OF VARIABLES

copper tube and tubing related components include: bolts, studs, gaskets, brackets, supports, hangers, spring cans, guides, anchors

tools and equipment include: tube cutters, tube benders, reamers, soldering, brazing

codes and regulations include: manufacturers' certification requirements, ASTM

types/methods of identification of copper tubing include: M, L, K, DWV, ACR

fittings include: elbows, tees, crosses

systems of measurement include: dimension, diameter, length

measuring procedures include: fitting allowance, offset calculations, trade math

cutting and reaming tools and equipment include: tubing cutters, hack saws, reamers, power cutting tools

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

bending tools and equipment include: hand benders, hydraulic benders

B-5.02 Lays out, identifies and installs plastic piping, tubing, fittings and related components

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-5.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to *types of* ***piping and tubing*** and task
B-5.02.02P	select and inspect piping and tubing material	piping and tubing are selected according to drawings and markings
B-5.02.03P	prepare material list	material list is cross referenced against packing list and drawings
B-5.02.04P	take field measurements	field measurements taken are complete and accurate
B-5.02.05P	measure, calculate and mark piping and tubing	piping and tubing are laid out according to drawings
B-5.02.06P	cut and ream piping and tubing	pipe and tubing are cut using ***cutting and reaming tools and equipment*** according to type of piping and tubing
B-5.02.07P	bend pipe and tubing	piping and tubing are built to required dimension using ***bending tools and equipment***
B-5.02.08P	prepare, assemble and join piping and tubing using ***preparation*** and ***joining methods***	piping and tubing ***joining*** and ***preparation methods*** are performed to produce a leak-free joint
B-5.02.09P	install piping, tubing, expansion joints, swing joints and expansion loops, and ***related components***	piping and tubing are installed according to drawings, are supported, are at the correct elevation and coordinates and markings are clearly visible where practical
B-5.02.10P	generate field required bracket and support drawings where none exist	drawings are legible and clear, and reflect field requirements
B-5.02.11P	perform mapping of joints	mapping is documented according to QC procedures
B-5.02.12P	itemize piping and tubing, fittings and related components and cross reference to drawings	piping and tubing, fittings and related components are matched to the drawings

B-5.02.13P	torque flanged joints	flanged joints hold required pressure and are documented
B-5.02.14P	test piping and tubing fittings and related components using ***testing methods***	tests are completed according to testing requirements

RANGE OF VARIABLES

tools and equipment include: tube cutters, fusion machines, scrapers, facers, reamers, crimpers, expansion tools

piping and tubing include: acrylonitrile butadiene styrene (ABS), polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), cross-linked PE (PEX)

cutting and reaming tools and equipment include: tubing cutters, hack saws, reamers, power cutting tools

bending tools and equipment include: heated bending tools

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

preparation methods include: sanding, priming, bevelling

related components include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

testing methods include: hydrostatic, pneumatic

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-5.02.01K	demonstrate knowledge of ***plastic piping and tubing***, fittings and ***related components***	identify ***tools and equipment*** relating to ***plastic piping and tubing***, fittings and ***related components*** and describe their applications and procedures for use
		interpret codes and regulations pertaining to ***plastic piping and tubing***
		interpret information pertaining to plastic piping and tubing found on drawings and specifications
		describe the identification systems and methods of identification for plastic piping and tubing
		identify types of plastic piping and tubing and describe their purpose and applications
		identify types of ***fittings*** used with plastic piping and tubing and describe their purpose and applications
		identify plastic piping and tubing related components and describe their purpose and applications
B-5.02.02K	demonstrate knowledge of the procedures used to measure and size plastic piping, tubing and related components	explain the ***systems of measurement*** for plastic piping and tubing
		describe the ***procedures*** used to ***measure*** plastic piping, tubing and fittings

		identify the systems and criteria used in referencing, selecting and ordering plastic piping and tubing
B-5.02.03K	demonstrate knowledge of the procedures used to cut, bend and join plastic piping, tubing and related components	identify the methods used to cut plastic pipe and tubing, and describe their associated procedures and ***cutting and reaming tools and equipment***
		demonstrate ***joining methods*** for plastic pipe and tubing
		describe the procedures and ***bending tools and equipment*** used to bend plastic piping and tubing
		describe the procedures used to install and ***test*** plastic piping and tubing, fittings and related components

RANGE OF VARIABLES

tools and equipment include: tube cutters, fusion machines, scrapers, facers, reamers

plastic piping and tubing related components include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

plastic piping and tubing include: ABS, CPVC, PP, PE, PEX

fittings include: elbows, tees, crosses

systems of measurement include: dimension, length

measuring procedures include: fitting allowance, offset calculations, trade math

cutting and reaming tools and equipment include: tubing cutters, hack saws, reamers, power cutting tools

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

bending tools and equipment include: heated bending tools

testing methods include: hydrostatic, pneumatic

B-5.03 Lays out, identifies and installs carbon steel piping, tubing, fittings and related components

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-5.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to types of ***carbon steel piping and tubing*** and task
B-5.03.02P	select and inspect piping and tubing material	piping and tubing are selected according to drawings and have visible markings
B-5.03.03P	prepare material list	material list is cross referenced against packing list and drawings
B-5.03.04P	take field measurements	field measurements taken are correct and accurate
B-5.03.05P	measure, calculate and mark piping and tubing	piping and tubing are laid out according to drawings
B-5.03.06P	cut and prepare piping and tubing	piping and tubing are cut using ***cutting***, ***bevelling and threading tools and equipment***, and are prepared according to type of piping and tubing
B-5.03.07P	bend pipe and tubing	piping and tubing are built to required dimension using ***bending tools and equipment***
B-5.03.08P	prepare, assemble and join piping and tubing using ***preparation*** and ***joining methods***	piping and fittings are orientated and aligned to match installation drawings; and fitting tolerance such as gap, high-low and alignment are addressed
B-5.03.09P	perform ***pre/post-weld activities***	***pre/post-weld activities*** are performed according to QC welding procedures
B-5.03.10P	install piping and tubing, expansion joints, swing joints, expansion loops and ***related components***	piping and tubing are installed according to drawings, are supported, are at the correct elevation and coordinates; and markings are clearly visible where practical
B-5.03.11P	generate field required bracket and support drawings where none exist	drawings are legible and clear, and reflect field requirements
B-5.03.12P	perform mapping of joints	mapping is documented according to QC procedures
B-5.03.13P	itemize piping and tubing, fittings and related components and cross reference to drawings	piping and tubing, fittings and related components are matched to the drawings

B-5.03.14P	torque flanged joints	flanged joints are torqued to QC specifications
B-5.03.15P	test piping and tubing, fittings and related components using ***testing methods***	tests are completed according to testing requirements

RANGE OF VARIABLES

tools and equipment include: grinders, oxyacetylene cutting torches, threading equipment, files, grooving equipment, tube cutters, tube benders

carbon steel piping and tubing include: grades, schedules

cutting, bevelling and threading tools and equipment include: grinders, reamers, power cutting tools, cutters

bending tools and equipment include: hand benders, hydraulic benders

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

preparation methods include: grinding, reaming, cutting, bevelling

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

related components include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

testing methods include: hydrostatic, pneumatic

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-5.03.01K	demonstrate knowledge of ***carbon steel piping and tubing***, fittings and related components	identify ***tools and equipment*** relating to ***carbon steel piping and tubing***, fittings and related components and describe their applications and procedures for use
		interpret ***codes and regulations*** pertaining to carbon steel piping
		interpret information pertaining to carbon steel piping and tubing found on drawings and specifications
		describe the identification systems and methods of identification for carbon steel piping and tubing
		identify ***fittings*** used with carbon steel piping and tubing and describe their purpose and applications
		identify ***carbon steel piping and tubing related components*** and describe their purpose and applications
B-5.03.02K	demonstrate knowledge of the procedures used to measure carbon steel piping and tubing	explain the ***systems of measurement*** for carbon steel piping and tubing
		describe the ***procedures*** used to ***measure*** carbon steel piping and tubing, and fittings
B-5.03.03K	demonstrate knowledge of the procedures used to cut and join carbon steel piping and tubing	describe the ***procedures*** used to ***inspect*** carbon steel piping and tubing

	describe the different ***methods*** of pipe and fitting end ***preparation***
	identify the methods used to cut carbon steel piping and tubing, and describe their associated procedures and ***cutting, bevelling and threading tools and equipment***
	identify the ***joining methods*** for carbon steel piping and tubing and describe their associated procedures
	describe pre/post-weld activities
	describe the procedures and ***bending tools and equipment*** used to bend carbon steel piping and tubing
	describe the procedures used to install and test fittings and related components for carbon steel piping and tubing

RANGE OF VARIABLES

tools and equipment include: grinders, oxyacetylene cutting torches, threading equipment, files, grooving equipment, tube cutters, tube benders

carbon steel piping and tubing include: grades, schedules

codes and regulations include: ASME B31

fittings include: elbows, tees, crosses

carbon steel piping and tubing related components include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

systems of measurement include: dimension, length, wall thickness/schedule

measuring procedures include: fitting allowance, offset calculations, trade math

inspection procedures include: quality assurance, quality control (QA/QC) requirements

preparation methods include: standard bevel, compound bevel

cutting, bevelling and threading tools and equipment include: grinders, reamers, power cutting tools, cutters

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

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

bending tools and equipment include: hand benders, hydraulic benders

B-5.04 Lays out, identifies and installs stainless steel piping, tubing, fittings and related components

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-5.04.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to types of ***stainless steel piping and tubing*** and task
B-5.04.02P	select and inspect piping and tubing material	piping and tubing are selected according to drawings and have visible markings
B-5.04.03P	prepare material list	material list is cross referenced against packing list and drawings
B-5.04.04P	take field measurements	field measurements are taken
B-5.04.05P	measure, calculate and mark piping and tubing	piping and tubing is laid out according to drawings
B-5.04.06P	cut and prepare piping and tubing	piping and tubing is cut using ***cutting***, ***bevelling and threading tools and equipment*** and prepared according to type of piping and tubing
B-5.04.07P	bend pipe and tubing	piping and tubing is built to required dimension using ***bending tools and equipment***
B-5.04.08P	prepare piping and tubing for assembly	piping and fittings are orientated and aligned to match installation drawings, and fitting tolerances such as gaps, high-low and alignment are addressed
B-5.04.09P	assemble and join piping and tubing using ***joining methods***	piping and tubing ***joining method*** is performed to produce a leak-free joint
B-5.04.10P	perform ***pre/post-weld activities***	***pre/post-weld activities*** are performed according to QC welding procedures
B-5.04.11P	prevent ***contamination*** of the parent material	tools and equipment are isolated to avoid ***cross contamination*** between stainless steel and other materials
B-5.04.12P	install piping, tubing, expansion joints, swing joints, expansion loops, and ***related components***	piping and tubing are installed according to drawings, are supported at the correct elevation and coordinates; and markings are clearly visible where practical
B-5.04.13P	generate field required bracket and support drawings where none exist	drawings are legible and clear, and reflect field requirements
B-5.04.14P	perform mapping of joints	mapping is documented according to QC procedures

B-5.04.15P	itemize piping, fittings and related components and cross reference to drawings	piping, tubing, fittings and related components are matched to the drawings
B-5.04.16P	torque flanged joints	flanged joints hold required pressure and are documented
B-5.04.17P	test piping and tubing fittings and related components using **testing methods**	tests are completed according to testing requirements

RANGE OF VARIABLES

tools and equipment include: grinders, plasma cutters, threading equipment, files, grooving equipment, tube cutters, tube benders

stainless steel piping and tubing include: 304, 308, 316 stainless steel

cutting, bevelling and threading tools and equipment include: grinders, reamers, power cutting tools, cutters

bending tools and equipment include: hand benders, hydraulic benders

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

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

cross contamination control methodology includes: labelling, physical separation, barriers

related components include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

testing methods include: hydrostatic, pneumatic

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-5.04.01K	demonstrate knowledge of ***stainless steel piping and tubing***, fittings and related components	describe the procedures and methods to prevent ***cross contamination***
		identify ***tools and equipment*** relating to stainless steel piping, tubing, fittings and related components and describe their applications and procedures for use
		interpret ***codes and regulations*** pertaining to stainless steel piping
		interpret information pertaining to stainless steel piping and tubing found on drawings and specifications
		describe the identification systems and methods for stainless steel piping and tubing
		identify ***fittings*** used with stainless steel piping and tubing and describe their purpose and applications
		identify ***stainless steel piping and tubing related components*** and describe their purpose and applications
B-5.04.02K	demonstrate knowledge of the procedures used to measure stainless steel piping	explain the ***systems of measurement*** for stainless steel piping and tubing

		describe the ***procedures*** used to ***measure*** stainless steel piping and tubing and fittings
B-5.04.03K	demonstrate knowledge of the procedures used to cut and join stainless steel piping	describe the ***procedures used to inspect*** stainless steel piping and tubing
		identify the methods used to cut stainless steel piping and tubing, and describe their associated procedures and ***cutting, bevelling and threading tools and equipment***
		describe the different ***methods*** of pipe and fitting end ***preparation***
		identify the ***joining methods*** used to join stainless steel piping and tubing and describe their associated procedures
		describe ***pre/post-weld activities***
		describe the procedures and ***bending tools and equipment*** used to bend stainless steel piping and tubing
		describe the procedures used to install and ***test*** fittings and related components for stainless steel piping and tubing

RANGE OF VARIABLES

stainless steel piping and tubing include: 304, 308, 316 stainless steel

cross contamination control methodology include: labelling, physical separation, barriers

tools and equipment include: grinders, plasma cutters, threading equipment, files, grooving equipment, tube cutters, tube benders

codes and regulations include: ASME B31

fittings include: elbows, tees, crosses

stainless steel piping and tubing related components include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

systems of measurement include: dimension, length, wall thickness/schedule

measuring procedures include: fitting allowance, offset calculations, trade math

inspection procedures include: QA/QC requirements

cutting, bevelling and threading tools and equipment include: grinders, reamers, power cutting tools, cutters

preparation methods include: standard bevel, compound bevel

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

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

bending tools and equipment include: hand benders, hydraulic benders

testing methods include: hydrostatic, pneumatic, NDE

B-5.05 Lays out, identifies and installs fibreglass piping, fittings and related components

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-5.05.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to types of ***piping*** and task
B-5.05.02P	select and inspect piping material	piping is selected according to drawings
B-5.05.03P	prepare material list	material list is cross referenced against packing list and drawings
B-5.05.04P	take field measurements	field measurements are taken
B-5.05.05P	measure, calculate and mark piping	piping is laid out according to drawings
B-5.05.06P	cut and prepare piping using ***cutting***, ***tapering and/or sanding tools and equipment***	pipe is cut and prepared such as being tapered and/or sanded according to type of piping
B-5.05.07P	assemble and join piping using ***joining methods***	piping ***joining method*** is performed to produce a leak-free joint
B-5.05.08P	install piping and ***related components***	piping is installed according to drawings, is supported at the correct elevation and coordinates; and markings are clearly visible where practical
B-5.05.9P	generate field required bracket and support drawings where none exist	drawings are legible, clear and reflect field requirements
B-5.05.10P	perform mapping of joints	mapping is documented according to QC procedures
B-5.05.11P	itemize piping, fittings and related components and cross reference to drawings	piping, fittings and related components are matched to the drawings
B-5.05.12P	torque flanged joints	flanged joints hold required pressure and are documented
B-5.05.13P	test piping fittings and related components using ***testing methods***	tests are completed according to testing requirements

RANGE OF VARIABLES

tools and equipment include: heat belts, air saws, jig saws, grinders

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

cutting, ***tapering and sanding tools and equipment*** include: hack saws, power cutting tools, sanders, grinders

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

related components include: washers, bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

testing methods include: hydrostatic, pneumatic

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-5.05.01K	demonstrate knowledge of fibreglass piping, fittings and related components	identify ***tools and equipment*** relating to fibreglass piping, fittings and related components and describe their applications and procedures for use
		interpret information pertaining to fibreglass piping found on drawings and specifications
		describe the identification systems and methods for fibreglass piping
		identify types of ***fiberglass piping*** and describe their purpose and applications
		identify fittings used with fibreglass piping and describe their purpose and applications
		identify ***fibreglass piping related components*** and describe their purpose and applications
B-5.05.02K	demonstrate knowledge of the procedures used to measure fibreglass piping	explain the ***systems of measurement*** for fibreglass piping
		identify the systems and criteria used in referencing, selecting and ordering fibreglass piping
		describe the ***procedures*** used to ***measure*** fibreglass piping
B-5.05.03K	demonstrate knowledge of the procedures used to cut and join fibreglass piping	describe the procedures and ***cutting***, ***tapering and sanding tools and equipment*** used to cut fibreglass piping
		identify the ***methods used to join fibreglass piping*** and describe their associated procedures and ***materials***
		describe the procedures used to install and ***test*** fibreglass piping, fittings and related components for fibreglass piping

RANGE OF VARIABLES

tools and equipment include: air saws, jig saws, grinders
fibreglass piping include: FRP, GFRP, GRE
fibreglass piping related components include: washers, bolts, studs, gaskets, brackets, supports, hangers, guides, anchors
systems of measurement include: dimension, length, wall thickness/schedule
measuring procedures include: fitting allowance, offset calculations, trade math
cutting, tapering and sanding tools and equipment include: hack saws, power cutting tools, sanders, grinders
joining methods include: butt and wrap, bell and spigot, and threading
materials include: vinyl ester, polyester, halogenated resins, epoxies
testing methods include: hydrostatic, pneumatic, NDE

B-5.06 Lays out, identifies and installs specialty piping, fittings and related components

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-5.06.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to types of ***specialty piping***
B-5.06.02P	select and inspect piping material	piping is selected according to drawings and has visible markings
B-5.06.03P	prepare material list	material list is cross referenced against packing list and drawings
B-5.06.04P	take field measurements	field measurements are taken
B-5.06.05P	measure, calculate and mark piping and tubing	Piping and tubing is laid out according to drawings
B-5.06.06P	cut and prepare piping	pipe is cut and prepared using ***cutting, bevelling and threading tools and equipment*** according to type of piping and tubing
B-5.06.07P	bend pipe	piping is built to required dimension using ***bending tools and equipment***
B-5.06.08P	prepare, assemble and join piping using ***joining methods***	piping and fittings are orientated and aligned to match installation drawings and ***fitting tolerances*** are addressed
B-5.06.09P	perform ***pre/post-weld activities***	***pre/post-weld activities*** are performed according to QC welding procedures

B-5.06.10P	prevent ***contamination*** of the parent material	tools and equipment are isolated to avoid ***cross contamination*** between alloys and other materials
B-5.06.11P	install piping, expansion joints, swing joints, expansion loops and ***related components***	piping is installed according to drawings, is supported, is at the correct elevation and coordinates; and markings are clearly visible where practical
B-5.06.12P	generate field required bracket and support drawings where none exist	drawings are legible and clear, and reflect field requirements
B-5.06.13P	perform mapping of joints	mapping is documented according to QC procedures
B-5.06.14P	itemize piping, fittings and related components and cross reference to drawings	piping, fittings and related components are matched to the drawings
B-5.06.15P	torque flanged joints	flanged joints hold required pressure and are documented
B-5.06.16P	test piping and tubing fittings and related components using ***testing methods***	tests are completed according to testing requirements

RANGE OF VARIABLES

tools and equipment includes: grinders, plasma cutters, threading equipment, files, grooving equipment

specialty piping includes: chrome, molybdenum**,** titanium, duplex, lined pipe

cutting, bevelling and threading tools and equipment includes: grinders, reamers, power cutting tools, cutters

bending tools and equipment include: hand benders, hydraulic benders

joining methods include: threading, tacking/welding, flanging, roll grooving

fitting tolerances include: gap, high-low, alignment

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

cross contamination control methodology includes: labelling, physical separation, barriers and tool selection

related components include: bolts, studs, gaskets, brackets, supports, hangers, guides, anchors

testing methods include: hydrostatic, pneumatic

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-5.06.01K	demonstrate knowledge of specialty piping, fittings and related components	describe the procedures and ***methods*** to prevent ***cross contamination***
		identify ***tools and equipment*** relating to specialty piping fittings and their ***components*** and describe their applications and procedures for use
		interpret ***codes and regulations*** pertaining to specialty piping
		interpret information pertaining to specialty piping found on drawings and specifications

		describe the identification systems and methods for ***specialty piping***
		identify fittings used with specialty piping and describe their purpose and applications
		identify specialty piping related components and describe their purpose and applications
B-5.06.02K	demonstrate knowledge of the procedures used to measure specialty piping	explain the ***systems of measurement*** for specialty piping
		describe the ***procedures used to measure*** specialty piping and fittings
B-5.06.03K	demonstrate knowledge of the procedures used to cut and join specialty piping	describe the ***procedures used to inspect*** specialty piping
		identify the methods used to cut specialty piping and fittings in particular lined piping, and describe their associated procedures and ***cutting, bevelling and threading tools and equipment***
		describe the different ***methods*** of pipe and fitting end ***preparation***
		identify the ***joining methods*** used to join specialty piping and describe their associated procedures
		describe ***pre/post-weld activities***
		describe the procedures *and* ***bending tools and equipment*** used to bend specialty piping
		describe the procedures used to install and test fittings and related components for specialty piping

RANGE OF VARIABLES

cross contamination control methodology includes: labelling, physical separation, barriers tool selection

tools and equipment include: grinders, plasma cutters, threading equipment, files, grooving equipment

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

codes and regulations include: ASME B31

specialty piping includes: chrome, molybdenum, titanium, duplex, lined pipe

systems of measurement include: dimension, length, wall thickness/schedule

measuring procedures include: fitting allowance, offset calculations, trade math

inspection procedures include: QA/QC requirements

cutting, bevelling and threading tools and equipment include: grinders, reamers, power cutting tools, cutters

preparation methods include: standard bevel, compound bevel

joining methods include: threading, tacking/welding, flanging, roll grooving

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

bending tools and equipment includes: hand benders, hydraulic benders

TASK B-6 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 valves that are part of those systems.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards, including Manufacturers Standardization Society (MSS) and American National Standards Institute (ANSI). All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-6.01 Installs valves

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to types of ***valves***
B-6.01.02P	select and inspect valves	valves are selected and inspected according to ***installation variables***, drawings and valve identification; ***valve components*** and ***related components*** itemized and cross referenced to drawings
B-6.01.03P	prepare material list	material list cross referenced against packing list and drawings

B-6.01.04P	take field measurements	field measurements taken are complete and accurate
B-6.01.05P	measure, calculate and mark piping and tubing for valve installation	clearances, flange, and valve alignment and orientation are maintained
B-6.01.06P	prepare valve for installation	traceability of removed components;, seat and handle positioned to required orientation, internals protected and valve integrity maintained
B-6.01.07P	install valve in piping, tubing and related equipment using ***joining methods***	***joining methods*** are performed to produce a leak-free and functional valve
B-6.01.08P	install valve related components	traceability of related components; handle positioned to required orientation and valve integrity and functionality maintained
B-6.01.09P	generate field required bracket and support drawings where none exist	drawings are legible and clear, and reflect field requirements
B-6.01.10P	perform mapping of joints	mapping is documented according to QC procedures
B-6.01.11P	torque flanged joints	flanged joints hold required pressure and are documented
B-6.01.12P	test system including valves, piping, tubing, and related components using ***testing methods***	tests completed according to testing requirements

RANGE OF VARIABLES

tools and equipment include: assorted wrenches, rigging tools, pin bars
valves include: gate, globe, ball, plug, butterfly, check, relief, pop safety, pressure reducing
installation variables include: temperature, medium, pressure, flow, functionality, systems
valve components include: seat, stem, disc, packing, bonnet
related components includes: bolts, studs, gaskets, brackets, chain wheels, actuators
joining methods include: threading, tacking/welding, flanging, roll grooving, compression fittings
testing methods include: hydrostatic, pneumatic

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.01.01K	demonstrate knowledge of piping valves, their applications and operation	interpret codes, regulations and ***standards*** pertaining to piping valves
		interpret information found on drawings and specifications pertaining to piping valves
		identify ***tools and equipment*** relating to piping valves and describe their applications and procedures for use
		identify types of ***piping valves*** and describe their characteristics, operation and applications

		identify types of ***valve actuators*** and describe their purpose
		explain ***piping valve rating*** systems and ***installation variables***
B-6.01.02K	demonstrate knowledge of the procedures used to install valves	identify ***joining methods*** used to install piping valves and describe their associated procedures
		describe ***testing methods*** for testing valves and related components

RANGE OF VARIABLES

standards include: MSS, ANSI
tools and equipment include: assorted wrenches, rigging tools, pinch bars
piping valves include: gate, globe, ball, plug, butterfly, check, relief, pop safety, pressure reducing
valve actuators include: electric, pneumatic, manual, hydraulic
piping valve rating include: pressure, temperature
installation variables include: temperature, medium, pressure, flow, functionality, systems
joining methods include: threading, tacking/welding, flanging, roll grooving, compression fittings
testing methods include: hydrostatic, pneumatic

B-6.02 Maintains, troubleshoots, repairs and tests valves.

Essential Skills Document Use, Thinking Skills, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.02.01P	select and use tools and equipment	***tools and equipment*** are selected according to types of **valves**
B-6.02.02P	follow a predetermined maintenance schedule and complete ***required documentation***	***maintenance procedures*** are performed according to the predetermined schedule and documentation is updated with the required information
B-6.02.03P	troubleshoot valves to determine requirements for repair or replacement	components that require repair or replacement are determined using ***troubleshooting techniques***
B-6.02.04P	lock out and tag out system	system is locked and tagged out to prevent activation of ***potential energy sources*** during repair
B-6.02.05P	***repair*** valve and ***valve related components***	valve is repaired to operational condition

B-6.02.06P	re-***test*** valve	valve is tested to ensure it meets ***operational and functional requirements***
B-6.02.07P	prepare ***documentation*** of valve repairs	***documentation*** is updated

RANGE OF VARIABLES

tools and equipment include: valve repair hooks, micrometers, lapping plates, grease guns, tool makers ink, stethoscopes, temperature guns, packing tubes, assorted wrenches

valves include: gate, globe, ball, plug, butterfly, check, relief, pop safety, pressure reducing

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

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

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

potential energy sources include: mechanical, electrical

repairs include: disc and seat refurbishment, stem realignment, valve repacking

valve related components include: actuators, diaphragms, discs, seats, chain wheels and stem

tests include: hydrostatic, blue check

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

documentation includes: QA/QC verification, recording of signoff that repair has been completed

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.02.01K	demonstrate knowledge of valves, their applications and operation	interpret codes, regulations and ***standards*** pertaining to piping valves
		interpret information found on drawings and specifications pertaining to valves
		identify ***valve repair and maintenance tools and equipment*** to maintain, troubleshoot, repair and test valves and describe their applications and procedures for use
		describe ***procedures used to maintain*** and ***troubleshoot*** valves
		identify valve and related component ***defects*** requiring repair
		describe procedures used to ***repair*** and ***test*** valves
		identify types of ***valve actuators*** and describe their purpose
		describe necessary ***documentation*** for valve repair

RANGE OF VARIABLES

standards include: MSS, ANSI

valve repair and maintenance tools and equipment include: valve repair hooks, micrometers, lapping plates, grease gun, tool makers ink, stethoscope, temperature gun, assorted wrenches

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

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

defects include: passing valve seal, leaking packing, seized or damaged related components

repairs include: disc and seat refurbishment, stem realignment, valve repacking

tests include: hydrostatic, blue check

valve actuators include: electric, pneumatic, manual, hydraulic

documentation includes: QA/QC verification, recording of signoff that repair has been completed

TASK B-7 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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

B-7.01 Installs steam tracing systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.01.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to type of ***steam tracing system***
B-7.01.02P	determine amount and type of ***material*** needed to perform task	***materials*** are selected and inspected according to installation variables and drawings; and ***components*** are itemized and cross referenced to drawings
B-7.01.03P	prepare material list	material list is cross referenced against packing list and drawings
B-7.01.04P	take field measurements	field measurements taken are complete and accurate
B-7.01.05P	measure, calculate and mark piping and tubing for installation	clearances, flange, and tubing alignment and orientation are maintained
B-7.01.06P	install steam tracing and components using ***joining methods***	***joining method*** is performed to produce a leak-free and functional system using ***piping practices***

B-7.01.07P	generate field required bracket and support drawings where none exist	drawings are legible, clear and reflect field requirements
B-7.01.08P	perform mapping of joints	mapping documented according to QC procedures
B-7.01.09P	test steam tracing system including valves, piping, tubing, and components using ***testing*** **methods**	tests are completed according to testing requirements

RANGE OF VARIABLES

tools and equipment include: benders, flaring and strapping devices
steam tracing systems include: low to high pressure, pre-insulated tubing
materials include: carbon, stainless steel and copper tubing, strapping, related fittings, pre-insulated tubing bundles (electrically traced)
components include: valves, breakouts, valve baskets, steam traps
joining methods include: welding, crimping, brazing, compression fittings
piping practices include: joints are accessible with consideration given to insulation requirements
testing methods include: hydrostatic, pneumatic

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-7.01.01K	demonstrate knowledge of ***steam tracing systems***, their applications and operation	interpret codes, regulations and ***standards*** pertaining to ***steam tracing systems***
		interpret information found on drawings and specifications pertaining to steam tracing systems
		identify ***tools and equipment*** relating to steam tracing systems and describe their applications and procedures for use
		identify types of steam tracing systems and describe their characteristics, operation and applications
		review working principles of steam systems
		describe steam tracing systems and ***installation variables***
B-7.01.02K	demonstrate knowledge of the procedures used to install steam tracing systems	identify ***joining methods*** used to install steam tracing systems and describe their associated ***piping practices***
		describe ***testing methods*** for steam tracing systems

RANGE OF VARIABLES

standards include: ASME
steam tracing systems include: low to high pressure, pre-insulated tubing bundles
tools and equipment include: benders, flaring and strapping devices
installation variables include: temperature, pressure, flow, functionality, systems

joining methods include: welding, soldering, grooving, crimping, brazing and compression fittings
piping practices include: joints are accessible with consideration given to insulation requirements
testing methods include: hydrostatic, pneumatic

B-7.02 Maintains, troubleshoots, repairs and tests steam tracing systems

Essential Skills	Document Use, Thinking Skills, Writing

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
B-7.02.01P	select and use ***tools and equipment***	***tools and* equipment** are selected according to type of ***steam tracing system***
B-7.02.02P	follow a predetermined maintenance schedule and complete ***required documentation***	***maintenance procedures*** are performed according to the predetermined schedule and ***documentation*** is updated with the required information
B-7.02.03P	troubleshoot steam tracing systems to determine requirements for repair or replacement	components 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 ***potential energy sources*** during repair
B-7.02.05P	***repair*** steam tracing system and ***components***	steam tracing system and ***components*** are repaired to operational condition
B-7.02.06P	remove lock-out and tag-out from components and piping system	locks and tags are removed
B-7.02.07P	reinstate system to operating condition after completing maintenance procedures	system is energized, pressurized, checked for leaks and returned to normal operating condition
B-7.02.08P	re-***test*** and energize steam tracing system	steam tracing system is tested to ensure it meets ***operational and functional requirements***
B-7.02.09P	prepare ***documentation*** of steam tracing system repairs	***documentation*** is updated

RANGE OF VARIABLES

steam tracing system repair and maintenance tools and equipment include: benders, temperature sensing devices, rubber mallets, stethoscopes, flaring and strapping devices
steam tracing system includes: low to high pressure and pre-insulated tubing bundles, heat taped, jacketed pipe
maintenance procedures include: checking steam traps, banding, cleaning and inspecting equipment components for correct operation and wear and replacing worn components, if required
required documentation includes: lock-out and tag-out, maintenance log, quality control reports
troubleshooting techniques include: functional checks, visual inspections, use of temperature sensing devices and stethoscopes
potential energy sources include: mechanical, electrical

repairs include: trap, tubing and fitting replacement
components include: valves, breakouts, valve baskets, steam traps
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 signoff that repair has been completed

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.02.01K	demonstrate knowledge of ***steam tracing systems***, their applications and operation	interpret codes, regulations and ***standards*** pertaining to ***steam tracing systems***
		interpret information found on drawings and specifications pertaining to steam tracing system
		identify ***steam tracing system repair and maintenance tools and equipment*** to maintain, troubleshoot, repair and test and describe their applications and procedures for use
		describe ***procedures*** used to ***maintain*** and ***troubleshoot*** steam tracing systems
B-7.02.02K	demonstrate knowledge of procedures for repairing and testing steam tracing systems and their ***components***	identify ***steam tracing system*** and ***component defects*** requiring repair
		describe procedures used to ***repair*** and ***test*** steam tracing system and components
		describe necessary ***documentation*** for steam tracing system and component repair and maintenance

RANGE OF VARIABLES

standards include: ASME, CSA
steam tracing systems include: low to high pressure, pre-insulated tubing bundles
steam tracing system repair and maintenance tools and equipment include: benders, temperature sensing devices, rubber mallets, stethoscopes, flaring and strapping devices
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
steam tracing system components include: valves, breakouts, valve baskets, steam traps
defects include: kinked tubing, passing traps, broken straps
repairs include: steam traps, tubing and fitting replacement
tests include: hydrostatic, pneumatic, in-service
documentation includes: QA/QC verification, recording of signoff that repair has been completed

B-7.03 Installs liquid-filled tracing systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.03.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to type of ***liquid-filled tracing system***
B-7.03.02P	determine amount and type of ***material*** needed to perform task	***materials*** are selected and inspected according to installation variables and drawings; ***components*** are itemized and cross referenced to drawings
B-7.03.03P	prepare material list	material list is cross referenced against packing list and drawings
B-7.03.04P	take field measurements	field measurements taken are complete and accurate
B-7.03.05P	measure, calculate and mark piping and tubing for installation	clearances, flange, and tubing alignment and orientation are maintained
B-7.03.06P	install liquid-filled tracing and components using ***joining methods***	***joining method*** is performed to produce a leak-free and functional system using ***piping practices***
B-7.03.07P	generate field required bracket and support drawings where none exist	drawings are legible and clear, and reflect field requirements
B-7.03.08P	perform mapping of joints	mapping is documented according to QC procedures
B-7.03.09P	test liquid-filled tracing system including valves, piping, tubing, and components using ***testing methods***	tests are completed according to testing requirements

RANGE OF VARIABLES

tools and equipment include: benders, flaring and strapping devices
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, crimping, brazing, compression fittings
piping practices include: joints are accessible with consideration given to insulation and tie in points requirements and ensure high point vents and pumps installed where necessary
testing methods include: hydrostatic, pneumatic

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.03.01K	demonstrate knowledge of ***liquid-filled tracing systems***, their applications and operation	interpret codes, regulations and ***standards*** pertaining to ***liquid-filled tracing systems***
		interpret information found on drawings and specifications pertaining to liquid-filled tracing systems
		identify ***tools and equipment*** relating to liquid-filled tracing systems and describe their applications and procedures for use
		identify types of liquid-filled tracing systems and describe their characteristics, operation and applications
		review working principles of high and low temperature hot water/glycol systems
		describe liquid-filled tracing systems and ***installation variables***
B-7.03.02K	demonstrate knowledge of the procedures used to install 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

RANGE OF VARIABLES

liquid-filled tracing systems include: low and high temperature hot water, glycol
standards include: ASME
tools and equipment include: benders, flaring and strapping devices
installation variables include: temperature, pressure, flow, functionality, systems
joining methods include: welding, soldering, grooving, crimping, brazing and compression fittings
piping practices include: joints are accessible with consideration given to insulation and tie in points requirements and ensure high point vents and pumps installed where necessary
testing methods include: hydrostatic, pneumatic

B-7.04 Maintains, troubleshoots, repairs and tests liquid-filled tracing systems

Essential Skills Document Use, Thinking Skills, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.04.01P	select and use tools and equipment	tools and equipment are selected according to type of ***liquid-filled tracing system***
B-7.04.02P	follow a predetermined maintenance schedule and complete ***required documentation***	***maintenance procedures*** are performed according to the predetermined schedule and documentation is updated with the required information
B-7.04.03P	troubleshoot liquid-filled tracing systems to determine requirements for repair or replacement	components that require repair or replacement are determined using ***troubleshooting techniques***
B-7.04.04P	lock out and tag out system	system is locked and tagged out to prevent activation of ***potential energy sources*** during repair
B-7.04.05P	***repair*** liquid-filled tracing system and ***components***	liquid-filled tracing system and ***components*** are repaired to operational condition
B-7.04.06P	remove lock-out and tag-out from components and piping system	locks and tags are removed
B-7.04.07P	reinstate system to operating condition after completing maintenance procedures	system is energized, pressurized, checked for leaks and returned to normal operating condition
B-7.04.08P	re-***test*** and energize liquid-filled tracing system	liquid-filled tracing system is tested to ensure it meets ***operational and functional requirements***
B-7.04.09P	prepare ***documentation*** of liquid-filled tracing system repairs	***documentation*** is updated
B-7.04.10P	dispose of liquid medium	medium is disposed of according to ***environmental regulations***

RANGE OF VARIABLES

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 if required

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

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

potential energy sources include: mechanical, electrical

repairs include: tubing, fitting and component replacement

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

tests include: hydrostatic, pneumatic**,** in-service

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

documentation includes: QA/QC verification, recording of signoff that repair has been completed

environmental regulations include: WHMIS

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
B-7.04.01K	demonstrate knowledge of ***liquid-filled tracing systems***, their applications and operation	interpret ***codes, regulations and standards*** pertaining to ***liquid-filled tracing systems***
		interpret information found on drawings and specifications pertaining to liquid-filled tracing system
		identify liquid-filled tracing system repair and maintenance ***tools and equipment*** to maintain, troubleshoot, repair and test and describe their applications and procedures for use
		describe ***procedures*** used to ***maintain*** and ***troubleshoot*** liquid-filled tracing systems
B-7.04.02K	demonstrate knowledge of procedures to repair and test ***liquid-filled tracing systems*** and their ***components***	identify liquid-filled tracing system and component ***defects*** requiring repair
		describe procedures used to ***repair*** and ***test*** liquid-filled tracing system and component
		describe necessary ***documentation*** for liquid-filled tracing system and component repair and maintenance
		identify disposal procedures of liquid medium

RANGE OF VARIABLES

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

codes, regulations and standards include: ASME, WHMIS, LEED

tools and equipment include: benders, flaring and strapping devices

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

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

liquid-filled tracing system components include: valves, breakouts, valve baskets, high point vents, pumps

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

repairs include: tubing and fitting replacement

tests include: hydrostatic, pneumatic, in-service

documentation includes: QA/QC verification, recording of signoff that repair has been completed

MAJOR WORK ACTIVITY C
PERFORMS RIGGING, HOISTING, LIFTING AND POSITIONING

TASK C-8 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. These lifts may include engineered lifts. They also maintain and store equipment to prevent premature defects and damage.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met. In the case of engineered lifts, engineers' recommendations must be followed.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

C-8.01 Determines load

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.01.01P	calculate load weight	weight of rigging and material is determined according to ***specifications***
C-8.01.02P	measure ***load dimensions***	height, length, width, area and volume of material and equipment are determined
C-8.01.03P	determine centre of gravity	calculations and test lift are performed
C-8.01.04P	assess ***load requirements***	rigging and hoisting capacity of slings and equipment is verified

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-8.01.01K	demonstrate knowledge of hoisting, lifting and rigging equipment, their applications, limitations and procedures for use	define terminology associated with hoisting, lifting, rigging and positioning
		identify ***hazards*** and describe safe work practices pertaining to hoisting, lifting, rigging and positioning
		identify codes and regulations pertaining to hoisting, lifting and rigging
		identify types of ***rigging equipment*** and accessories and their weight using various ***sources***
C-8.01.02K	demonstrate knowledge of calculations required when performing hoisting and lifting operations	explain how to calculate load weight

RANGE OF VARIABLES

hazards include: wind, shock loading

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

sources of rigging equipment weight include: shop drawings, manufacturers' specifications

C-8.02 Prepares lift plan(s)

Essential Skills	Document Use, Oral Communication, Thinking Skills

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.02.01P	review and interpret ***engineering recommendations***, if applicable	***engineering recommendations*** are followed
C-8.02.02P	determine ***communication strategy*** with rigging crew	***communication strategy*** is implemented according to job requirements
C-8.02.03P	ensure work area is clear of ***obstructions*** and personnel	control zones are identified with barrier tapes and signage ***obstructions*** are eliminated and plan is revised to work around the obstruction
C-8.02.04P	identify new and existing ***hazards***	hazards are identified during tool box talks and ***job safety cards*** are completed
C-8.02.05P	assess ***weather conditions***	current ***weather conditions*** are reviewed
C-8.02.06P	participate in dry run of hoisting equipment to ensure lift plan is accurate	***strategy*** is reviewed to ensure the plan is feasible

RANGE OF VARIABLES

engineering recommendations include: drawings, crane prints, lift drawings
communication strategy includes: using hand signals, radio communication and a signaler
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), field level risk assessments (FLRA), safety plan of action (SPA)
weather conditions include: rain, high winds, snow, lightning, heat, cold, ice
strategy includes: documentation or oral review of procedures

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.02.01K	demonstrate knowledge of rigging, hoisting, lifting and positioning equipment, their 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 codes and regulations pertaining to rigging, hoisting, lifting and positioning

		identify types of ***rigging equipment*** and accessories and describe their limitations, applications and procedures for use
C-8.02.02K	demonstrate knowledge of the procedures used to select equipment for hoisting, lifting and positioning operations	identify types of ***hoisting, lifting and positioning equipment*** and accessories and describe their applications and procedures for use
		identify types of knots, hitches and bends and describe their applications and the procedures used to tie them
		identify documentation required for engineered lifts
C-8.02.03K	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
		identify the ***factors to consider when selecting*** rigging hoisting and lifting equipment

RANGE OF VARIABLES

hazards include: wind, shock loading
rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers
hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists
sling angle includes: 45°, 60°
selection factors include: load characteristics, rigging inspection, equipment fatigue, environment, safety factors, sling angles

C-8.03 Selects rigging, hoisting, lifting and positioning equipment

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.03.01P	determine ***rigging and hoisting equipment*** component requirements	rating of the ***rigging and hoisting equipment*** is verified to meet or exceed the weight of the load
C-8.03.02P	Refer to ***rigging tables and load charts*** to determine safe working load (SWL)	rigging, hoisting, lifting and positioning equipment chosen is verified to ensure that it is compliant to the load chart
C-8.03.03P	determine equipment capacity to ensure that rigging components and equipment meets ***load requirements***	rigging, hoisting, lifting and positioning equipment chosen is verified to ensure that it is compliant to the load chart

RANGE OF VARIABLES

rigging and hoisting equipment includes: wire rope, shackles, come-alongs, nylon slings, softeners, tag line

rigging tables and load charts include: rating tags, load charts

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.03.01K	demonstrate knowledge of rigging, hoisting, lifting and positioning equipment, their 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 codes and regulations pertaining to rigging, hoisting and lifting
		identify types of ***rigging equipment*** and accessories and describe their limitations, applications and procedures for use
C-8.03.02K	demonstrate knowledge of the procedures used to perform hoisting, lifting and positioning operations	identify types of ***hoisting, lifting and positioning equipment*** and accessories and describe their applications and procedures for use
		describe the procedures used to inspect, maintain and store rigging, hoisting, lifting and positioning equipment

		identify types of knots, hitches and bends and describe their applications and the procedures used to tie them
		identify documentation required for engineered lifts
		identify types of ropes used in rigging
C-8.03.03K	demonstrate knowledge of calculations required when performing hoisting and lifting operations	describe the procedures used to rig material/equipment for lifting
		explain ***sling angle*** when preparing for hoisting and lifting operation
		explain correlation of sling angles to sling capacities
		identify the ***factors to consider when selecting*** rigging, hoisting and lifting equipment
		describe the procedures used for attaching rigging equipment to the load

RANGE OF VARIABLES

rigging equipment includes: lugs, chain falls, come-alongs, spreader bars, shackles, slings, tuggers
hoisting, lifting and positioning equipment includes: cranes, forklifts, rollers, chain falls, jacks, cable grip hoists
sling angle includes: 45°, 60°
selection factors include: load characteristics, rigging inspection, equipment fatigue, environment, safety factor (5 to 1 and 10 to 1), sling angles

C-8.04 Inspects rigging, hoisting, lifting and positioning equipment

Essential Skills Document Use, Thinking Skills, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.04.01P	detect rigging, hoisting, lifting and positioning ***equipment faults***	equipment is inspected physically and visually, and is determined to be in good condition
C-8.04.02P	check for certification on ***equipment***	rating tags are verified and certification of ***equipment*** is current
C-8.04.03P	assess, tag, report and remove damaged equipment from service	damaged equipment is tagged, removed from service and documented

C-8.04.04P	document regular inspection requirements	inspections are documented according to jurisdictional requirements
C-8.04.05P	inspect knots, hitches and bends	faulty knots, hitches and bends are de-rated when required

RANGE OF VARIABLES

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

equipment requiring current certification includes: chain falls, tuggers, cranes, forklifts

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.04.01K	demonstrate knowledge of inspection for rigging, hoisting, lifting and positioning equipment	identify hazards and describe safe work practices pertaining to rigging, hoisting, lifting and positioning
		identify codes, regulations and certification pertaining to rigging, hoisting, lifting, and positioning equipment
		identify types of rigging equipment and accessories and describe their limitations, applications and procedures for use
		identify documentation required for inspection of engineered lifts
		identify types of hoisting and lifting equipment and accessories and describe their applications and procedures for use
		describe the procedures used to inspect, maintain and store rigging, hoisting, lifting and positioning equipment
		identify types of knots, hitches and bends and describe their applications and the procedures used to tie them

C-8.05 Secures lift area

Essential Skills	Oral Communication, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.05.01P	communicate lift plan to others	personnel, clients and authorities are advised of lift plan
C-8.05.02P	identify swing radius and potential obstructions and hazards	***equipment*** is positioned to clear obstructions and hazards
C-8.05.03P	restrict access to lift area and path of travel using barrier tape, barricades and signage	barricades, signage and barrier tape are erected to restrict vehicular and pedestrian traffic to lift area

RANGE OF VARIABLES

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.05.01K	demonstrate knowledge of rigging, hoisting, lifting and positioning equipment, their applications, limitations and procedures for use	identify hazards and describe safe work practices pertaining to rigging, hoisting, lifting and positioning
		identify jurisdictional regulations and trade practice pertaining to rigging, hoisting, lifting and positioning
		identify types of equipment used to secure the lift area
		identify documentation required for engineered lifts
		identify types of hoisting, lifting and positioning equipment and accessories and describe their applications and procedures for use
		describe the ***procedures used to ensure the work area*** is safe for rigging, hoisting, lifting and positioning
		identify and describe ***procedures used to communicate*** during rigging, hoisting, lifting and positioning operations

RANGE OF VARIABLES

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

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

C-8.06 Sets up rigging, hoisting, lifting and positioning equipment

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.06.01P	communicate lift plan to others	personnel, clients and authorities are advised of lift plan
C-8.06.02P	determine ***method of connecting*** rigging, hoisting, lifting and positioning equipment	rigging, hoisting, lifting and positioning equipment is visually and physically inspected according to safe work practices
C-8.06.03P	attach rigging, hoisting, lifting and positioning equipment to load to ensure a safe lift	rigging, hoisting, lifting and positioning equipment is visually and physically inspected according to safe work practices
C-8.06.04P	determine placement of equipment on load considering centre of gravity, lifting points, size and shape of load	load is test lifted to determine centre of gravity
C-8.06.05P	tie ***knots***	***knots*** are visually inspected
C-8.06.06P	attach tag line to orientate and stabilize the lift	tag line is secured to load

RANGE OF VARIABLES

method of connecting includes: hooks, basket hitches, choker hitches, shackles, d-rings

knots include: bow line, cat's paw, clove hitch and half hitch

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-8.06.01K	demonstrate knowledge of rigging, hoisting, lifting and positioning equipment, their 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 codes and regulations pertaining to rigging, hoisting, lifting and positioning
		identify types of rigging equipment and accessories and describe their limitations, applications and procedures for use
C-8.06.02K	demonstrate knowledge of the procedures used to perform rigging, hoisting and lifting and positioning operations	identify types of rigging, hoisting, lifting and positioning equipment and accessories and describe their applications and procedures for use
		identify types of knots, hitches and bends and describe their applications and the procedures used to tie them
		identify documentation required for engineered lifts
C-8.06.03K	demonstrate knowledge of calculations required when performing hoisting and lifting operations	describe the procedures used to rig material/equipment for lifting
		describe the ***procedures used to ensure the work area*** is safe for lifting
		identify and describe ***procedures used to communicate*** during set up operations
		explain sling angle when preparing for hoisting and lifting operations
		describe the procedures used for attaching rigging equipment to the load

RANGE OF VARIABLES

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

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

C-8.07 Performs lift and positioning

Essential Skills	Oral Communication, Thinking Skills, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.07.01P	perform test lift in order to balance load and ensure centre of gravity	load is balanced and plumbed
C-8.07.02P	use ***communication methods*** to communicate with operator and workers	designated ***communication methods*** are used
C-8.07.03P	use tag lines to orientate and stabilize load	load is under control at all times
C-8.07.04P	transfer load to other rigging equipment for final placement of load	load is transferred without damage to material, equipment or personnel
C-8.07.05P	place (land) load and ***secure*** in location using various ***methods***	load placement has met job requirements

RANGE OF VARIABLES

communication methods include: hand signals, flags, horns, electronic communication devices
methods for securing load include: bolting, lashing, site-specific methods

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.07.01K	demonstrate knowledge of rigging, hoisting, lifting and positioning equipment, their 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 codes and regulations pertaining to rigging, hoisting, lifting and positioning according to site and jurisdictional requirements
		identify types of rigging equipment and accessories and describe their limitations, applications and procedures for use
C-8.07.02K	demonstrate knowledge of the procedures used to perform hoisting, lifting and positioning operations	identify types of hoisting, lifting and positioning equipment and accessories and describe their applications and procedures for use

		identify types of knots, hitches and bends and describe their applications and the procedures used to tie them
		identify documentation required for engineered lifts
C-8.07.03K	demonstrate knowledge of calculations required when performing hoisting and lifting operations	describe the procedures used to rig material/equipment for lifting
		describe the ***procedures used to ensure the work area*** is safe for lifting
		identify and describe ***procedures used to communicate*** during rigging, hoisting, lifting and positioning operations
		explain ***sling angle*** when preparing for hoisting and lifting operation
		explain correlation of sling angles to sling capacities
		identify the ***factors to consider when selecting*** rigging equipment
		describe the procedures used for attaching rigging equipment to the load
		describe the ***procedures used to perform a lift***

RANGE OF VARIABLES

ensuring safe work area procedures include: supervision of lift, securing work area, communication
communication procedures include: hand signals, electronic communications, audible/visual
sling angle includes: 45°, 60°
selection factors includes: load characteristics, environment, safety factors
lift procedures include: load determination, communication methods, pre-lift checks, placement of load, post-lift inspection

C-8.08 Maintains and stores rigging, hoisting, lifting and positioning equipment

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.08.01P	organize equipment according to size, components and capacity	equipment is logged and catalogued according to site specifications, organized and stowed
C-8.08.02P	clean and lubricate ***equipment***	***equipment*** is cleaned, lubricated and maintained according to manufacturers' specifications
C-8.08.03P	protect rigging and lifting equipment from ***elements***	equipment is stored according to manufacturers' recommendations

RANGE OF VARIABLES

equipment includes: chain falls, come-alongs, cable grip hoists
elements include: weather, temperature, chemicals

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.08.01K	demonstrate knowledge of hoisting, lifting and rigging equipment, their applications, limitations and procedures for use and storage	define terminology associated with hoisting, lifting and rigging
		identify hazards and describe safe work practices pertaining to storage of hoisting, lifting, rigging and positioning equipment
		describe the procedures used to inspect, maintain and store rigging, hoisting, lifting, and positioning equipment
		identify the ***factors to consider when selecting*** rigging equipment
		identify documentation required for engineered lifts

RANGE OF VARIABLES

selection factors includes: load characteristics, environment, safety factors

TASK C-9 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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met. In the case of engineered lifts, engineers' recommendations must be followed.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

C-9.01 Prepares lift plan for complex and critical rigging, hoisting, lifting and positioning

Essential Skills Document Use, Thinking Skills, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.01.01P	review and interpret ***engineer recommendations***, if applicable	***engineering recommendations*** are followed
C-9.01.02P	interpret ***lift information***	***lift information*** is followed according to direction
C-9.01.03P	assess jobsite	jobsite is assessed taking into consideration site observations, ***hazards***, clearances, other restrictions, changing conditions and equipment requirements
C-9.01.04P	identify new and existing hazards	tool box talks occur and ***risk assessments*** are completed prior to lift commencing

C-9.01.05P	review jobsite assessment with ***essential personnel***	jobsite assessment is reviewed to determine lift plan requirements
C-9.01.06P	determine ***communication strategy*** with essential personnel	***communications strategy*** is implemented according to job requirements
C-9.01.07P	determine ***load information***	***load information*** is determined by interpreting documentation and taking measurements
C-9.01.08P	determine ***equipment requirements***	***equipment requirements*** are determined by load weight and size, lifting range and type of material being lifted
C-9.01.09P	secure lift area and ensure work area is clear of ***obstructions*** and personnel	affected areas are identified with barrier tapes and signage, secured and included in the control zone and lift plan is revised to work around the ***obstructions***
C-9.01.10P	assess ***weather conditions***	current ***weather conditions*** are reviewed
C-9.01.11P	participate in dry run of hoisting equipment to ensure lift plan is accurate	***strategy*** is reviewed to ensure the plan is feasible
C-9.01.12P	document lift plan	lift plan is documented according to jurisdictional and site requirements

RANGE OF VARIABLES

engineering recommendations 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, powerlines, overhead piping and live equipment, and site specific hazards, ground conditions, multi-tag lines
risk assessments include: JSA, FLRA and SPA, WHMIS controlled products
essential personnel includes: crew, engineer, supervisors, clients, regulatory authority
communication strategy includes: using hand signals, radio communication, horns, signaler
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, powerlines, railways, energy sources, vehicular traffic
weather conditions include: rain, high winds, snow, lightning, heat, cold, ice
strategy includes: documentation or oral review of procedures

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
C-9.01.01K	demonstrate knowledge of ***rigging, hoisting, lifting, and positioning equipment***, their applications, limitations and procedures for use	identify ***hazards*** and describe safe work practices pertaining to complex and critical rigging, hoisting, lifting and positioning operations
		identify documentation required for engineered lifts
		demonstrate procedures for ***complex and critical lifts*** and positioning
C-9.01.02K	demonstrate knowledge of ***calculations*** required when performing complex and critical rigging, hoisting, lifting and positioning operations	perform ***calculations*** pertaining to rigging, hoisting, lifting and positioning

RANGE OF VARIABLES

hazards include: energized power lines, weather conditions, live equipment, ground conditions, multi-tag lines

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

hoisting equipment includes: cranes, boom trucks, chain falls

lifting equipment includes: jacks, forklifts, high lifts, articulated fork trucks

positioning equipment includes: lugs, chain falls, come-alongs, jacks, rollers, forklifts, shackles, shims, skids, pinch bars, slings, tuggers

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

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

C-9.02 Performs calculations for complex and critical rigging, hoisting, lifting and positioning

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.02.01P	calculate load weight	weight of rigging and material are calculated according to ***specifications***
C-9.02.02P	measure ***load dimensions***	***load dimensions*** are determined by measuring height, length, width, area and volume of material and equipment
C-9.02.03P	determine centre of gravity	test lift is performed to identify centre of gravity and to confirm that the load is balanced
C-9.02.04P	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-9.02.01K	demonstrate knowledge of rigging, hoisting, lifting and positioning equipment, their applications, limitations and procedures for use	identify ***hazards*** and describe safe work practices pertaining to advanced rigging, hoisting, lifting, and positioning operations
		identify documentation required for engineered lifts
		demonstrate procedures for ***complex and critical lifts*** and positioning
C-9.02.02K	demonstrate knowledge of ***calculations*** required when performing complex and critical rigging, hoisting, lifting and positioning operations	perform ***calculations*** pertaining to rigging, hoisting, lifting, and positioning

RANGE OF VARIABLES

hazards include: energized power lines, weather conditions, live equipment, ground conditions, multi-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

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

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

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.03.01P	determine ***rigging, hoisting, lifting and positioning equipment*** component requirements	rating of the ***rigging, hoisting, lifting and positioning equipment*** is verified to meet or exceed the weight of the load
C-9.03.02P	refer to ***rigging tables and load charts*** to determine SWL	rigging, hoisting, lifting and positioning equipment chosen is verified to ensure that it is compliant to the load chart
C-9.03.03P	determine equipment capacity to ensure that rigging components and equipment meets ***load requirements***	rigging, hoisting, lifting and positioning equipment chosen is verified to ensure that it is compliant to the load chart

RANGE OF VARIABLES

rigging, hoisting, lifting and positioning equipment includes: spreader bars, equalizer beams, tuggers and rollers, wire rope, shackles, nylon slings, softeners, tag line

rigging tables and load charts include: rating tags, load charts

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-9.03.01K	demonstrate knowledge of rigging, hoisting, lifting, and positioning equipment, their applications, limitations and procedures for use	identify ***hazards*** and describe safe work practices pertaining to complex and critical rigging, hoisting, lifting, and positioning operations
		identify documentation required for engineered lifts
		demonstrate procedures for ***complex and critical lifts*** and positioning
C-9.03.02K	demonstrate knowledge of ***calculations*** required when performing advanced hoisting and lifting operations	perform ***calculations*** pertaining to rigging, hoisting and lifting

RANGE OF VARIABLES

hazards include: energized power lines, weather conditions, live equipment, ground conditions, multi-tag lines

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

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

C-9.04 Sets up rigging, hoisting, lifting and positioning equipment for complex and critical lifts

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.04.01P	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
C-9.04.02P	attach rigging, hoisting, lifting and positioning equipment to load to ensure a safe lift	rigging, hoisting, lifting and positioning equipment is connected considering ***additional equipment*** may be required for a potential load transfer, and visually and physically inspected according to safe work practices
C-9.04.03P	verify engineers' specifications and recommendations	engineers' specifications and recommendations are followed

C-9.04.04P	inspect rigging, hoisting, lifting and positioning equipment	rigging, hoisting, lifting and positioning equipment is visually and physically inspected according to safe work practices
C-9.04.05P	determine placement of equipment on load considering centre of gravity, lifting points, size and shape of load	lift test identifies centre of gravity and confirms that the load is balanced
C-9.04.06P	tie ***knots, bends and hitches***	***knots, bends and hitches*** are visually inspected
C-9.04.07P	attach tag line to orientate and stabilize the lift	tag line is secured to load

RANGE OF VARIABLES

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

additional equipment includes: shackles, cable grip hoists, tuggers, rollers, 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-9.04.01K	demonstrate knowledge of hoisting, lifting and rigging and positioning equipment, their applications, limitations and procedures for use	identify ***hazards*** and describe safe work practices pertaining to advanced rigging, hoisting, lifting and positioning operations
		identify documentation required for engineered lifts
		demonstrate ***complex and critical lifts***
C-9.04.02K	demonstrate knowledge of ***calculations*** required when performing complex and critical hoisting and lifting operations	perform ***calculations*** pertaining to rigging, hoisting, lifting and positioning

RANGE OF VARIABLES

hazards include: energized power lines, weather conditions, live equipment, ground conditions, multi-tag lines

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

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

C-9.05 Performs complex and critical lifts and positioning

Essential Skills	Oral Communication, Thinking Skills, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.05.01P	use ***communication methods*** to communicate with operator, lift crew and competent persons	designated ***communication methods*** are used to coordinate lift and positioning
C-9.05.02P	use tag lines to orientate and stabilize load	load is under control at all times
C-9.05.03P	transfer load to other rigging equipment for final placement	load is transferred without damage to material, equipment or personnel
C-9.05.04P	place (land) load and ***secure*** in location using various ***methods***	load placement has met job requirements

RANGE OF VARIABLES

communication methods include: hand signals, flags, horns, electronic communication devices
methods for securing load include: bolting, lashing, site-specific methods

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-9.05.01K	demonstrate knowledge of rigging, hoisting, lifting, and positioning equipment, their applications, limitations and procedures for use	identify ***hazards*** and describe safe work practices pertaining to complex and critical rigging, hoisting, lifting and positioning operations
		identify documentation required for engineered lifts
		demonstrate procedures for ***complex and critical lifts***
C-9.05.02K	demonstrate knowledge of ***calculations*** required when performing advanced hoisting, lifting and positioning operations	perform ***calculations*** pertaining to rigging, hoisting, lifting, and positioning

RANGE OF VARIABLES

hazards include: energized power lines, weather conditions, live equipment, limited visibility, ground conditions, multi-tag lines
complex and critical lifts include: multi-crane lifts, load transferring, lift over live equipment, unbalanced load and positioning load, may include engineered lifts
calculations include: sling angle, load/weight, centre of gravity, SWL

MAJOR WORK ACTIVITY D

INSTALLS, TESTS, MAINTAINS, TROUBLESHOOTS AND REPAIRS LOW AND HIGH PRESSURE STEAM AND CONDENSATE SYSTEMS

TASK D-10 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. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

D-10.01 Installs equipment for low pressure steam and condensate systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
D-10.01.01P	select ***equipment***	***equipment*** is selected according to load and demand, and type of ***low pressure steam and condensate system***
D-10.01.02P	size equipment	low pressure steam and condensate system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
D-10.01.03P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings***
D-10.01.04P	determine ***high points*** and ***low points*** for low pressure steam and condensate system ***equipment*** and components	***high points*** and ***low points*** are identified
D-10.01.05P	select and use ***tools and equipment*** required for installation of low pressure steam and condensate system equipment	appropriate ***tools and equipment*** for the installation are selected based on type of system and size of piping
D-10.01.06P	install equipment ***supports*** and ***fasteners***	equipment ***supports*** and ***fasteners*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system
D-10.01.07P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
D-10.01.08P	set and secure equipment in place	low pressure steam and condensate system equipment is installed respecting the required clearances, limitations are aligned/orientated, leveled and anchored in place

RANGE OF VARIABLES

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

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

sizing methods include: performing calculations, determining measurements, consulting manufacturers/supplier documentation

drawings include: engineered, mechanical, architectural

high points include: vents

low points include: drains, steam traps

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machine, brazing, soldering and, welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-10.01.01K	demonstrate knowledge of low pressure steam and condensate systems, their applications and operation	explain the applications and operation of low pressure steam and condensate systems
		interpret information pertaining to low pressure steam and condensate system equipment found on drawings and specifications
D-10.01.02K	demonstrate knowledge of low pressure steam and condensate system ***equipment***, their applications and operation	identify types of low pressure steam and condensate system ***equipment*** and describe their characteristics and operation
		identify low pressure steam and condensate system equipment ***supports and fasteners*** and describe their applications and procedures for use
		identify low pressure steam and condensate system ***control components*** and describe their purpose and operation
		identify types of ***fuel*** used in low pressure steam and condensate systems
		explain the ***principles of heat transfer***
		identify types of ***heat transfer equipment*** and describe their characteristics and operation
D-10.01.03K	demonstrate knowledge of the procedures used to install equipment for low pressure steam and condensate systems	identify equipment, controls, supports and fasteners used in low pressure steam and condensate systems, and describe their purpose and operation
		describe the procedures used to install equipment for low pressure steam and condensate systems, their controls, supports and fasteners

RANGE OF VARIABLES

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

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

control components include: low water cut-offs (LWCO), operating pressure controls, feed water level controls, high limit pressure controls, automatic valves (motorized)

fuel includes: fuel oil, gas, coal

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, horizontal and vertical unit heaters, heat exchangers

D-10.02 Installs piping for low pressure steam and condensate systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-10.02.01P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
D-10.02.02P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
D-10.02.03P	select and use ***tools and equipment***	appropriate ***tools and equipment*** for the installation selected are based on type and size of piping
D-10.02.04P	clean and prepare fittings and joints	***joining methods*** are used and fit-up to avoid leaks is ensured
D-10.02.05P	determine joining method for piping system	joining method is determined by engineered drawings and specifications, type and size of pipe
D-10.02.06P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
D-10.02.07P	install piping ***supports***	piping ***supports*** are installed to required spacing, height and grade in order to accommodate efficient operation of the system
D-10.02.08P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of steam lines including sleeving and proper spacing, and making ***allowances for contraction and expansion***

RANGE OF VARIABLES

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

routing conflicts include: high and low points, clearances, protection from environmental damage (rain, frost, snow), protection from mechanical damage (overhead doors, forklifts, machinery)

piping includes: carbon steel, copper, stainless steel

tools and equipment include: hand tools, power tools and equipment, lifting equipment, threading machines and welding equipment, tube bending equipment

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

supports include: rollers, hangers, clamps, brackets, stands, anchors, guides
allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-10.02.01K	demonstrate knowledge of the ***properties of steam***	explain the ***properties of steam***
		describe the use of steam tables to identify the relationship between pressure and temperature
		calculate grade and pitch of piping to ensure system efficiency and functionality
D-10.02.02K	demonstrate knowledge of low pressure steam and condensate piping ***configurations***, their ***applications*** and operation	explain the ***applications*** of low pressure steam and condensate piping ***configurations***
		identify type of ***pipe*** and ***piping components*** for low pressure steam and condensate systems***,*** and describe their purpose and operation
		interpret information pertaining to low pressure steam and condensate piping found on drawings and specifications
		explain the effects of expansion and contraction on piping in low pressure steam and condensate systems
		explain the effects of trapped air in low pressure steam and condensate piping systems and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping system components for low pressure steam and condensate systems
D-10.02.03K	demonstrate knowledge of the procedures used to install piping and piping components for low pressure steam and condensate systems	describe the procedures used to install piping and piping components for low pressure steam and condensate systems
		describe the procedures used to ***protect*** and restrain low pressure steam and condensate system piping and piping components

RANGE OF VARIABLES

properties of steam include: pressure, temperature, latent heat, sensible heat, total heat, volume
configurations include: parallel flow, counter flow, two pipe, gravity return, mechanical return, wet or dry return
applications include: residential heating, industrial, commercial and institutional (ICI) heating, process heating
piping includes: carbon steel, stainless steel, copper

piping components include: manual and automatic valves, steam traps, air vents, expansion joints, strainers, check valves

selection considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

protection includes: protection from mechanical damage, seismic activity, environmental conditions

D-10.03 Tests low pressure steam and condensate systems

Essential Skills Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-10.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
D-10.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
D-10.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected and ***method of filling, draining or purging*** is determined by the medium
D-10.03.04P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
D-10.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
D-10.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
D-10.03.07P	install ***testing equipment and components***	***testing equipment and components*** are connected following the test procedures
D-10.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
D-10.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
D-10.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed

D-10.03.11P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled
D-10.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic, vacuum

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

test medium includes: water, water/glycol mix, air, inert gases

method of filling, draining or purging includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: spectacle 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, and equipment is inoperable

testing equipment and components include: test trees and components, pressure gauges, pumps, compressors, test medium

appropriate parties include: QA/QC personnel, owner/operator, AHJ

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-10.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
D-10.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of low pressure steam and condensate systems, 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 the effect of elevation and temperature on pressure when testing low pressure steam and condensate systems
		explain the effects trapped air in a low pressure steam and condensate system will have on testing and describe the procedures to prevent or correct it

D-10.03.03K	demonstrate knowledge of the procedures used to test low pressure steam and condensate systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix, air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

D-10.04 Maintains, troubleshoots and repairs low pressure steam and condensate systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-10.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
D-10.04.02P	troubleshoot low pressure steam and condensate systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
D-10.04.03P	lock out and tag out system	system is locked and tagged out to prevent activation during repair
D-10.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	isolation components are installed and ***confirmation of zero energy state*** is completed
D-10.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area

D-10.04.06P	reinstate system to operating condition and verify repair	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition
D-10.04.07P	document the repairs	repairs are documented
D-10.04.08P	lock out and tag out system	system is locked and tagged out to prevent activation during maintenance
D-10.04.09P	isolate equipment or components requiring maintenance	equipment or components are isolated from the system to allow for completing the required ***maintenance procedure***
D-10.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***components*** are free of contaminants and operating efficiently, and ***documentation*** is updated with the required information
D-10.04.11P	check water quality	water quality is tested for hardness, acidity, dissolved gases and suspended particulates using a test kit
D-10.04.12P	treat water in system with chemicals	system water quality is within required parameters depending on type and application of the system, and based on the results of the water quality test
D-10.04.13P	remove lock-out and tag-out from components and piping system	locks and tags are removed
D-10.04.14P	reinstate system to operating condition after completing maintenance procedures	system is filled and pressurized, bled of air or contaminants, checked for leaks, and returned to normal operating condition

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, smell, touch), diagnostic testing, monitor system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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 procedures include: adding chemicals, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear

components include: pumps, strainers, filters, traps, valves

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-10.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting low pressure steam and condensate systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to low pressure steam and condensate system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effect of pressure on elevation when troubleshooting low pressure steam and condensate systems
		explain the effects trapped air in a low pressure steam and condensate system will have on system operation and describe the procedures to prevent or correct it
D-10.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain low pressure steam and condensate systems	describe the procedures used to troubleshoot low pressure steam and condensate systems
		describe the procedures used to repair low pressure steam and condensate systems
		describe the procedures used to maintain low pressure steam and condensate systems
		describe the procedures used to complete documentation following low pressure steam and condensate system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, manometer, infrared thermometer, chemical testing equipment

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

TASK D-11 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, indirect water heating and central heating.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

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

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-11.01.01P	select ***equipment***	***equipment*** is selected according to load and demand, and type of ***high pressure steam and condensate system***
D-11.01.02P	size equipment	high pressure steam and condensate system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
D-11.01.03P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings*** and manufacturers' specifications
D-11.01.04P	determine ***low points*** for equipment and components	***low points*** are identified
D-11.01.05P	select and use ***tools and equipment*** required for installation of high pressure steam and condensate system equipment	appropriate ***tools and equipment*** for the installation of equipment are selected based on type of system and size of piping

D-11.01.06P	install equipment ***supports*** and ***fasteners***	equipment ***supports*** and ***fasteners*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system
D-11.01.07P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
D-11.01.08P	set and secure system equipment in place	system equipment is installed respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

equipment includes: boilers, boiler trim, expansion joints, pumps, heat transfer equipment, steam traps, valves, flash tanks, superheaters, re-heaters, de-aerators, desuperheaters, condensers, water treatment equipment

high pressure steam and condensate systems include: condensing/non-condensing plant, generating plant, process

sizing methods include: performing calculations, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, architectural

low points include: blowdown tanks, drains, condensate receivers

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machine, welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

equipment fasteners include: expansion type 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-11.01.01K	demonstrate knowledge of high pressure steam and condensate systems, their applications and operation	explain the ***applications*** and operation of high pressure steam and condensate systems
		interpret information pertaining to high pressure steam and condensate system ***equipment*** found on drawings and specifications
D-11.01.02K	demonstrate knowledge of high pressure steam and condensate system equipment, their applications and operation	identify types of high pressure steam and condensate system equipment, and describe their characteristics and operation
		identify high pressure steam and condensate system ***supports*** and ***fasteners,*** and describe their applications and procedures for use

		identify high pressure steam and condensate system ***control components*** and describe their purpose and operation
		identify types of ***fuel*** used in high pressure steam and condensate systems
		identify ***sources of cooling*** used in high pressure steam and condensate system
		explain the ***principles of heat transfer***
		identify types of ***heat transfer equipment*** and describe their characteristics and operation
D-11.01.03K	demonstrate knowledge of the procedures used to install equipment for high pressure steam and condensate systems	identify equipment, controls, supports and fasteners used in high pressure steam and condensate systems, and describe their purpose and operation
		describe the procedures used to install equipment for high pressure steam and condensate systems, their controls, supports and fasteners

RANGE OF VARIABLES

applications include: power generation, process, central heating

equipment includes: boilers, boiler trim, expansion joints, pumps, heat transfer equipment, steam traps, valves, flash tanks, superheaters, re-heaters, de-aerators, desuperheaters, condensers, water treatment equipment

system supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

control components include: LWCO, operating pressure controls, high limit pressure controls, safety controls, feed water controls

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

sources of cooling include: cooling towers, condensers, flash tanks, blowdown tanks, converters

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: converters, turbines, radiators, convectors, pipe coils, horizontal, and vertical unit heaters

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

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-11.02.01P	determine ***routing*** of piping	***routing*** of piping is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
D-11.02.02P	select and size ***piping***	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
D-11.02.03P	select and use ***tools and equipment***	appropriate ***tools and equipment*** for the installation selected are based on type and size of piping
D-11.02.04P	clean and prepare fittings and joints	use ***joining methods*** and ensure fit-up to avoid leaks
D-11.02.05P	determine joining method for piping system	joining method is determined by engineered drawings and specifications, type and size of pipe
D-11.02.06P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
D-11.02.07P	install ***piping supports***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system
D-11.02.08P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of steam lines including sleeving and proper spacing, and making ***allowances for contraction and expansion***

RANGE OF VARIABLES

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

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

piping includes: chrome, carbon steel, stainless steel

tools and equipment include: hand tools, power tools and equipment, lifting equipment, threading machines, welding equipment

joining methods include: flanging, threading, grooving, welding, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides
allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-11.02.01K	demonstrate knowledge of the properties of steam	explain the ***properties of steam***
		describe the use of steam tables to identify the relationship between pressure and temperature
D-11.02.02K	demonstrate knowledge of high pressure steam and condensate piping, their ***applications*** and operation	explain the ***applications*** of high pressure steam and condensate piping
		identify types of ***pipe*** and ***piping components*** for high pressure steam and condensate systems, and describe their purpose and operation
		interpret information pertaining to high pressure steam and condensate system piping found on drawings and specifications
		explain the effects of expansion and contraction on piping in high pressure steam and condensate systems
		identify the ***considerations*** for selecting piping components for high pressure steam and condensate systems
		calculate grade and pitch of piping to ensure system efficiency and functionality
D-11.02.03K	demonstrate knowledge of the procedures used to install piping and piping components for high pressure steam and condensate systems	describe the procedures used to install piping and piping components for high pressure steam and condensate systems
		describe the procedures used to ***protect*** and restrain high pressure steam and condensate system piping and piping components

RANGE OF VARIABLES

properties of steam include: pressure, temperature, latent heat, sensible heat, total heat, superheat, volume
applications include: power generation, process, central heating
piping includes: chrome, carbon steel, stainless steel
piping components include: manual and automatic valves, steam traps, expansion joints, strainers, check valves
considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction
protection includes: protection from mechanical damage, seismic activity, environmental conditions

D-11.03 Tests high pressure steam and condensate systems

Essential Skills	Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-11.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
D-11.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
D-11.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***test medium*** to be used is determined based on type of test selected and ***method of filling, draining or purging*** is determined by the medium
D-11.03.04P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
D-11.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
D-11.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
D-11.03.07P	install testing equipment and components	testing equipment and components are connected following the test procedures
D-11.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
D-11.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
D-11.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
D-11.03.11P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled
D-11.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic and pneumatic

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers

test medium includes: water, water/glycol mix

method of filling, draining or purging includes: using pumps, using high pressure water supply hoses

isolation components include: spectacle 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

appropriate parties include: QA/QC personnel, owner/operator, AHJ

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
D-11.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
D-11.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of high pressure steam and condensate systems, 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 the effect of elevation and temperature on pressure when testing high pressure steam and condensate systems
		explain the effects trapped air in a high pressure steam and condensate system will have on testing and describe the procedures to prevent or correct it
D-11.03.03K	demonstrate knowledge of the procedures used to test high pressure steam and condensate systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers

tests include: hydrostatic, pneumatic

test medium include: water, water/glycol mix

method of filling, draining or purging includes: using pumps, using high pressure water supply hoses

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

D-11.04 Maintains, troubleshoots and repairs high pressure steam and condensate systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-11.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
D-11.04.02P	troubleshoot high pressure steam and condensate systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
D-11.04.03P	lock out and tag out system being repaired	system is locked and tagged out to prevent activation during repair
D-11.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	isolation components are installed and ***confirmation of zero energy state*** is completed
D-11.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
D-11.04.06P	reinstate system to operating condition and verify repair	system is energized, pressurized, checked for leaks, locks removed and returned to normal operating condition
D-11.04.07P	document the repairs	repairs are documented
D-11.04.08P	lock out and tag out system being maintained	system is locked and tagged out to prevent activation during maintenance
D-11.04.09P	isolate equipment or components requiring maintenance	equipment or components are isolated from the system to allow for completing the required ***maintenance procedure***

D-11.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and ***documentation*** is updated with the required information
D-11.04.11P	check water quality	water quality is tested for hardness, acidity, dissolved gases and suspended particulates using a test kit
D-11.04.12P	treat water in system with chemicals	system water quality is within required parameters depending on type and application of the system, and based on the results of the water quality test
D-11.04.13P	remove lock-out and tag-out from components and piping system	locks and tags are removed
D-11.04.14P	reinstate system to operating condition after completing maintenance procedures	system is energized, pressurized, checked for leaks and returned to normal operating condition

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, smell and touch), diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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 procedure includes: adding chemicals, lubricating, checking fluids, cleaning components, inspecting equipment and components for wear

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

equipment includes: boilers, expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tanks, isolators, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-11.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting high pressure steam and condensate systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to high pressure steam and condensate system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effect of pressure on elevation when troubleshooting high pressure steam and condensate systems

D-11.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain high pressure steam and condensate systems	describe the procedures used to troubleshoot high pressure steam and condensate systems
		describe the procedures used to repair high pressure steam and condensate systems
		describe the procedures used to maintain high pressure steam and condensate systems
		describe the procedures used to complete documentation following high pressure steam and condensate system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, manometer, infrared thermometer, chemical testing equipment

isolation components include: spectacle blinds, spades, plugs and caps and temporary spool pieces

MAJOR WORK ACTIVITY E

INSTALLS, TESTS, MAINTAINS, TROUBLESHOOTS AND REPAIRS HEATING, COOLING AND PROCESS PIPING SYSTEMS

TASK E-12 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 responsible for diagnosing, locating and repairing or replacing equipment and material. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-12.01 Installs equipment for hydronic systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.01.01P	select ***hydronic equipment*** and ***controls***	***hydronic equipment*** and ***controls*** are selected according to load and demand, and type of ***hydronic systems***
E-12.01.02P	size ***hydronic equipment*** and controls	hydronic system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
E-12.01.03P	determine location and placement of equipment and ***controls***	location and placement of equipment is determined according to ***drawings***
E-12.01.04P	determine ***high points*** and ***low points*** for hydronic equipment	***high points*** and ***low points*** are identified
E-12.01.05P	select and use ***tools and equipment*** required for installation of hydronic equipment and controls	appropriate ***tools and equipment*** for the installation are selected based on type of system and size of piping
E-12.01.06P	install ***equipment supports*** and ***fasteners***	***equipment supports*** and ***fasteners*** are installed to the required spacing, weight capacity, vibration isolation, height and grade in order to accommodate operation of the system
E-12.01.07P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
E-12.01.08P	set and secure equipment in place	hydronic equipment is installed respecting the required clearances and limitations, is aligned/orientated, leveled and anchored
E-12.01.09P	install controls	controls are installed according to system specifications

RANGE OF VARIABLES

hydronic equipment includes: boilers, expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tanks, isolators, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

controls include: pressure, temperature and liquid level controls, zone valves (motorized), safety controls, LWCO, high and low limit temperature controls

hydronic systems include: heating, cooling

sizing methods include: performing calculations, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical and electrical

high points include: air vents, valves, bleeders

low points include: drains

tools and equipment include: hand tools, power tools and equipment, multimeters, rigging and material handling equipment, threading machines, tube benders, brazing, soldering and welding tools and equipment

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

equipment 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**
E-12.01.01K	demonstrate knowledge of ***hydronic systems***, their applications and operation	explain the applications and operation of ***hydronic systems***
		interpret information pertaining to hydronic systems found on drawings and specifications
E-12.01.02K	demonstrate knowledge of ***hydronic equipment***, their applications and operation	identify types of piping components and accessories for hydronic systems, and describe their purpose and operation
		identify hydronic ***equipment supports*** and ***fasteners*** and describe their applications and procedures for use
		identify ***hydronic controls*** and describe their purpose and operation
		identify ***sources of heat*** used in hydronic systems
		identify ***sources of cooling*** used in hydronic systems
		explain the ***principles of heat transfer***
		identify types of ***heat transfer equipment*** and describe their characteristics and operation
E-12.01.03K	demonstrate knowledge of the procedures used to install equipment for hydronic systems	identify hydronic equipment, controls, supports and fasteners used in hydronic systems, and describe their purpose and operation
		describe the procedures used to install equipment for hydronic systems, their controls, supports and fasteners
		interpret jurisdictional codes and specifications for the installation of hydronic equipment

RANGE OF VARIABLES

hydronic systems include: heating, cooling

hydronic equipment includes: boilers, expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tanks, isolators, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

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

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

hydronic controls include: pressure, temperature and liquid level controls, zone valves (motorized), safety controls, LWCO, high and low limit temperature controls

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

E-12.02 Installs piping for hydronic systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.02.01P	determine ***routing*** of piping	***routing*** of piping is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
E-12.02.02P	determine ***high points*** and ***low points*** for hydronic piping	***high points*** and ***low points*** are identified
E-12.02.03P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
E-12.02.04P	select and use ***tools and equipment***	appropriate ***tools and equipment*** for the installation are selected and based on type and size of piping
E-12.02.05P	clean and prepare fittings and joints	use ***joining methods*** and ensure fit-up to avoid leaks
E-12.02.06P	determine joining method for piping system	joining method is determined by engineered drawings and specifications, type and size of pipe
E-12.02.07P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality

E-12.02.08P	install ***piping supports***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system
E-12.02.09P	install ***piping restraints***	***piping restraints*** are installed to protect piping system from damage during seismic activity
E-12.02.10P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of piping including sleeving and proper spacing, and making ***allowances for contraction and expansion***

RANGE OF VARIABLES

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

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

high points include: air vents, valves, bleeders

low points include: drains

piping includes: carbon steel, copper, plastic, stainless steel

tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe and tube bending equipment

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

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

piping restraints include: seismic wire, clamps, pipe, brackets

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.02.01K	demonstrate knowledge of hydronic ***piping configurations***, their ***applications*** and operation	explain the ***applications*** of hydronic ***piping configurations***
		identify types of ***piping*** and ***piping components*** for hydronic systems***,*** and describe their purpose and operation
		interpret information pertaining to hydronic piping found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on hydronic piping and components
		explain the effects of expansion and contraction on piping in hydronic systems
		explain the effects of trapped air in hydronic piping systems and describe the procedures to prevent it

		identify the ***considerations*** for selecting piping components for hydronic systems
E-12.02.02K	demonstrate knowledge of the procedures used to install piping and piping components for hydronic systems	describe the procedures used to install piping and piping components for hydronic systems
		describe the procedures used to ***protect*** hydronic piping and piping components
		identify systems that require pitch and grade of piping for the hydronic system

RANGE OF VARIABLES

piping configurations include: perimeter/series loop, reverse return, direct return, primary/secondary

applications include: residential, ICI heating and/or cooling

piping includes: plastic, carbon steel, stainless steel, copper

piping components include: fittings, dielectric fittings, hangers, brackets, sleeves, anchors, guides, valves, strainers, expansion joints, expansion loops, backflow preventers

selection considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

protection includes: protection from mechanical damage, seismic activity, environmental conditions

E-12.03 Tests hydronic systems

Essential Skills	Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
E-12.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
E-12.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
E-12.03.04P	assemble testing equipment and components	testing equipment is assembled and allows for test to be completed
E-12.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing

E-12.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
E-12.03.07P	install testing equipment and components	testing equipment and components are connected following the test procedures
E-12.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-12.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
E-12.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-12.03.11P	reinstate system	isolation components and testing equipment and components are removed and original components are reinstalled
E-12.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed
E-12.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method of filling, draining or purging includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: spectacle 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

appropriate parties include: QA/QC personnel, owner/operator, AHJ

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
E-12.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of hydronic systems 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 the effect of elevation and temperature on pressure when testing hydronic systems
		explain the effects trapped air in a hydronic system will have on testing and describe the procedures to prevent or correct it
E-12.03.03K	demonstrate knowledge of the procedures used to test hydronic systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system
		interpret jurisdictional codes and specifications for testing of hydronic equipment

RANGE OF VARIABLES

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

tests include: hydrostatic, pneumatic

method of filling, draining or purging includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

E-12.04 Maintains, troubleshoots and repairs hydronic systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

	SKILLS	
	Performance Criteria	**Evidence of Attainment**
E-12.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
E-12.04.02P	troubleshoot ***hydronic systems*** to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
E-12.04.03P	lock out and tag out system being repaired	system is locked and tagged out to prevent activation during repair
E-12.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed
E-12.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
E-12.04.06P	reinstate system to operating condition and verify repair	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition
E-12.04.07P	document the repairs	repairs are documented
E-12.04.08P	lock-out and tag-out system being maintained	system is locked and tagged out to prevent activation during maintenance
E-12.04.09P	isolate equipment or components requiring maintenance	equipment or components are isolated from the system to allow for completing the required ***maintenance procedures***
E-12.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and ***documentation*** is updated with the required information
E-12.04.11P	check water quality	water quality is tested to determine if it is suitable for the system using a test kit
E-12.04.12P	treat water in system with chemicals	system water quality is within required parameters depending on type and application of the system, and based on the results of the water quality test
E-12.04.13P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-12.04.14P	reinstate system to operating condition after completing ***maintenance procedures***	system is filled and pressurized, bled of air or contaminants, checked for leaks, and returned to normal operating condition

RANGE OF VARIABLES

hydronic systems include: heating, cooling

testing and inspection includes: sensory inspection, diagnostic testing, monitoring system operation

sensory inspection includes: visual, auditory, smell, touch

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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 procedures include: adding chemicals, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components if required

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

equipment includes: boilers, expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tanks, isolators, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

maintenance procedures include: adding chemicals, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components if required

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting ***hydronic systems***	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to hydronic system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effects of pressure on elevation when troubleshooting hydronic systems
		explain the effects trapped air in a hydronic system will have on system operation and describe the procedures to prevent or correct it
E-12.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain hydronic systems	describe the procedures used to troubleshoot hydronic systems
		describe the procedures used to repair hydronic systems
		describe the procedures used to maintain hydronic systems
		describe the procedures used to complete documentation following hydronic system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, manometer, infrared thermometer, balancing equipment, chemical testing equipment

hydronic systems include: heating, cooling

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

TASK E-13 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. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-13.01 Installs equipment for process piping systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.01.01P	select ***equipment*** and ***controls***	***equipment*** and ***controls*** are selected according to load, demand and type of ***process piping systems***
E-13.01.02P	size equipment and controls	process piping system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
E-13.01.03P	determine location and placement of equipment and controls	location and placement of equipment and controls is determined according to ***drawings***
E-13.01.04P	determine ***high points*** and ***low points*** for process piping system equipment	***high points*** and ***low points*** are identified
E-13.01.05P	select and use ***tools and equipment*** required for installation of process piping system equipment and controls	appropriate ***tools and equipment*** for the installation are selected based on type of system and size of piping
E-13.01.06P	install ***equipment supports*** and ***fasteners***	***equipment supports*** and ***fasteners*** are installed to required spacing, weight capacity, vibration isolation, height and grade in order to accommodate operation of the system
E-13.01.07P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
E-13.01.08P	set and secure equipment in place	process piping system equipment is set respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored
E-13.01.09P	installs controls	controls are installed according to system specifications

RANGE OF VARIABLES

equipment include: circulating pumps, tanks, pressure vessels, heat exchangers, transfer pumps, holding tanks, isolators, relief valves, isolation valves for equipment, strainers, filters

controls include: operating and temperature controls, flow meters, liquid level controls, safety controls

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing

sizing methods include: performing calculations, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, electrical

high points include: air vents, valves and bleeders

low points include: drains

tools and equipment include: hand tools, power tools and equipment, multimeter rigging and material handling equipment, threading machines, tube benders, torque wrenches, brazing, soldering and welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

equipment fasteners include: expansion type 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
E-13.01.01K	demonstrate knowledge of process piping systems, their applications and operation	explain the applications and operation of ***process piping systems***
		interpret information pertaining to process piping systems equipment found on drawings and specifications
E-13.01.02K	demonstrate knowledge of process piping system ***equipment***, their applications and operation	identify types of process piping system ***equipment***, and describe their characteristics and operation
		identify process piping system ***equipment supports and fasteners*** and describe their applications and procedures for use
		identify process piping system ***controls*** and describe their purpose and operation
E-13.01.03K	demonstrate knowledge of the procedures used to install equipment for process piping systems	describe the procedures used to install equipment for process piping systems, their controls, supports and fasteners
		interpret jurisdictional codes and specifications for installation 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

equipment includes: circulating pumps, tanks, pressure vessels, heat exchangers, transfer pumps, holding tanks, isolators, relief valves, isolation valves for equipment, strainers, filter

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

equipment fasteners include: expansion type inserts, beam clamps, nuts, bolts, screws
controls include: operating and temperature controls, flow meters, liquid level controls, safety controls

E-13.02 Installs piping for process piping systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.02.01P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
E-13.02.02P	determine ***high points*** and ***low points*** for process piping system	***high points*** and ***low points*** are identified
E-13.02.03P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
E-13.02.04P	select and use ***tools and equipment***	appropriate ***tools and equipment*** for the installation are selected and based on type and size of piping
E-13.02.05P	clean and prepare fittings and joints	use ***joining methods*** and ensure fit-up to avoid leaks
E-13.02.06P	determine joining method for piping system	joining method is determined by engineered drawings and specifications, type and size of pipe
E-13.02.07P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
E-13.02.08P	install ***piping supports*** and ***restraints***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system ***piping restraints*** are installed to protect piping system from damage during seismic activity
E-13.02.09P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of process piping including sleeving and proper spacing, making ***allowances for contraction and expansion***, and ensuring that the system is not contaminated during assembly

RANGE OF VARIABLES

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

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

high points include: air vents, valves, bleeders

low points include: drains

piping includes: carbon steel, copper, chrome, plastic, fibreglass, titanium, copper-nickel, stainless steel

tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe and tube bending equipment, torque wrenches

joining methods include: flanging, bonding, grooving, crimping, threading, welding, soldering, brazing, mechanical joints, clamp connectors (high pressure mechanical joints)

piping supports include: hangers, clamps, brackets, stands, anchors, guides

piping restraints include: seismic wire, clamps, pipe, brackets

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.02.01K	demonstrate knowledge of ***process piping system***, their applications and operation	explain the ***applications*** of ***process piping systems***
		identify types of ***pipe*** and ***piping components*** for process piping systems, and describe their purpose and operation
		interpret information pertaining to process piping found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on process piping system piping and piping components
		explain the effects of expansion and contraction on piping in process piping systems
		explain the effects of trapped air in a process piping system and describe the procedures to prevent it
		identify the ***considerations for selecting*** piping system components for process piping systems
E-13.02.02K	demonstrate knowledge of the procedures used to install piping and piping components for process piping systems	describe the procedures used to install piping and piping components for process piping systems
		describe the procedures used to ***protect*** process piping and piping components

RANGE OF VARIABLES

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing

applications include: ICI processes

piping includes: carbon steel, copper, chrome, plastic, fibreglass, titanium, copper-nickel, stainless steel

piping components include: manual and automatic valves, fittings, expansion joints, strainers, filters, check valves

selection considerations include: client requirements, insulation requirements, type of supports, shoes and sleeves, expansion, contraction

protection includes: dielectric unions, cathodic protection, protection from contamination, protective coatings, impressed current

E-13.03 Tests process piping systems

Essential Skills	Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
E-13.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
E-13.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***test medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
E-13.03.04P	assemble testing equipment and components	testing equipment is assembled and allows for test to be completed
E-13.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
E-13.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed sensitive equipment is protected from test pressures
E-13.03.07P	install testing equipment and components	testing equipment and components are connected following the test procedures

E-13.03.08P	perform test on system to verify the integrity of system	***test medium*** is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-13.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
E-13.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-13.03.11P	reinstate system	isolation components and testing equipment and components are removed and original components are reinstalled
E-13.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic, vacuum

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method of filling, draining or purging includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: spectacle 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

test medium includes: water, compressed air, glycol, water/glycol mix, inert gases

appropriate parties include: QA/QC personnel, owner/operator, AHJ

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
E-13.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of ***process piping systems***, 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 the effect of elevation and temperature on pressure when testing process piping systems
		explain the effects trapped air in a process piping system will have on testing and describe the procedures to prevent or correct it
E-13.03.03K	demonstrate knowledge of the procedures used to test process piping systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, compressed air, glycol, water/glycol mix, inert gases

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing

method of filling, draining or purging includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blind flanges, plugs and caps, temporary spool pieces

E-13.04 Maintains, troubleshoots and repairs process piping systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
E-13.04.02P	troubleshoot ***process piping systems*** to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
E-13.04.03P	lock out and tag out system being repaired	system is locked and tagged out to prevent activation during repair
E-13.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed

E-13.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
E-13.04.06P	reinstate system to operating condition and verify repair	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition
E-13.04.07P	document the repairs	repairs are documented
E-13.04.08P	lock out and tag out system being maintained	system is locked and tagged out to prevent activation during maintenance
E-13.04.09P	isolate equipment or components requiring maintenance	equipment or components are isolated from the system to allow for completing the required ***maintenance procedures***
E-13.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and ***documentation*** is updated with the required information
E-13.04.11P	check quality of system medium	system medium quality is tested to determine if it is suitable for the system using a test kit
E-13.04.12P	treat system medium with chemicals	system medium quality is within required parameters depending on type and application of the system, and based on the results of the test
E-13.04.13P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-13.04.14P	reinstate system to operating condition after completing maintenance procedures	system is filled and pressurized, bled of air or contaminants, checked for leaks and returned to normal operating condition

RANGE OF VARIABLES

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing

testing and inspection include: sensory inspection (visual, auditory, smell, touch), diagnostic testing, monitoring system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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

maintenance procedures include: adding chemicals, lubricating, checking fluids, cleaning components, inspecting equipment or components for wear, replacing worn components if required

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

equipment includes: boilers, expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tanks, isolator pads, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-13.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting ***process piping systems***	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to process piping system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effect of pressure on elevation when troubleshooting process piping systems
		explain the effects trapped air in a process piping system will have on system operation and describe the procedures to prevent or correct it
E-13.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain process piping systems	describe the procedures used to troubleshoot process piping systems
		describe the procedures used to repair process piping systems
		describe the procedures used to maintain process piping systems
		describe the procedures used to complete documentation following process piping system repair or maintenance

RANGE OF VARIABLES

process piping systems include: gas/oil refining, pulp production, mining, food processing, chemical production, ship building, sawmills, manufacturing

testing equipment and components include: multimeter, manometer, infrared thermometer, chemical testing equipment

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

TASK E-14 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 wastewater. Steamfitter/Pipefitters are responsible for installing, maintaining and repairing the 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 responsible for diagnosing, locating and repairing or replacing equipment and material. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-14.01 Installs equipment for industrial water and waste treatment systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-14.01.01P	select ***equipment***	***equipment*** is selected according to load and demand, and type of industrial water and waste treatment systems
E-14.01.02P	size equipment	industrial water and waste treatment system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
E-14.01.03P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings***, jurisdictional codes and specifications
E-14.01.04P	select and use ***tools and equipment*** required for installation of industrial water and waste treatment equipment	appropriate ***tools and equipment*** for the installation are selected based on type of system and size of piping

E-14.01.05P	install ***equipment supports*** and ***fasteners***	***equipment supports*** and ***fasteners*** are installed to required spacing, weight capacity, vibration isolation, height and grade in order to accommodate operation of the system
E-14.01.06P	set and secure equipment in place	***installation method*** used to set equipment in place is determined by size, weight and location of equipment industrial water and waste treatment equipment is installed respecting the required clearances and limitations and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

equipment includes: pumps, tanks, valves, filters, strainers, separators, skimmers, aerators, water treatment equipment

sizing methods include: performing calculations, determining measurements, consulting manufacturers/supplier documentation

drawings include: engineered, mechanical, electrical

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machines, plastic bonding, brazing, soldering and welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

equipment fasteners include: expansion type 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**
E-14.01.01K	demonstrate knowledge of industrial water and waste treatment systems, their applications and operation	explain the applications and operation of industrial water and waste treatment systems
		interpret information pertaining to industrial water and waste treatment equipment found on drawings and specifications
E-14.01.02K	demonstrate knowledge of industrial water and waste treatment ***equipment***, their applications and operation	identify types of industrial water and waste treatment systems ***equipment***, and describe their characteristics and operation
		identify industrial water and waste treatment systems ***equipment supports and fasteners*** and describe their applications and procedures for use
		identify industrial water and waste treatment system ***control components*** and describe their purpose and operation

E-14.01.03K	demonstrate knowledge of the procedures used to install equipment for industrial water and waste treatment systems	identify equipment, controls, supports and fasteners used in industrial water and waste treatment systems, and describe their purpose and operation
		describe the procedures used to install equipment for industrial water and waste treatment systems, their controls, supports and fasteners
		interpret jurisdictional codes and specifications for installation of industrial water and waste treatment systems

RANGE OF VARIABLES

equipment includes: pumps, tanks, valves, filters, strainers, separators, skimmers, aerators, water treatment equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

control components include: operating and temperature controls, flow controls, safety controls

E-14.02 Installs piping for industrial water and waste treatment systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-14.02.01P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
E-14.02.02P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
E-14.02.03P	determine ***high points*** and ***low points*** for industrial water and waste treatment piping	***high points*** and ***low points*** are identified
E-14.02.04P	select and use ***tools and equipment***	appropriate ***tools and equipment*** for the installation are selected and based on type and size of piping
E-14.02.05P	clean and prepare fittings and joints	use ***joining methods*** and ensure fit-up to avoid leaks
E-14.02.06P	determine joining method for piping system	joining method is determined by engineered drawings and specifications, type and size of pipe

E-14.02.07P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
E-14.02.08P	install ***piping supports*** and ***restraints***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system ***piping restraints*** are installed to protect piping system from damage during seismic activity
E-14.02.09P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of piping including sleeving and proper spacing

RANGE OF VARIABLES

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

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

piping includes: carbon steel, copper, plastic, stainless steel

high points include: air vents, valves, bleeders

low points include: drains

tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe and tube bending equipment

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

piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides, concrete piers (underground)

piping restraints include: seismic wire, clamps, pipe, brackets

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-14.02.01K	demonstrate knowledge of industrial water and waste treatment ***piping configurations***, their ***applications*** and operation	explain the ***applications*** of industrial water and waste treatment ***piping configurations***
		identify types of ***piping, piping components*** and ***supports*** for industrial water and waste treatment systems, and describe their purpose and operation
		interpret information pertaining to industrial water and waste treatment piping found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on industrial water and waste treatment piping and components

		explain the effects of trapped air in industrial water and waste treatment piping system and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping system components for industrial water and waste treatment systems
E-14.02.02K	demonstrate knowledge of the procedures used to install piping, components and supports for industrial water and waste treatment systems	describe the procedures used to install piping, components and supports for industrial water and waste treatment systems
		describe the procedures used to ***protect*** industrial water and waste treatment system piping and piping components

RANGE OF VARIABLES

piping configurations include: gravity, pressurized

applications include: transfer liquid from point of use for treatment and possible reuse

piping includes: plastic, carbon steel, copper***,*** stainless steel

piping components include: fittings, dielectric fittings, hangers, brackets, sleeves, anchors, guides, manual and automatic valves, strainers, backflow preventers, check valves

piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides, concrete piers (underground)

selection considerations include: insulation requirements, type of supports, shoes, sleeves

protection includes: protection from mechanical damage, seismic activity, environmental conditions, contamination

E-14.03 Tests industrial water and waste treatment systems

Essential Skills Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-14.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
E-14.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
E-14.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
E-14.03.04P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
E-14.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
E-14.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed sensitive equipment is protected from test pressures
E-14.03.07P	install ***testing equipment and components***	***testing equipment and components*** are connected following the test procedures
E-14.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-14.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
E-14.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-14.03.11P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled
E-14.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic

testing equipment and components include: blind flanges, calibrated pressure gauges, test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

test medium includes: water, water/glycol mix, compressed air, glycol, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle 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

testing equipment and components include: blind flanges, calibrated pressure gauges, test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

appropriate parties include: QA/QC personnel, owner/operator, AHJ

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-14.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
E-14.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of industrial water and waste treatment systems, 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 treatment system testing found on drawings and specifications
		explain the effect of elevation and temperature on pressure when testing industrial water and waste treatment systems
		explain the effects trapped air in an industrial water and waste treatment system will have on testing and describe the procedures to prevent or correct it
E-14.03.03K	demonstrate knowledge of the procedures used to test industrial water and waste treatment systems	describe the procedures used to perform system testing

	describe the procedures used to remove test medium from system
	describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

tests include: hydrostatic, pneumatic

test medium includes: water, compressed air, glycol, water/glycol mix, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

E-14.04 Maintains, troubleshoots and repairs industrial water and waste treatment systems

Essential Skills Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-14.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
E-14.04.02P	troubleshoot industrial water and waste treatment systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
E-14.04.03P	lock out and tag out system being maintained and repaired	system is locked and tagged out to prevent activation during maintenance and repair
E-14.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed
E-14.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
E-14.04.06P	reinstate system to operating condition and verify repair	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition
E-14.04.07P	document the repairs	repairs are documented

E-14.04.08P	isolate equipment or components requiring maintenance	equipment or components are isolated from the system to allow for completing the required ***maintenance procedure***
E-14.04.09P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and ***documentation*** is updated with the required information
E-14.04.10P	check water quality	water quality is tested to determine if it is suitable for the system using a test kit
E-14.04.11P	treat water in system with chemicals	system water quality is within required parameters depending on type and application of the system, and based on the results of the water quality test
E-14.04.12P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-14.04.13P	reinstate system to operating condition after completing maintenance procedures	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition

RANGE OF VARIABLES

testing and inspection include: sensory inspection (visual, auditory, smell, touch), diagnostic testing, monitor system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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

maintenance procedures include: lubricating, checking fluids, cleaning components, inspecting equipment or components for wear

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

equipment includes: boilers, expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tanks, isolators, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-14.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting industrial water and waste treatment systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to industrial water and waste treatment system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals

		explain the effect of pressure on elevation when troubleshooting industrial water and waste treatment systems
		explain the effects trapped air in an industrial water and waste treatment system will have on system operation and describe the procedures to prevent or correct it
E-14.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain industrial water and waste treatment systems	describe the procedures used to troubleshoot industrial water and waste treatment systems
		describe the procedures used to repair industrial water and waste treatment systems
		describe the procedures used to maintain industrial water and waste treatment systems
		describe the procedures used to complete documentation following water and waste treatment system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, micrometer, stethoscope, chemical testing equipment

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

TASK E-15 INSTALLS, TESTS, MAINTAINS TROUBLESHOOTS AND REPAIRS HYDRAULIC SYSTEMS

TASK DESCRIPTOR

Hydraulic systems are used to drive hydraulic motors and actuators in a variety of 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 responsible for diagnosing, locating and repairing or replacing equipment and material. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-15.01 Installs equipment for hydraulic systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-15.01.01P	select ***equipment***	***equipment*** for ***hydraulic systems*** is selected according engineered drawings or owner specifications
E-15.01.02P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings***
E-15.01.03P	select and use ***tools and equipment*** required for installation of hydraulic equipment	***tools and equipment*** for the installation are selected based on type of system and size of piping

E-15.01.04P	install ***equipment supports*** and ***fasteners***	***equipment supports*** and ***fasteners*** are installed to required spacing, weight capacity, vibration isolation, height and grade in order to accommodate operation of the system
E-15.01.05P	set and secure equipment in place	***installation method*** used to set equipment in place is determined by size, weight and location of equipment hydraulic equipment is installed respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

equipment includes: reservoir tanks, pumps, motors, fittings, valves, cylinders, pistons, actuators, accumulators, fluid coolers, fluid heaters, strainers, filters

hydraulic systems include: open loop, closed loop

drawings include: engineered, mechanical

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machines, pipe bending equipment, welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-15.01.01K	demonstrate knowledge of hydraulic systems, their applications and operation	explain the applications and operation of hydraulic systems
		interpret information pertaining to hydraulic system equipment found on drawings, schematics and specifications
E-15.01.02K	demonstrate knowledge of ***hydraulic equipment***, their applications and operation	identify types of ***hydraulic equipment***, and describe their characteristics and operation
		identify hydraulic ***equipment supports*** and ***fasteners*** and describe their applications and procedures for use
		identify ***hydraulic control components*** and describe their purpose and operation
		identify types of fluids and fluid-related formulae, and describe their characteristics and applications

E-15.01.03K	demonstrate knowledge of the procedures used to install equipment for hydraulic systems	identify equipment, controls, supports and fasteners used in hydraulic systems, and describe their purpose and operation
		describe the procedures used to install equipment for hydraulic systems, their ***controls***, supports and fasteners

RANGE OF VARIABLES

hydraulic equipment includes: reservoir tanks, pumps, motors, relief valves, fittings, valves, cylinders, pistons, actuators, accumulators, fluid coolers, fluid heaters, strainers, filters

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

hydraulic control components include: operating, temperature and pressure controls, safety controls, valves, actuators

controls include: operating, temperature and pressure controls, safety controls, valves, actuators

E-15.02 Installs piping, tubing and hoses for hydraulic systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-15.02.01P	determine routing of piping, tubing and hoses	***routing*** of piping, tubing and hoses is confirmed by referencing drawings or modified to avoid ***obstructions*** and/or ***conflicts***
E-15.02.02P	determine ***high points*** and ***low points*** for hydraulic piping	***high points*** and ***low points*** are identified
E-15.02.03P	select and size piping, tubing and hoses	type of ***piping, tubing and hose*** is selected based on system application and sized according to the drawings or owner specifications
E-15.02.04P	select and use ***tools and equipment***	***tools and equipment*** for the installation are selected based on type and size of piping
E-15.02.05P	clean and prepare fittings and joints	use ***joining methods*** and ensure fit-up to avoid leaks
E-15.02.06P	determine joining method for piping, tubing and hoses	joining method is determined by engineered drawings and specifications, type and size of pipe, tubing and hoses

E-15.02.07P	calculate grade or pitch of piping and tubing	grade or pitch of piping and tubing is calculated in order to ensure system efficiency and functionality
E-15.02.08P	install ***piping, tubing and hose supports***	***piping, tubing and hose supports*** are installed to required spacing, height and grade in order to accommodate operation of the system
E-15.02.09P	assemble and install piping, tubing and hoses	piping, tubing and hoses are assembled and installed using joining methods and in a manner to allow for sleeving, proper spacing, allowances for movement of equipment, and ensuring there is no contamination of the system

RANGE OF VARIABLES

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

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

high points include: valves, bleeders

low points include: drains

piping, tubing and hoses include: carbon steel, stainless steel, hydraulic hose

tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe and tube bending equipment, hydraulic hose crimpers

joining methods include: flanging, threading, grooving, crimping, welding, mechanical joints

piping, tubing and hose supports include: hangers, vibration-dampening clamps, brackets, guides

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-15.02.01K	demonstrate knowledge of ***hydraulic piping systems***, their ***applications*** and operation	explain the ***applications*** of ***hydraulic piping systems***
		identify types of ***piping***, tubing and hoses for hydraulic systems, and describe their purpose and operation
		interpret information pertaining to hydraulic piping, tubing and hoses found on drawings, schematics and specifications
		explain the effects of trapped air in hydraulic systems and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping, tubing and hoses for hydraulic systems
E-15.02.02K	demonstrate knowledge of the procedures used to install piping, tubing and hoses for hydraulic systems	describe the procedures used to install piping, tubing and hoses for hydraulic systems

		describe the procedures used to ***protect*** hydraulic system piping, tubing and hoses
E-15.02.01K	demonstrate knowledge of ***hydraulic piping systems***, their ***applications*** and operation	explain the ***applications*** of ***hydraulic piping systems***

RANGE OF VARIABLES

hydraulic piping systems include: open loop, closed loop
applications include: to operate lifting devices, to operate motors
piping includes: plastic, carbon steel, copper***,*** stainless steel
selection considerations include: type of supports, system pressure, movement of the equipment
protection includes: protection from mechanical damage, seismic activity, vibration, environmental conditions

E-15.03 Tests hydraulic systems

Essential Skills Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-15.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
E-15.03.02P	determine type of ***test, testing equipment and components***, and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
E-15.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
E-15.03.04P	assemble testing equipment and components	assembled testing equipment allows for test to be completed
E-15.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
E-15.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed sensitive equipment is protected from test pressures
E-15.03.07P	install testing equipment and components	test equipment and components are connected following the test procedures

E-15.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-15.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
E-15.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-15.03.11P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled
E-15.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic

testing equipment and components include: blind flanges, calibrated pressure gauges, test pumps, relief valves, valves, testing trees/headers, regulators

test medium include: fluid, compressed air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle 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

appropriate parties include: QA/QC personnel, owner/operator, AHJ

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-15.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
E-15.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of hydraulic systems, 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, schematics and specifications

		explain the effects trapped air in a hydraulic system will have on testing and describe the procedures to prevent or correct it
E-15.03.03K	demonstrate knowledge of the procedures used to test hydraulic systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: blind flanges, calibrated pressure gauges, test pumps, relief valves, valves, testing trees/headers, regulators

tests include: hydrostatic, pneumatic

test medium includes: test fluids, test gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressed gas cylinders

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

E-15.04 Maintains, troubleshoots and repairs hydraulic systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-15.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
E-15.04.02P	troubleshoot hydraulic systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
E-15.04.03P	lock out and tag out system being repaired and maintained	system is locked and tagged out to prevent activation during maintenance and repair
E-15.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed
E-15.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area

E-15.04.06P	reinstate system to operating condition and verify repair	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition
E-15.04.07P	document the repairs	repairs are documented
E-15.04.08P	isolate equipment or components requiring maintenance	equipment or components are isolated from the system to allow for completing the required ***maintenance procedure***
E-15.04.09P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and the ***documentation*** is updated with the required information
E-15.04.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-15.04.11P	reinstate system to operating condition after completing maintenance procedures	system is filled and pressurized, bled of air or contaminants, checked for leaks and returned to normal operating condition

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, smell, touch), diagnostic testing, monitor system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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

maintenance procedure includes: lubricating, checking/replacing fluids, cleaning components, inspecting equipment or components for wear

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

equipment includes: reservoir tanks, pumps, motors, relief valves, fittings, valves, cylinders, pistons, actuators, accumulators, fluid coolers, fluid heaters strainers, filters

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-15.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting hydraulic systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to hydraulic system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals

		explain the importance of ensuring contaminants do not enter the system when repairing or maintain hydraulic systems
		explain the effects trapped air in a hydraulic system will have on system operation and describe the procedures to prevent or correct it
E-15.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain hydraulic systems	describe the procedures used to troubleshoot hydraulic systems
		describe the procedures used to repair hydraulic systems
		describe the procedures used to maintain hydraulic systems
		describe the procedures used to complete documentation following hydraulic system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, infrared thermometer, calibrated gauges
isolation components include: spectacle blinds, spades, plugs and caps

TASK E-16 INSTALLS, TESTS, MAINTAINS, TROUBLESHOOTS AND REPAIRS HEATING, VENTILATION, AIR CONDITIONING AND REFRIGERATION (HVACR) SYSTEMS

TASK DESCRIPTOR

According to jurisdictional guidelines, steamfitters/pipefitters install refrigeration equipment and piping for ICI applications such as food processing plants, recreational facilities, medical facilities, industrial manufacturing processes and liquefied natural gas plants. System components and design can vary depending on the type of refrigerant used, such as chlorofluorocarbons (CFC) and hydrofluorocarbons (HCFC). They may also work on the refrigeration units for co-gen systems in industrial applications.

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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-16.01 Installs equipment for HVACR systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-16.01.01P	identify and determine location and placement of ***HVACR equipment***	location and placement of equipment is determined using approved ***methods*** and drawings
E-16.01.02P	select and use ***tools and equipment*** required for installation of HVACR equipment	***tools and equipment*** for the installation are selected based on type of system and size of piping
E-16.01.03P	install ***equipment supports*** and ***fasteners***	***equipment supports*** and ***fasteners*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system

E-16.01.04P	set and secure HVACR equipment in place	***installation method*** used to set equipment in place is determined by size, weight and location of equipment HVACR equipment is installed respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

HVACR equipment includes: compressors, condensers, heat pumps, chillers, evaporators, cooling towers, fin fans, liquid receivers, accumulators, humidifiers

methods include: performing calculations, determining measurements, consulting manufacturer/supplier documentation

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machines, brazing, soldering and welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-16.01.01K	demonstrate knowledge of refrigeration systems, their components, applications and operation	interpret information pertaining to refrigeration equipment found on drawings and specifications
		identify types of ***refrigeration systems*** and describe their characteristics and applications
		identify refrigeration system ***equipment*** and describe their purpose and operation
		identify ***refrigeration system components*** and describe their purpose and operation
		identify refrigeration ***equipment supports*** and ***fasteners*** and describe their applications and procedures for use
		identify refrigeration ***control components*** and describe their purpose and operation
		identify ***sources of energy*** used in refrigeration systems
		explain the ***principles of heat transfer***
		identify types of ***heat transfer equipment*** and describe their characteristics and operation
		interpret codes and regulations pertaining to refrigeration systems
		explain the applications and operation of refrigeration systems

E-16.01.02K	demonstrate knowledge of the procedures used to install ***equipment*** for refrigeration systems	identify ***equipment, supports*** and fasteners used in refrigeration systems, and describe their purpose and operation
		describe the procedures used to install equipment for refrigeration systems, their controls , supports and fasteners

RANGE OF VARIABLES

refrigeration systems include: compressor, absorption
equipment includes: condensers, heat pumps, chillers, cooling towers, fin fans, co-gen devices, plate exchangers
refrigeration system components include: expansion joints, controls, coils, compressors, evaporators, condensers
equipment supports include: expansion tanks, pumps, outdoor controllers, control valves
equipment fasteners include: expansion type inserts, beam clamps, nuts, bolts, screws
control components include: operating and temperature controls, safety controls
sources of energy include: oil, gas, wood, steam, geothermal, solar
principles of heat transfer include: radiation, conduction, convection
heat transfer equipment includes: pipe coils, radiant panels, demisters, heat/plate exchangers
equipment includes: compressors, condensers, heat pumps, chillers, evaporators, cooling towers, fin fans, liquid receivers, accumulators, humidifiers
supports include: stands, hangers, plates, isolator pads, embeds

E-16.02 Installs hydronic piping and refrigeration tubing for HVACR systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-16.02.01P	select and use ***tools and equipment***	***tools and equipment*** are selected according to application
E-16.02.02P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
E-16.02.03P	determine ***joining method*** for piping system	***joining method*** is determined by engineered drawings and specifications, type and size of pipe
E-16.02.04P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
E-16.02.05P	bend tubing	tubing is bent for routing from one component to another

E-16.02.06P	assemble piping and tubing using joining methods	piping and tubing is assembled according to engineered drawings, jurisdictional codes and specifications
E-16.02.07P	prepare pipe and fittings using approved ***methods***	pipe is ***prepared*** using approved ***methods***
E-16.02.08P	allow for ***insulation*** of refrigerant lines	***insulation*** of refrigerant lines is allowed for using approved ***methods***
E-16.02.09P	determine ***high points*** and ***low points*** for piping and tubing	***high points*** and ***low points*** are identified
E-16.02.10P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
E-16.02.11P	install ***piping supports***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system

RANGE OF VARIABLES

tools and equipment include: flaring tools, swaging tools, tube benders
piping includes: carbon steel, copper, alloys
joining method includes: flanging, threading, welding, soldering, grooving, crimping, brazing, mechanical joints
preparation methods include: purging, reaming, flaring and cleaning ends, bevelling
insulation methods include: sleeving and proper spacing, installing shoes/blocks
high points include: air vents, valves, bleeders
low points include: drains
routing obstructions include: structural components (beams, walls), other mechanical and electrical systems
routing conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)
piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-16.02.01K	demonstrate knowledge of refrigeration systems, their components, applications and operation	interpret information pertaining to refrigeration equipment found on drawings and specifications
		identify types of ***refrigeration systems*** and describe their characteristics and applications
		identify refrigeration system ***equipment*** and describe their purpose and operation
		identify ***refrigeration system components*** and describe their purpose and operation
		identify refrigeration equipment ***supports and fasteners*** and describe their applications and procedures for use

		identify ***refrigeration control components*** and describe their purpose and operation
		identify types of refrigeration ***piping and tubing***
		identify ***sources of energy*** used in refrigeration systems
		explain the ***principles of heat transfer***
		identify types of ***heat transfer equipment*** and describe their characteristics and operation
		explain the applications and operation of refrigeration systems
		interpret codes and regulations pertaining to refrigeration systems
		identify the properties and characteristics of ***refrigerants***
E-16.02.02K	demonstrate knowledge of the procedures used to install piping and components for refrigeration systems	describe the procedures used to install piping and components for refrigeration systems
		explain the ***applications*** of ***refrigeration piping configurations***
		interpret information pertaining to refrigeration piping found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on refrigeration piping and components
		explain the effects of expansion and contraction on piping in refrigeration systems
		explain the effects of trapped air in refrigeration piping systems and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping system components for refrigeration systems
		describe the procedures used to ***protect*** refrigeration system piping and components from vibration

RANGE OF VARIABLES

refrigeration systems include: compressor, absorption

equipment includes: condensers, heat pumps, chillers, cooling towers, fin fans, co-gen devices, plate exchangers

refrigeration system components include: expansion joints, controls, coils, compressors, evaporators, condensers

equipment supports include: expansion tanks, pumps, outdoor controllers, control valves

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

refrigeration control components include: operating and temperature controls, safety controls
piping and tubing includes: carbon steel, copper, alloys
sources of energy include: oil, gas, wood, steam, geothermal, solar
principles of heat transfer include: radiation, conduction, convection
heat transfer equipment includes: pipe coils, radiant panels, demisters, heat/plate exchangers
refrigerants include: CFCs, HCFCs
applications include: residential cooling, ICI cooling, process applications
refrigeration piping configurations include: liquid line, gas line, grade, supply and return
selecting considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction
protection includes: protection from mechanical damage, seismic activity, environmental conditions

E-16.03 Tests associated components of HVACR systems

Essential Skills	Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-16.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
E-16.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and test parameters are determined to match system application and requirements according to engineered specifications
E-16.03.03P	determine ***test medium*** to be used and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
E-16.03.04P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, ***confirmation of zero energy state*** is completed and sensitive equipment is protected from test pressures
E-16.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
E-16.03.06P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
E-16.03.07P	test and check system using ***testing equipment and components***	system tested and checked using ***testing equipment and components***
E-16.03.08P	install ***testing equipment and components***	***testing equipment and components*** are connected following the test procedures

E-16.03.09P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-16.03.10P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
E-16.03.11P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-16.03.12P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled
E-16.03.13P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic, vacuum

testing equipment and components include: blind flanges, calibrated pressure gauges, test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

test medium includes: water, water/glycol mix, air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

test medium includes: water, water/glycol mix, air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

testing equipment and components includes: hydrostatic test equipment, infrared temperature sensor, manometer

testing equipment and components includes: test tree and components, pressure gauge, pumps, compressors, test medium

appropriate parties include: QA/QC personnel, owner/operator, AHJ

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-16.03.01K	demonstrate knowledge of the procedures used to test ***associated components of refrigeration systems***	describe the procedures used to test refrigeration systems
		describe the procedures used to test refrigeration system control components
		identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of refrigeration systems, 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 testing of associated components of refrigeration system found on drawings and specifications
	explain the effect of elevation and temperature on pressure when testing the components of refrigeration systems
	explain the effects trapped air in components of a refrigeration system will have on testing and describe the procedures to prevent or correct it
	describe the procedures used to remove test medium from system
	describe the procedures used to reinstate system

RANGE OF VARIABLES

associated components of refrigeration systems include: high point vents, low point drains, test pumps, gauges, test trees

testing equipment and components includes: chart recorders, nitrogen bottles, pressure gauges, hydro pumps

tests include: hydrostatic, pneumatic

test medium includes: water, water/glycol mix, compressed air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: blind flanges, plugs and caps, temporary spool pieces

E-16.04 Maintains, troubleshoots and repairs associated components of HVACR systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-16.04.01P	perform sensory inspection of system and equipment for ***conditions for repair or replacement***	sensory inspection of system and equipment performed
E-16.04.02P	verify ***associated components*** to be repaired or replaced	***associated components*** to be repaired or replaced are verified according to available drawings and specifications
E-16.04.03P	lock out and tag out system	system is locked and tagged out to prevent activation during maintenance and repair
E-16.04.04P	depressurize and drain medium from system and secure area	piping to be repaired or replaced is at zero energy state
E-16.04.05P	disassemble system by removing and replacing piping and components	system is disassembled using safe work practices
E-16.04.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
E-16.04.07P	follow a predetermined maintenance schedule	***required documentation*** is completed
E-16.04.08P	clean and lubricate associated ***components*** of refrigeration system	cleaning and lubrication is confirmed through visual inspection and documentation in maintenance schedule
E-16.04.9P	replace defective ***components***	equipment is re-instated to working order
E-16.04.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-16.04.11P	re-energize ***system*** with new or removed medium	requirements of a full system are met and verified

RANGE OF VARIABLES

conditions for repair or replacement include: temperature, leaks, corrosion, vibration, irregular movement

associated components include: pumps, coils, pressure gauges, cooling towers

isolation components include: spectacle 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

required documentation includes: lock-out and tag-out, quality control reports, tool box meeting reports

components to be cleaned and lubricated include: valves, pumps, bearings

components to be replaced include: belts, filters, valves, pumps, bearings

systems that are re-energized are: co-gen systems, cooling water, condenser water, glycol-filled plate exchangers

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-16.04.01K	demonstrate knowledge of the procedures used to maintain, troubleshoot and repair associated components of refrigeration systems	describe the procedures used to maintain and repair associated components of refrigeration systems
		describe the procedures used to troubleshoot associated components of refrigeration systems
		describe the procedures used to protect associated components of refrigeration systems and piping
		describe the procedures used to set and adjust associated components of refrigeration systems

TASK E-17 INSTALLS, TESTS, MAINTAINS, TROUBLESHOOTS AND REPAIRS FUEL SYSTEMS

TASK DESCRIPTOR

Fuel systems supply required 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.

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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-17.01 Installs equipment for fuel systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-17.01.01P	select ***equipment***	***equipment*** is selected according to load and demand, and type of ***fuel***
E-17.01.02P	size equipment	***fuel system*** is sized by consulting engineered drawings, jurisdictional codes and specifications
E-17.01.03P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings***
E-17.01.04P	select and use installation ***tools and equipment***	***tools and equipment*** for the installation are selected based on type of system and size of piping
E-17.01.05P	install ***equipment supports, fasteners*** and ***components***	***equipment supports, fasteners*** and ***components*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system

E-17.01.06P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
E-17.01.07P	set and secure equipment in place	equipment is installed respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

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

fuel includes: bunker C (grade 4 oil or heavier), natural gas, propane, liquid natural gas, liquid propane, black liquor, diesel, light oils, hydro-carbon derivatives, bio fuels, recovered bio-gases (sewer, landfill)

fuel systems include: natural gas, propane, diesel, fuel oil, black liquor, hydro-carbon derivatives, bio fuels

drawings include: engineered, mechanical, architectural, manufacturers' installation instructions

installation tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machines, brazing, soldering and welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

components include: seismic restraints

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-17.01.01K	demonstrate knowledge of ***fuel systems***, their components, applications and operation	explain the applications and operation of ***fuel systems***
		interpret information pertaining to fuel system equipment found on drawings and specifications
E-17.01.02K	demonstrate knowledge of fuel system ***equipment***, their applications and operation	identify types of fuel system ***equipment***, and describe their characteristics and operation
		identify fuel system ***equipment supports and fasteners*** and describe their applications and procedures for use
		identify ***fuel system control components*** and describe their purpose and operation
E-17.01.03K	demonstrate knowledge of the procedures used to install equipment for fuel systems	identify equipment, ***controls***, ***supports*** and fasteners used in fuel systems, and describe their purpose and operation

	describe the procedures used to install equipment for fuel systems, their controls, supports and fasteners
	describe trenching and shoring requirements

RANGE OF VARIABLES

fuel systems include: natural gas, propane, diesel, fuel oil, black liquor, hydro-carbon derivatives, bio fuels

equipment includes: expansion joints, pumps, heat transfer equipment, heat exchangers, tanks (may include rail or marine), vacuum breakers, valves and blowers, flare stacks, flashback arrestors, scrubbers, vaporizers

equipment supports include: expansion tanks, pumps, outdoor controllers, control valves

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

fuel system control components include: operating and temperature controls, safety controls

controls include: operating pressure controls, high limit pressure controls, pressure relief valves,

supports include: stands, hangers, plates, isolator pads, embeds

E-17.02 Installs piping and tubing for fuel systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-17.02.01P	select and size ***piping and tubing***	type of ***piping and tubing*** is selected based on system application and sized to ensure operation of system and flow requirements
E-17.02.02P	determine routing of piping and tubing	***routing*** of piping and tubing is confirmed by referencing drawings, including grade, pitch, depth or modified to avoid ***obstructions*** and/or ***conflicts***
E-17.02.03P	determine ***high points*** and ***low points*** for fuel equipment and components	***high points*** and ***low points*** are identified
E-17.02.04P	select and use ***installation tools and equipment***	***installation tools and equipment*** are selected and based on type and size of piping
E-17.02.05P	determine ***joining method*** for piping system	***joining method*** is determined by engineered drawings and specifications, type and size of pipe
E-17.02.06P	clean and prepare fittings and joints	use joining methods and ensure fit-up to avoid leaks

E-17.02.07P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
E-17.02.08P	install ***piping supports***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system
E-17.02.09P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of piping including sleeving and proper spacing, and making ***allowances for contraction and expansion*** with required grounding, bonding and cathodic protection
E-17.02.10P	assemble and install ***venting and exhaust piping components***	piping is assembled and installed using joining methods and in a manner to allow for insulation of piping including sleeving and proper spacing, and making ***allowances for contraction and expansion***
E-17.02.11P	determine bonding requirements	bonding cable is present in loading and off-loading of rail cars and, marine and mobile tankers to tank farms and pipelines

RANGE OF VARIABLES

piping and tubing includes: carbon steel, copper, HD polyethylene (HDPE), stainless steel, yellow jacket
routing obstructions include: structural components (beams, walls), other mechanical and electrical systems
routing conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)
high points include: air vents, valves, bleeders
low points include: drains, drip pockets
installation tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe and tube bending equipment, fusion
joining method includes: flanging, flaring, threading, welding, fusion, brazing, dielectric unions, mechanical joints
piping supports include: rollers, hangers, clamps, brackets, stands, anchors, tubing blocks, guides
allowances for contraction and expansion include: expansion joints, expansion loops, swing joints
venting and exhaust piping components include: mufflers, silencers, sound attenuation
allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

KNOWLEDGE		
	Learning Outcomes	**Learning Objectives**
E-17.02.01K	demonstrate knowledge of fuel piping and tubing, their ***applications*** and operation	explain the ***applications*** of fuel piping and tubing
		identify types of ***piping and tubing, piping components*** and ***venting and exhaust components*** for fuel systems, and describe their purpose and operation
		interpret information pertaining to fuel piping and tubing found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on fuel piping and components
		explain the effects of expansion and contraction on piping in fuel systems
		explain the effects of trapped air in fuel piping systems and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping and tubing components for fuel systems
E-17.02.02K	demonstrate knowledge of the procedures used to install piping and components for fuel systems	describe the procedures used to install piping and components for fuel systems
		describe the procedures used to ***protect*** and restrain fuel system piping and components
		interpret jurisdictional codes and specifications for installation of fuel systems

RANGE OF VARIABLES

applications include: residential heating, ICI heating and/or process

piping and tubing include: carbon steel, copper, HDPE, stainless steel, yellow jacket

piping components include: heat exchangers, pump trim, manual and automatic valves, expansion joints, flexible connectors, strainers, check valves

venting and exhaust components include: mufflers, silencers, sound attenuation

selection considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

protection includes: protection from mechanical damage, seismic activity, environmental conditions

E-17.03 Tests fuel systems

Essential Skills	Document Use, Numeracy, Writing

SKILLS

	Performance Criteria	Evidence of Attainment
E-17.03.01P	perform a ***visual pre-check*** inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
E-17.03.02P	determine type of ***test, testing equipment and components*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
E-17.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
E-17.03.04P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
E-17.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
E-17.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
E-17.03.07P	install ***testing equipment and components***	***testing equipment and components*** are connected following the test procedures
E-17.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-17.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
E-17.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-17.03.11P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled (may or may not include filling)
E-17.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

visual pre-check includes: soap bubble test, small leak meter test
tests include: hydrostatic, pneumatic, NDE

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, gas detection meter and regulators, holiday testers

test medium includes: water, water/glycol mix, air, inert gases, fuels

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders, other pipeline sources

isolation components include: spectacle 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

testing equipment and components include: test tree and components, pressure gauges, pumps, compressors, test medium, gas detection meters

appropriate parties include: QA/QC personnel, owner/operator, AHJ

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-17.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components,*** and describe their characteristics and applications
E-17.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of fuel systems, 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 systems system testing found on drawings and specifications
		explain the effect of elevation and temperature on pressure when testing fuel systems
		explain the effects trapped air in a fuel system will have on testing and describe the procedures to prevent or correct it
E-17.03.03K	demonstrate knowledge of the procedures used to test fuel systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: test tree and components, pressure gauges, pumps, compressors, test medium

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix (appropriate for the piping or system), air, inert gases

method of filling, draining or purging includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blind flanges, plugs and caps, temporary spool pieces

E-17.04 Maintains, troubleshoots and repairs fuel systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-17.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
E-17.04.02P	troubleshoot fuel systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
E-17.04.03P	lock out and tag out system being repaired	system is locked and tagged out to prevent activation during repair
E-17.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed
E-17.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
E-17.04.06P	document the repairs	repairs are documented
E-17.04.07P	remove lock-out and tag-out from components and piping system	locks and tags are removed

E-17.04.08P	reinstate system to operating condition after completing maintenance procedures	system is filled and pressurized, bled of air or contaminants, checked for leaks and returned to normal operating condition
E-17.04.09P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***components*** are free of contaminants and operating efficiently, and ***documentation*** is updated with the required information

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, smell, touch), diagnostic testing, monitor system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

components include: pumps, strainers, filters, traps, valves

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-17.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting fuel systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to fuel system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effect of pressure on elevation when troubleshooting fuel systems
		explain the effects trapped air in a fuel system will have on system operation and describe the procedures to prevent or correct it
E-17.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain fuel systems	describe the procedures used to troubleshoot fuel systems
		describe the ***procedures*** used to repair fuel systems

	describe the procedures used to maintain fuel systems
	describe the procedures used to complete documentation following fuel system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, manometer, infrared thermometer, combustible gas indicators, O_2 and CO sensors

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

procedures include: verify continuous bonding

TASK E-18 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. 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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-18.01 Installs equipment for medical gas systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-18.01.01P	select ***equipment***	***equipment*** is selected according to load and demand as specified in engineered specifications, and type of ***medical gas system***
E-18.01.02P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings***
E-18.01.03P	select and use ***tools and equipment*** required for installation of medical gas equipment	appropriate ***tools and equipment*** for the installation are selected based on type of system and size of piping
E-18.01.04P	install ***equipment supports*** and ***fasteners***	***equipment supports*** and ***fasteners*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system

E-18.01.05P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
E-18.01.06P	set and secure equipment in place	medical gas equipment is installed, aligned/orientated, leveled and anchored respecting the required clearances and limitations

RANGE OF VARIABLES

equipment includes: valve boxes, terminal boxes, compressors, regulators, pumps, cryogenic tanks, valves, gauges, alarms

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases

drawings include: engineered, mechanical, architectural

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, brazing tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads

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

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-18.01.01K	demonstrate knowledge of ***medical gas systems***, their components, applications and operation	identify types of ***medical gas systems*** and describe their ***applications***
		identify types of ***medical gases*** and describe their characteristics
		identify medical gas system ***equipment*** and describe their applications and operation
		identify ***supports*** and ***fasteners*** used for medical gas system equipment, and describe their purpose and operation
		interpret information pertaining to medical gas system equipment found on drawings and specifications
		interpret ***codes and regulations*** pertaining to medical gas system equipment
		identify ***medical gas connection systems***
		explain the importance of maintaining cleanliness of installation tools and equipment
E-18.01.02K	demonstrate knowledge of the procedures used to install equipment for medical gas systems	describe the procedures used to install equipment for medical gas systems, their supports and fasteners

RANGE OF VARIABLES

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases
applications include: hospitals, dental suites, veterinary clinics, laboratories
medical gases include: oxygen, nitrogen, nitrous oxide/anesthetic, medical air
equipment includes: valve boxes, terminal boxes, compressors, regulators, pumps, cryogenic tanks, valves, gauges, alarms
equipment supports include: brackets, stands, hangers, plates, isolator pads
equipment fasteners include: expansion type inserts, beam clamps, nuts, bolts, screws
codes and regulations include: CSA, AHJ, site specifications
medical gas connection systems include: diameter index safety system (DISS), pin indexing system

E-18.02 Installs piping and tubing for medical gas systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-18.02.01P	determine routing of piping and tubing	***routing*** of piping and tubing is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
E-18.02.02P	select piping and tubing	type of ***piping and tubing*** is selected based on system ***application*** and sized to ensure operation of system and flow requirements
E-18.02.03P	select and use installation ***tools and equipment***	***tools and equipment*** for the installation selected are based on type and size of piping or tubing
E-18.02.04P	clean and prepare piping, tubing, fittings and joints	piping, tubing and fittings are cleaned to avoid contamination, and joints are cleaned to ensure bonding of the ***filler metal*** following codes and regulations
E-18.02.05P	determine ***joining method*** for piping and tubing	***joining method*** is determined by engineered drawings and specifications, type and size of pipe
E-18.02.06P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
E-18.02.07P	install ***supports***	***supports*** and ***fasteners*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system

E-18.02.08P	assemble and install piping	piping and tubing is assembled according to engineered drawings and specifications using joining methods
E-18.02.09P	purge and charge piping and tubing	piping and tubing are purged and charged ensuring system remains a closed system to prevent environmental contamination
E-18.02.10P	install emergency shut-off valves	emergency shut-off valves are installed according to engineered drawings
E-18.02.11P	label system	entire system is labelled to clearly identify gas products in each line

RANGE OF VARIABLES

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

routing conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from physical damage

piping and tubing include: copper certified for medical gas service, carbon steel, stainless steel

application includes: hospitals, dental suites, veterinary clinics, laboratories

tools and equipment include: hand tools, power tools and equipment, lifting equipment, brazing and welding equipment

filler metal includes: AWS BCuP and Bag series brazing rods

joining methods include: flanging, threading, welding, brazing

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

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-18.02.01K	demonstrate knowledge of ***medical gas systems***, their components, applications and operation	identify types of ***medical gas systems*** and describe their ***applications***
		identify types of ***medical gases*** and describe their characteristics
		identify medical gas system ***piping and tubing***
		identify ***supports*** and ***fasteners*** used for medical gas piping and tubing, and describe their purpose and operation
		interpret information pertaining to medical gas system piping and tubing found on drawings and specifications
		interpret ***codes and regulations*** pertaining to medical gas system piping and tubing
		explain the importance of maintaining cleanliness of installation tools, piping and fittings

E-18.02.02K	demonstrate knowledge of the procedures used to install piping and tubing for medical gas systems	describe the procedures used to install piping and tubing for medical gas systems, their supports and fasteners
		describe the procedures used to ***protect*** medical gas piping and piping components

RANGE OF VARIABLES

medical gas systems include: oxygen, nitrogen, vacuum, mixed gases
applications include: hospitals, dental suites, veterinary clinics, laboratories
medical gases include: oxygen, nitrogen, nitrous oxide/anesthetic, medical air
piping and tubing include: copper certified for medical gas service, carbon steel, stainless steel
supports include: brackets, stands, hangers, plates
fasteners include: expansion type inserts, beam clamps, nuts, bolts, screws
codes and regulations include: DISS, pin indexing system, joining methods, cleaning, supporting
protection includes: protection from mechanical damage, seismic activity, environmental conditions

E-18.03 Tests medical gas systems

Essential Skills Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-18.03.01P	perform a visual pre-check inspection of system to check for possible ***deficiencies***	punch list is completed to confirm all components are installed
E-18.03.02P	participate in testing of medical gas systems with third-party agency	***certification tests*** are completed and system is certified for service by third-party agency
E-18.03.03P	determine ***method of purging and filling*** the medical gas system using ***test medium***	***test medium*** and ***method of purging and filling*** to be used are determined by engineered specifications
E-18.03.04P	assemble ***test equipment*** and components	assembled ***test equipment*** allows the test to be completed
E-18.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
E-18.03.06P	install ***isolation components*** to protect sensitive equipment	***isolation components*** are installed and sensitive equipment is protected from test pressures
E-18.03.07P	install test equipment	test equipment is connected following the test procedures

E-18.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-18.03.09P	remove test medium from system	test medium is removed and vented or disposed of depending on type of test medium
E-18.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-18.03.11P	reinstate system	isolation components and test equipment are removed and original components are reinstalled
E-18.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

deficiencies include: missing supports and fasteners, leaks, physical damage to equipment and/or piping
certification tests include: particulate test, purification test, cross-connection test, destructive test, operational test
test medium includes: nitrogen and system gases
method of purging and filling includes: using compressors and compressed gas cylinders
test equipment includes: test trees and components, pressure gauges, compressors, test medium, gas cylinders, pneumatic safety valve
isolation components include: valves, plugs and caps
appropriate parties include: QA/QC personnel, owner/operator, AHJ

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-18.03.01K	demonstrate knowledge of ***test equipment*** and test medium, their characteristics and applications	identify types of ***test equipment*** and describe their characteristics and applications
		identify types of ***test medium*** and describe their characteristics and applications
E-18.03.02K	demonstrate knowledge of the procedures used to test medical gas systems	explain the importance of maintaining cleanliness of installation tools, piping and fittings
		identify types of ***certification tests*** and describe their applications
		identify ***method of purging and filling*** medical gas systems
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to medical gas system testing found on drawings and specifications

	describe the procedures used to perform system testing
	describe the procedures used to remove test medium from system
	describe the procedures used to reinstate system

RANGE OF VARIABLES

test equipment includes: test trees and components, pressure gauges, compressors, test medium
test medium includes: nitrogen and system gases
certification tests include: particulate test, purification test, cross-connection test, operational test
method of purging and filling includes: compressors, compressed gas cylinders
isolation components include: valves, plugs and caps

E-18.04 Maintains, troubleshoots and repairs medical gas systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-18.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
E-18.04.02P	troubleshoot medical gas systems to determine requirements for repair or replacement	perform ***testing and inspection*** of medical gas system to determine equipment or components in ***condition for repair or replacement***
E-18.04.03P	lock out and tag out system	system is locked and tagged out to prevent activation during repair
E-18.04.04P	isolate equipment and components requiring repair	valves are closed to isolate affected sections of the medical gas system and system pressure is reduced to atmospheric pressure
E-18.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
E-18.04.06P	reinstate system to operating condition and verify repair	system is purged, re-pressurized, checked for leaks, locks removed and returned to normal operating condition
E-18.04.07P	document the repairs	repairs are documented

E-18.04.08P	lock out and tag out system being repaired	system is locked and tagged out to prevent activation during maintenance
E-18.04.09P	isolate equipment and components requiring maintenance	equipment and components are isolated from the system to allow for completing the required ***maintenance procedures***
E-18.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** and piping are free of contaminants and operating efficiently, and ***documentation*** is updated with the required information
E-18.04.11P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-18.04.12P	reinstate system to operating condition after completing maintenance procedures	system is purged, re-pressurized, checked for leaks and returned to normal operating condition

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, touch), diagnostic testing, monitor system operation, purification test

conditions for repair or replacement include: leaks, control malfunction, vibration, irregular movement

maintenance procedures include: lubricating pumps, checking fluids, cleaning components, calibrating equipment, gauges and alarms, inspecting equipment or components for wear, replacing worn components

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

equipment includes: valve boxes, terminal boxes, compressors, regulators, pumps, cryogenic tanks, valves, gauges, alarms

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-18.04.01K	demonstrate knowledge of ***test equipment*** for troubleshooting medical gas systems	identify types of ***test equipment*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to medical gas system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
E-18.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain medical gas systems	describe the procedures used to troubleshoot medical gas systems
		describe the procedures used to repair medical gas systems

	describe the procedures used to maintain medical gas systems
	describe the procedures used to complete documentation following medical gas repair or maintenance

RANGE OF VARIABLES

test equipment includes: multimeter, pressure gauges, manometers
isolation components include: valves, plugs and caps

TASK E-19 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 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. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-19.01 Installs equipment for compressed air and pneumatic systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-19.01.01P	select ***equipment*** and ***controls***	***equipment*** and ***controls*** are selected according to load and demand, and type of ***compressed air and pneumatic systems***
E-19.01.02P	size equipment and controls	compressed air/pneumatic system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
E-19.01.03P	determine location and placement of equipment and controls	location and placement of equipment is determined according to ***drawings*** and client requirements
E-19.01.04P	determine ***high points*** and ***low points*** for compressed air/pneumatic equipment and components	***high points*** and ***low points*** are identified
E-19.01.05P	select and use ***tools and equipment*** required for installation of compressed air/pneumatic equipment and controls	appropriate ***tools and equipment*** for the installation are selected based on type of system and size of piping

E-19.01.06P	install ***equipment supports*** and ***fasteners***	***equipment supports*** and ***fasteners*** are installed to required spacing, weight capacity, vibration isolation, height and grade in order to accommodate operation of the system
E-19.01.07P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
E-19.01.08P	set and secure equipment in place	compressed air and pneumatic equipment is installed respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored
E-19.01.09P	install controls	controls are installed according to system requirements

RANGE OF VARIABLES

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

controls include: regulators, solenoids, actuators, pressure switches, flow switch, alarm switches

compressed air and pneumatic systems include: compressed air, compressed gases

sizing methods include: performing calculations, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical

high points include: air vents, valves, bleeders

low points include: drains

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machines, brazing, soldering, welding equipment, tube benders

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-19.01.01K	demonstrate knowledge of compressed air and pneumatic systems, their applications and operation	explain the applications and operation of compressed air and pneumatic systems
		interpret information pertaining to compressed air/pneumatic equipment found on drawings and specifications
E-19.01.02K	demonstrate knowledge of compressed air and pneumatic ***equipment***, their applications and operation	identify types of compressed air and pneumatic ***equipment***, and describe their characteristics and operation
		identify compressed air and pneumatic ***equipment supports*** and ***fasteners*** and describe their applications and procedures for use

		identify compressed air and pneumatic ***control*** components and describe their purpose and operation
		explain the ***principles of heat transfer***
		identify types of ***heat transfer equipment*** and describe their characteristics and operation
E-19.01.03K	demonstrate knowledge of the procedures used to install equipment for compressed air and pneumatic systems	identify equipment, controls, supports and fasteners used in compressed air and pneumatic systems, and describe their purpose and operation
		describe the procedures used to install equipment for compressed air and pneumatic systems, their controls, supports and fasteners

RANGE OF VARIABLES

equipment includes: compressors (piston, screw type, rotary, axial, reciprocating, vane), heat transfer equipment, receiver tanks, valves, dryers, separators, filters, lubricators, compressed gas cylinders, tanks
equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds
equipment fasteners include: expansion type inserts, beam clamps, nuts, bolts, screws
controls include: regulators, solenoids, actuators, pressure switches, flow switches, alarm switches
principles of heat transfer include: radiation, conduction, convection
heat transfer equipment includes: heat exchangers, pipe coils

E-19.02 Installs piping and tubing for compressed air and pneumatic systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-19.02.01P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
E-19.02.02P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
E-19.02.03P	select and use ***tools and equipment***	***tools and equipment*** for the installation are selected based on type and size of piping
E-19.02.04P	clean and prepare fittings and joints	use ***joining methods*** and ensure fit-up to avoid leaks

E-19.02.05P	determine joining method for piping system	joining method is determined by engineered drawings and specifications, type and size of pipe
E-19.02.06P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
E-19.02.07P	install ***piping supports***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system
E-19.02.08P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for sleeving and proper spacing, and making ***allowances for contraction and expansion*** (when exposed to extreme temperature fluctuations)

RANGE OF VARIABLES

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

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

piping includes: carbon steel, copper, plastic (approved for use on compressed air and pneumatic systems), galvanized, stainless steel

tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe and tube bending equipment

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

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

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-19.02.01K	demonstrate knowledge of compressed air and pneumatic ***piping configurations***, their applications and operation	explain the ***applications*** of compressed air/pneumatic ***piping configurations***
		identify types of ***piping*** and ***piping components*** for compressed air and pneumatic systems***,*** and describe their purpose and operation
		interpret information pertaining to compressed air and pneumatic piping found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on compressed air and pneumatic piping and components
		explain the effects of expansion and contraction on piping in compressed air and pneumatic systems

		explain the effects of trapped moisture in compressed air and pneumatic piping systems and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping system components for compressed air and pneumatic systems
E-19.02.02K	demonstrate knowledge of the procedures used to install piping and piping components for compressed air and pneumatic systems	describe the procedures used to install piping and piping components for compressed air and pneumatic systems
		describe the procedures used to ***protect*** compressed air and pneumatic piping and piping components

RANGE OF VARIABLES

piping configurations include: branch lines above the horizontal centerline
applications include: instrument air, utility air, process air, inert gases used in ICI settings
piping includes: carbon steel, copper, plastic (approved to withstand high pressures), galvanized
piping components include: manual and automatic valves, fittings, flexible connectors and hoses, strainers, check valves
selection considerations include: suitability of piping material for the application, insulation requirements, type of supports, shoes and sleeves, expansion, contraction
protection includes: protection from mechanical damage, seismic activity, environmental conditions

E-19.03 Tests compressed air and pneumatic systems

Essential Skills	Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-19.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
E-19.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
E-19.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium

E-19.03.04P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
E-19.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
E-19.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
E-19.03.07P	install test equipment and components	test equipment and components are connected following the test procedures
E-19.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-19.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
E-19.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-19.03.11P	reinstate system	isolation components, testing equipment and components are removed and original components are reinstalled
E-19.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, valves, recorders, testing trees/headers, regulators

test medium includes: water, air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle 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

appropriate parties include: QA/QC personnel, owner/operator, AHJ

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-19.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
E-19.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of compressed air and pneumatic systems, 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 the effect of elevation and temperature on pressure when testing compressed air and pneumatic systems
		explain the effects trapped air in a compressed air and pneumatic system will have on hydrostatic testing and describe the procedures to prevent or correct it
E-19.03.03K	demonstrate knowledge of the procedures used to test compressed air and pneumatics systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: blind flanges, calibrated pressure gauges, test pumps, relief valves, valves, recorders, testing trees/headers, regulators

tests include: hydrostatic, pneumatic

test medium includes: water, air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

E-19.04 Maintains, troubleshoots and repairs compressed air and pneumatic systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-19.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
E-19.04.02P	troubleshoot compressed air and pneumatic systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
E-19.04.03P	lock out and tag out system being repaired	system is locked and tagged out to prevent activation during repair
E-19.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	isolation components are installed and ***confirmation of zero energy state*** is completed
E-19.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
E-19.04.06P	reinstate system to operating condition and verify repair	system is filled and pressurized, bled of contaminants, checked for leaks, locks removed and returned to normal operating condition
E-19.04.07P	document the repairs	repairs are documented
E-19.04.08P	lock out and tag out system being maintained	system is locked and tagged out to prevent activation during maintenance
E-19.04.09P	isolate equipment or components requiring maintenance	equipment or components are isolated from the system to allow for completing the required ***maintenance procedures***
E-19.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and ***documentation*** is updated with the required information

E-19.04.11P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-19.04.12P	reinstate system to operating condition after completing maintenance procedures	system is filled and pressurized, bled of contaminants, checked for leaks, locks removed and returned to normal operating condition

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, smell, touch), diagnostic testing, monitor system operation

conditions for repair or replacement include: leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces, lockable block and bleed valves

confirmation of zero energy state includes: ensuring necessary valves and drains are open and clear, pressure gauges identify zero energy, equipment is inoperable

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

required documentation includes: lock-out and tag-out, maintenance log, quality control reports, work permits

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
E-19.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting compressed air and pneumatic systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to compressed air and pneumatic system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effects trapped moisture and particulate in a compressed air and pneumatic system will have on system operation and describe the procedures to prevent or correct it
E-19.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain compressed air and pneumatic systems	describe the procedures used to troubleshoot compressed air and pneumatic systems
		describe the procedures used to repair compressed air/pneumatic systems

	describe the procedures used to maintain compressed air and pneumatic systems
	describe the procedures used to complete documentation following compressed air and pneumatic system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, infrared thermometer, test gauge, flow meter, ultrasonic leak detector, liquid leak detector

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces, lockable block and bleed valves

TASK E-20 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 jurisdiction in Canada, work on fire protection systems can only be performed by a certified and trained sprinkler system installer 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 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 may perform diagnosing, locating and repairing or replacing equipment and material. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

E-20.01 Installs equipment for fire protection systems (NOT COMMON CORE)

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-20.01.01P	select ***equipment***	***equipment*** is selected according to engineered drawings, applicable codes and type of ***fire protection system***
E-20.01.02P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings*** and client requirements
E-20.01.03P	determine ***low points*** for fire protection equipment	***low points*** are identified
E-20.01.04P	select and use ***tools and equipment*** required for installation of fire protection equipment	appropriate ***tools and equipment*** for the installation are selected based on type of system and size of piping

E-20.01.05P	install ***equipment supports*** and ***fasteners***	***equipment supports*** and ***fasteners*** are installed to required spacing, weight capacity, vibration isolation, seismic, height and grade in order to accommodate operation of the system
E-20.01.06P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
E-20.01.07P	set and secure equipment in place	fire protection equipment is installed respecting the clearances, limitations and thrusting requirements, and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

equipment includes: water supply systems, tanks, valves, drains, connections, backflow preventers

fire protection systems include: standpipes, hose cabinets, and wet, dry, pre-action, deluge systems

drawings include: engineered, mechanical, architectural

low points include: valves, drains

tools and equipment include: hand tools, power tools and equipment, alignment tools, rigging and material handling equipment, threading machines, grooving machines, brazing, soldering and welding equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-20.01.01K	demonstrate knowledge of ***fire protection systems***, their applications and operation	explain the applications and operation of ***fire protection systems***
		interpret information pertaining to fire protection equipment found on drawings and specifications
E-20.01.02K	demonstrate knowledge of fire protection ***equipment***, their applications and operation	identify types of fire protection ***equipment***, and describe their characteristics and operation
		identify fire protection ***equipment supports*** and ***fasteners*** and describe their applications and procedures for use
		explain the requirements for control valves supplying water to fire protection systems

E-20.01.03K	demonstrate knowledge of the procedures used to install equipment for fire protection systems	identify equipment, supports and fasteners used in fire protection systems, and describe their purpose and operation
		describe the procedures used to install equipment for fire protection systems, their supports and fasteners

RANGE OF VARIABLES

fire protection systems include: standpipes, hose cabinets, and wet, dry, pre-action, deluge systems
equipment includes: water supply systems, tanks, valves, drains, connections, backflow preventers
equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds
equipment fasteners include: expansion type inserts, beam clamps, nuts, bolts, screws

E-20.02 Installs piping for fire protection systems (NOT COMMON CORE)

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-20.02.01P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, or modified to avoid ***obstructions*** and/or ***conflicts***
E-20.02.02P	select and size piping	type of ***pipe*** is selected based on system application and sized according to engineered requirements
E-20.02.03P	select and use ***tools and equipment***	appropriate ***tools and equipment*** for the installation are selected based on type and size of piping
E-20.02.04P	clean and prepare fittings and joints	use ***joining methods*** and ensure fit-up to avoid leaks
E-20.02.05P	determine joining method for piping system	joining method is determined by engineered drawings and specifications, type and size of pipe
E-20.02.06P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
E-20.02.07P	install ***piping supports*** and restraints	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system

E-20.02.08P	install ***piping restraints***	***piping restraints*** are installed to protect piping system from damage during seismic activity and pipe thrust
E-20.02.09P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for sleeving and proper spacing, and making ***allowances for contraction and expansion*** (when exposed to extreme temperature fluctuations)

RANGE OF VARIABLES

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

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

piping includes: carbon steel, copper, plastic, galvanized, copper-nickel, titanium, stainless steel

tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe bending equipment

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

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

piping restraints include: seismic wire, clamps, pipes, brackets

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-20.02.01K	demonstrate knowledge of ***fire protection systems*** their applications and operation	explain the applications of ***fire protection systems***
		identify types of ***pipe*** and ***piping components*** for fire protection systems, and describe their purpose and operation
		identify ***piping supports*** and ***fasteners*** for fire protection piping
		interpret information pertaining to fire protection systems found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on fire protection systems
		explain the effects of expansion and contraction on piping in fire protection systems
		explain the effects of trapped air in fire protection systems and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping system components for fire protection systems

E-20.02.02K	demonstrate knowledge of the procedures used to install piping and piping components for fire protection systems	describe the procedures used to install piping and piping components for fire protection systems
		describe the procedures used to ***protect*** fire protection piping and piping components

RANGE OF VARIABLES

fire protection systems include: standpipes, hose cabinets, and wet, dry, pre-action and deluge systems

piping includes: carbon steel, copper, plastic, galvanized, copper-nickel, stainless steel

piping components include: manual and automatic valves, fittings, strainers, check valves, backflow preventers

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

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

selection considerations include: suitability of piping material for the application, type of supports, shoes and sleeves, expansion, contraction

protection includes: protection from mechanical damage, seismic activity, environmental conditions

E-20.03 Tests fire protection systems (NOT COMMON CORE)

Essential Skills	Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-20.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
E-20.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications and applicable codes
E-20.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
E-20.03.04P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
E-20.03.05P	lock out and tag out system for testing	system components are locked and tagged out to prevent activation during testing

E-20.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
E-20.03.07P	install test equipment and components	test equipment and components are connected following the test procedures
E-20.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
E-20.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
E-20.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
E-20.03.11P	reinstate system	isolation components, testing equipment and components are removed and original components are reinstalled
E-20.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic and pneumatic

testing equipment and components include: blind flanges, plugs, calibrated pressure gauges***,*** test pumps, relief valves, valves, recorders, testing trees/headers, regulators

test medium includes: water, glycol, water/glycol mix, compressed air and inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle 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

appropriate parties include: QA/QC personnel, owner/operator, AHJ

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-20.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
E-20.03.02K	demonstrate knowledge of ***fire protection systems*** testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of ***fire protection systems***, 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 the effect of elevation and temperature on pressure when testing fire protection systems
		explain the effects trapped air in a fire protection system will have on hydrostatic testing and describe the procedures to prevent or correct it
E-20.03.03K	demonstrate knowledge of the procedures used to test fire protection systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, valves, recorders, testing trees/headers, regulators

tests include: hydrostatic, pneumatic

test medium includes: water, glycol, water/glycol mix, compressed air, inert gases

fire protection systems include: standpipes, hose cabinets, and wet, dry, pre-action and deluge systems

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

MAJOR WORK ACTIVITY F
INSTALLS, TESTS, MAINTAINS, TROUBLESHOOTS AND REPAIRS RENEWABLE ENERGY SYSTEMS

TASK F-21 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 responsible for diagnosing, locating and repairing or replacing equipment and material. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

F-21.01 Installs equipment for geo-exchange and geothermal systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-21.01.01P	select ***equipment***	***equipment*** is selected according to load and demand, and type of ***geo-exchange and geothermal systems***
F-21.01.02P	size equipment	geo-exchange and geothermal system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
F-21.01.03P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings***
F-21.01.04P	select and use ***tools and equipment*** required for installation of geo-exchange and geothermal equipment	***tools and equipment*** for the installation are selected based on type of system and size of piping
F-21.01.05P	install ***equipment supports, fasteners*** and ***components***	***equipment supports, fasteners*** and ***components*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system
F-21.01.06P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
F-21.01.07P	set and secure equipment in place	geo-exchange and geothermal equipment is installed respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

equipment includes: expansion joints, pumps, heat transfer equipment, heat exchangers, steam traps, tanks, valves, water treatment equipment

geo-exchange and geothermal systems include: domestic hot water heating, hydronic heating and cooling, radiant heating, compression cycle ground source heat pumps (GSHP, air-to-air, water-to-air, water-to-water), open loop, closed loop, horizontal loop and vertical loop, direct exchange (DX) systems

sizing methods include: performing calculations, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, and architectural, and manufacturers' installation instructions

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machines, brazing, soldering and welding tools and equipment, fusion equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

components include: seismic restraints

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-21.01.01K	demonstrate knowledge of ***geo-exchange and geothermal systems***, their components, applications and operation	explain the applications and operation of ***geo-exchange and geothermal systems***
		interpret information pertaining to geothermal system equipment found on drawings and specifications
		explain ***compression refrigeration components*** and cycle
F-21.01.02K	demonstrate knowledge of ***geo-exchange and geothermal equipment***, their applications and operation	identify types of ***geo-exchange and geothermal equipment***, and describe their characteristics and operation
		identify geo-exchange and geothermal equipment ***supports*** and ***fasteners*** and describe their applications and procedures for use
		identify geo-exchange and geothermal ***control components*** and describe their purpose and operation
		identify ***sources of heat*** used in geo-exchange and geothermal systems
		identify ***sources of cooling*** used in geo-exchange and geothermal systems
		explain the ***principles of heat transfer***
		identify types of ***heat transfer equipment*** and describe their characteristics and operation
		identify piping configurations for earth loops
		identify purpose and functionality of reversing valve within heat pump
		identify difference in operation of DX system
F-21.01.03K	demonstrate knowledge of the procedures used to install equipment for geo-exchange and geothermal systems	identify equipment***, controls***, ***supports*** and fasteners used in geo-exchange and geothermal systems, and describe their purpose and operation
		describe the procedures used to install equipment for geo-exchange and geothermal systems, their controls, supports and fasteners

RANGE OF VARIABLES

geo-exchange and geothermal systems include: domestic hot water heating, hydronic heating and cooling, radiant heating, open loop, closed loop, horizontal loop, vertical loop

compression refrigeration components include: evaporators, compressors, condensers, metering devices, refrigerant controls, related piping

geo-exchange and geothermal equipment includes: expansion joints, pumps, heat transfer equipment, steam traps, tanks, valves, water treatment equipment

equipment supports include: expansion tanks, pumps, outdoor controllers, control valves

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

control components include: operating and temperature controls, safety controls

sources of heat include: deep earth, ground source

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, horizontal and vertical unit heaters, radiant panels, heat exchangers

controls include: LWCO, operating pressure controls, high limit pressure controls, zone valves (motorized)

supports include: stands, hangers, plates, isolator pads, embeds

F-21.02 Installs piping for geo-exchange and geo-thermal systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-21.02.01P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
F-21.02.02P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, including grade, pitch, depth or modified to avoid ***obstructions*** and/or ***conflicts***
F-21.02.03P	determine ***high points*** and ***low points*** for geo-exchange and geothermal equipment and components	***high points*** and ***low points*** are identified
F-21.02.04P	select and use ***tools and equipment***	***tools and equipment*** for the installation are selected and based on type and size of piping
F-21.02.05P	determine ***joining method*** for piping system	***joining method*** is determined by engineered drawings and specifications, type and size of pipe
F-21.02.06P	clean and prepare fittings and joints	use joining methods and ensure fit-up to avoid leaks

F-21.02.07P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
F-21.02.08P	install ***piping supports***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system
F-21.02.09P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of piping including sleeving and proper spacing, and making ***allowances for contraction and expansion***

RANGE OF VARIABLES

piping includes: carbon steel, copper, HDPE, low density polyethylene (LDPE), medium density polyethylene (MDPE), PEX, PEX-AL-PEX, stainless steel

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

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

high points include: air vents, valves, bleeders

low points include: drains

tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines and welding equipment, pipe and tube bending equipment, crimping tools, expansion tools, fusion equipment

joining method includes: flanging, threading, grooving, crimping, welding, soldering, solvent cement and bonding, fusion, brazing, mechanical joints

piping supports include: rollers, hangers, clamps, brackets, stands, anchors, saddles, guides

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-21.02.01K	demonstrate knowledge of geo-exchange and geothermal ***piping configurations***, their ***applications*** and operation	explain the ***applications*** of geo-exchange and geothermal ***piping configurations***
		identify types of ***piping*** and ***piping components*** for geo-exchange and geothermal systems***,*** and describe their purpose and operation
		interpret information pertaining to geo-exchange and geothermal piping found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on geo-exchange and geothermal piping and components
		explain the effects of expansion and contraction on piping in geo-exchange and geothermal systems

		explain the effects of trapped air in geo-exchange and geothermal piping systems and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping system components for geo-exchange and geothermal systems
F-21.02.02K	demonstrate knowledge of the procedures used to install piping and piping components for geo-exchange and geothermal systems	describe the procedures used to install piping and components for geo-exchange and geothermal systems
		describe the procedures used to ***protect*** and restrain geo-exchange and geothermal system piping and components

RANGE OF VARIABLES

piping configurations include: domestic hot water heating, hydronic heating and cooling, radiant heating, open loop, closed loop, horizontal loop, vertical loop

applications include: residential heating, ICI heating, process

piping includes: carbon steel, copper, HDPE, LDPE, MDPE, PEX, PEX-AL-PEX, stainless steel

piping components include: heat exchangers, pump trim, manual and automatic valves, expansion joints, strainers, check valves

selection considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

protection includes: protection from mechanical damage, seismic activity, environmental conditions

F-21.03 Tests geo-exchange and geothermal systems

Essential Skills Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-21.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
F-21.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
F-21.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium

F-21.03.04P	assemble testing equipment and components	assembled testing equipment allows test to be completed
F-21.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
F-21.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
F-21.03.07P	install ***testing equipment and components***	***testing equipment and components*** are connected following the test procedures
F-21.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
F-21.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
F-21.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
F-21.03.11P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled
F-21.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic, NDE

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, isolation valves, recorders, testing trees/headers, regulators

test medium includes: water, air and inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle 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

testing equipment and components includes: test tree and components, pressure gauge, pumps, compressors, test medium

appropriate parties include: QA/QC personnel, owner/operator, AHJ

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-21.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
F-21.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of geo-exchange and geothermal systems, 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 the effect of elevation and temperature on pressure when testing geo-exchange and geothermal systems
		explain the effects trapped air in a geo-exchange and geothermal system will have on testing and describe the procedures to prevent or correct it
F-21.03.03K	demonstrate knowledge of the procedures used to test geo-exchange and geothermal systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system
		identify hazards associated with heat transfer fluid

RANGE OF VARIABLES

testing equipment and components include: test tree and components, pressure gauge, pumps, compressors, test medium

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix (appropriate for the piping), air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: blind flanges, plugs and caps, temporary spool pieces

F-21.04 Maintains, troubleshoots and repairs geo-exchange and geothermal systems

Essential Skills Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-21.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
F-21.04.02P	troubleshoot geo-exchange and geothermal systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
F-21.04.03P	lock out and tag out system	system is locked and tagged out to prevent activation during repair and maintenance
F-21.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed
F-21.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
F-21.04.06P	check medium	medium quality is tested for hardness, acidity, dissolved gases and suspended particulates using a test kit including freeze protection limits (glycol)
F-21.04.07P	document the repairs	repairs are documented
F-21.04.08P	remove lock-out and tag-out from components and piping system	locks and tags are removed
F-21.04.09P	reinstate system	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition
F-21.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and ***documentation*** is updated with the required information

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, smell, touch), diagnostic testing, monitor system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

equipment includes: expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tanks, isolators, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-21.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting geo-exchange and geothermal systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to geo-exchange and geothermal system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effect of pressure on elevation when troubleshooting geo-exchange and geothermal systems
		explain the effects trapped air in a geo-exchange and geothermal system will have on system operation and describe the procedures to prevent or correct it
F-21.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain geo-exchange and geothermal systems	describe the procedures used to troubleshoot geo-exchange and geothermal systems
		describe the procedures used to repair geo-exchange and geothermal systems
		describe the procedures used to maintain geo-exchange and geothermal systems
		describe the procedures used to complete documentation following geo-exchange and geothermal systems repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, manometer, infrared thermometer, balancing equipment, chemical testing equipment

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

TASK F-22 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. It encompasses environmentally sound practices, technologies and methodologies 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. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ) must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

F-22.01 Installs equipment for solar heating systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-22.01.01P	select ***equipment***	***equipment*** is selected according to load and demand, and type of ***solar heating systems***
F-22.01.02P	size equipment	solar heating system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
F-22.01.03P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings***
F-22.01.04P	select and use ***installation tools and equipment*** required for installation of solar equipment	***tools and equipment*** for the installation are selected based on type of system and size of piping

F-22.01.05P	install ***equipment supports, fasteners*** and ***components***	***equipment supports, fasteners*** and ***components*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system
F-22.01.06P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
F-22.01.07P	set and secure equipment in place	solar heating equipment is installed respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

equipment includes: solar collectors (flat plate, evacuated tube), indirect water heaters, heat dissipaters, controls, expansion joints, pumps, heat transfer equipment, tanks, valves, water treatment equipment

solar heating systems include: domestic water heating, space heating, direct and indirect systems, closed loop systems

sizing methods include: performing calculations, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, architectural, and manufacturers' installation instructions

installation tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machines, brazing, soldering and welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

components include: seismic restraints

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-22.01.01K	demonstrate knowledge of ***solar heating systems***, their components, applications and operation	explain the applications and operation of solar heating systems
		interpret information pertaining to solar system equipment found on drawings and specifications
F-22.01.02K	demonstrate knowledge of solar ***equipment***, their applications and operation	identify types of solar ***equipment***, and describe their characteristics and operation
		identify solar equipment ***supports*** and ***fasteners*** and describe their applications and procedures for use
		identify ***solar control components*** and describe their purpose and operation
		identify ***sources of heat*** used in solar heating systems
		explain the ***principles of heat transfer***

		identify types of ***heat transfer equipment*** and describe their characteristics and operation
F-22.01.03K	demonstrate knowledge of the procedures used to install equipment for solar heating systems	identify equipment, ***controls***, ***supports*** and ***fasteners*** used in solar heating systems, and describe their purpose and operation
		describe the procedures used to install equipment for solar heating systems, their controls, supports and fasteners

RANGE OF VARIABLES

solar heating systems include: domestic water heating, space heating, direct and indirect systems, closed loop systems

equipment includes: solar collectors (flat plate, evacuated tube), indirect water heaters, heat dissipaters, controls expansion joints, pumps, heat transfer equipment, tanks, valves, water treatment equipment

equipment supports include: expansion tanks, pumps, collector rackings, outdoor controllers, control valves

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

solar control components include: operating and temperature controls, safety controls

sources of heat include: solar radiation

principles of heat transfer include: radiation, conduction, convection

heat transfer equipment includes: radiators, convectors, pipe coils, horizontal and vertical unit heaters, radiant panels, solar collectors (flat plate, evacuated tube), water heaters, heat dissipaters, heat exchangers

controls include: differential temperature controllers, flow switches, motorized zone valves, sensors

supports include: stands, hangers, plates, isolator pads, embeds

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

F-22.02 Installs piping for solar heating systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-22.02.01P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
F-22.02.02P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, including grade, pitch or modified to avoid ***obstructions*** and/or ***conflicts***
F-22.02.03P	determine ***high points*** and ***low points*** for solar equipment and components	***high points*** and ***low points*** are identified
F-22.02.04P	select and use ***tools and equipment***	***tools and equipment*** for the installation are selected based on type and size of piping
F-22.02.05P	determine ***joining method*** for piping system	***joining method*** is determined by engineered drawings and specifications, type and size of pipe
F-22.02.06P	clean and prepare fittings and joints	use joining method and ensure fit-up to avoid leaks
F-22.02.07P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
F-22.02.08P	install ***piping supports***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system
F-22.02.09P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of piping including sleeving and proper spacing, and making ***allowances for contraction and expansion***

RANGE OF VARIABLES

piping includes: carbon steel, copper, HDPE, LDPE, MDPE, PEX, PEX-AL-PEX, stainless steel
routing obstructions include: structural components (beams, walls), other mechanical and electrical systems
routing conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)
high points include: air vents, valves and bleeders
low points include: drains

tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe and tube bending equipment

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

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

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

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-22.02.01K	demonstrate knowledge of solar ***piping configurations***, their ***applications*** and operation	explain the ***applications*** of solar ***piping configurations***
		identify types of ***piping*** and ***piping components*** for solar heating systems, and describe their purpose and operation
		interpret information pertaining to solar piping found on drawings and specifications
		explain the effects of electrolysis when connecting dissimilar metals on solar piping and components
		explain the effects of expansion and contraction on piping in solar heating systems
		explain the effects of trapped air in solar piping systems and describe the procedures to prevent it
		identify the ***considerations for selecting*** piping system components for solar heating systems
		identify systems that require pitch
F-22.02.02K	demonstrate knowledge of the procedures used to install piping and components for solar heating systems	describe the procedures used to install piping and components for solar heating systems
		describe the procedures used to ***protect*** and restrain solar heating system piping and components

RANGE OF VARIABLES

piping configurations include: domestic hot water heating, hydronic heating and cooling, radiant heating, open loop, closed loop, horizontal loop, vertical loop

applications include: residential heating, ICI heating, process

piping includes: carbon steel, copper, HDPE, LDPE, MDPE, PEX, PEX-AL-PEX, stainless steel

piping components include: heat exchangers, pump trim, manual and automatic valves, expansion joints, flexible connectors, strainers, check valves

selection considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

protection includes: protection from mechanical damage, seismic activity, environmental conditions

F-22.03 Tests solar heating systems

Essential Skills	Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-22.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
F-22.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
F-22.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
F-22.03.04P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
F-22.03.05P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
F-22.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
F-22.03.07P	install ***testing equipment and components***	***testing equipment and components*** are connected following the test procedures
F-22.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
F-22.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
F-22.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
F-22.03.11P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled
F-22.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic, NDE, vacuum

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

test medium includes: water, air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle 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

testing equipment and components include: test tree and components, pressure gauges, pumps, compressors, test medium

appropriate parties include: QA/QC personnel, owner/operator, AHJ

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-22.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
F-22.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of solar heating systems, 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 the effect of elevation and temperature on pressure when testing solar heating systems
		explain the effects trapped air in a solar heating system will have on testing and describe the procedures to prevent or correct it
		identify hazards related to heat transfer fluid
F-22.03.03K	demonstrate knowledge of the procedures used to test solar heating systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system

	describe the procedures used to reinstate system
	identify codes and standards

RANGE OF VARIABLES

testing equipment and components include: test tree and components, pressure gauges, pumps, compressors, test medium

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix, air, inert gases

method of filling, draining or purging includes: using hand pump, centrifugal pump, compressors, compressed gas cylinders

isolation components include: blind flanges, plugs and caps, temporary spool pieces

F-22.04 Maintains, troubleshoots and repairs solar heating systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-22.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
F-22.04.02P	troubleshoot solar heating systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
F-22.04.03P	lock out and tag out system	system is locked and tagged out to prevent activation during repair and maintenance
F-22.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed
F-22.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
F-22.04.06P	check medium	medium quality is tested for hardness, acidity, dissolved gases and suspended particulates using a test kit including freeze protection limits (glycol)
F-22.04.07P	document the repairs	repairs are documented

F-22.04.08P	remove lock-out and tag-out from components and piping system	locks and tags are removed
F-22.04.09P	reinstate system	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition
F-22.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and ***documentation*** is updated with the required information

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, smell, touch), diagnostic testing, monitor system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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

required documentation includes: lock-out and tag- out, maintenance log, quality control reports

equipment includes: expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tank, isolators, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-22.04.01K	demonstrate knowledge of diagnostic and testing equipment for troubleshooting solar heating systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to solar heating systems system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effect of pressure on elevation when troubleshooting solar heating systems
		explain the effects trapped air in a solar heating system will have on system operation and describe the procedures to prevent or correct it
F-22.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain solar heating systems	describe the procedures used to troubleshoot solar heating systems
		describe the procedures used to repair solar heating systems

	describe the procedures used to maintain solar heating systems
	describe the procedures used to complete documentation following solar heating system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, manometer, infrared thermometer, balancing equipment, chemical testing equipment

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

TASK F-23 INSTALLS, TESTS, MAINTAINS, TROUBLESHOOTS AND REPAIRS HEAT RECOVERY SYSTEMS

TASK DESCRIPTOR

Heat recovery systems transfer heat from various sources of heat such as gland seals, refrigerant gas, exhaust steam, flash steam, waste water, cooling water and heat recovery ventilators. 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. Repairs are performed on an as-needed basis.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

At a journeyperson level of performance, all tasks must be done with minimal direction and supervision.

F-23.01 Installs equipment for heat recovery systems

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-23.01.01P	select ***equipment***	***equipment*** is selected according to load and demand, and type of ***heat recovery systems***
F-23.01.02P	size equipment	heat recovery system is ***sized*** using approved ***methods*** and consulting engineered drawings, jurisdictional codes and specifications
F-23.01.03P	determine location and placement of equipment	location and placement of equipment is determined according to ***drawings***
F-23.01.04P	select and use ***tools and equipment*** required for installation of heat recovery equipment	***tools and equipment*** for the installation are selected based on type of system and size of piping

F-23.01.05P	install ***equipment supports, fasteners*** and ***components***	***equipment supports, fasteners*** and ***components*** are installed to required spacing, weight, vibration isolation, height and grade in order to accommodate operation of the system
F-23.01.06P	determine ***installation method***	***installation method*** used to set equipment in place is determined by size, weight and location of equipment
F-23.01.07P	set and secure equipment in place	heat recovery equipment is installed respecting the required clearances and limitations, and is aligned/orientated, leveled and anchored

RANGE OF VARIABLES

equipment includes: pumps, heat transfer equipment,

heat recovery systems include: domestic and process water heating, space heating and cooling

sizing methods include: performing calculations, determining measurements, consulting manufacturer/supplier documentation

drawings include: engineered, mechanical, architectural, structural, manufacturers' installation instructions

tools and equipment include: hand tools, power tools and equipment, rigging and material handling equipment, threading machines, brazing, soldering and welding tools and equipment

equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds

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

components include: seismic restraints

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-23.01.01K	demonstrate knowledge of ***heat recovery systems***, their components, applications and operation	explain the applications and operation of ***heat recovery systems***
		interpret information pertaining to heat recovery system equipment found on drawings and specifications
F-23.01.02K	demonstrate knowledge of heat recovery ***equipment***, their applications and operation	identify types of heat recovery ***equipment***, and describe their characteristics and operation
		identify heat recovery ***equipment supports*** and ***fasteners*** and describe their applications and procedures for use
		identify heat recovery ***control components*** and describe their purpose and operation
		identify ***sources of heat*** used in heat recovery systems
		explain the ***principles of heat transfer***

		identify types of ***heat transfer equipment*** and describe their characteristics and operation
F-23.01.03K	demonstrate knowledge of the procedures used to install equipment for heat recovery systems	identify equipment, ***controls***, ***supports*** and fasteners used in heat recovery systems, and describe their purpose and operation
		describe the procedures used to install equipment for heat recovery systems, their controls, supports and fasteners

RANGE OF VARIABLES

heat recovery systems include: domestic and process water heating, space heating and cooling
equipment includes: expansion joints, pumps, heat transfer equipment (rooftop units), heat exchangers, tanks, valves, water treatment equipment
equipment supports include: stands, hangers, plates, housekeeping pads, isolator pads, concrete embeds
equipment fasteners include: expansion type inserts, beam clamps, nuts, bolts, screws
control components include: operating and temperature controls, safety controls
sources of heat include: gland seals, refrigerant gases, exhaust steam, flash steam, waste water, cooling water, heat recovery ventilators (HRV) (pre-heat coils, exhaust steam coils)
principles of heat transfer include: radiation, conduction, convection
heat transfer equipment includes: radiators, convectors, pipe coils, horizontal and vertical unit heaters, radiant panels, heat exchangers
controls include: differential temperature controllers, flow switches, motorized zone valves, sensors

F-23.02 Installs piping for heat recovery systems

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-23.02.01P	select and size piping	type of ***pipe*** is selected based on system application and sized to ensure operation of system and flow requirements
F-23.02.02P	determine routing of piping	***routing*** of piping is confirmed by referencing drawings, including grade or pitch, depth or modified to avoid ***obstructions*** and/or ***conflicts***
F-23.02.03P	determine ***high points*** and ***low points*** for heat recovery equipment and components	***high points*** and ***low points*** are identified

F-23.02.04P	select and use ***tools and equipment***	***tools and equipment*** for the installation are selected and based on type and size of piping
F-23.02.05P	determine ***joining method*** for piping system	***joining method*** is determined by engineered drawings and specifications, type and size of pipe
F-23.02.06P	clean and prepare fittings and joints	use joining methods and ensure fit-up to avoid leaks
F-23.02.07P	calculate grade or pitch of piping	grade or pitch of piping is calculated in order to ensure system efficiency and functionality
F-23.02.08P	install ***piping supports***	***piping supports*** are installed to required spacing, height and grade in order to accommodate operation of the system
F-23.02.09P	assemble and install piping	piping is assembled and installed using joining methods and in a manner to allow for insulation of piping including sleeving and proper spacing, and making ***allowances for contraction and expansion***

RANGE OF VARIABLES

piping include: carbon steel, copper, HDPE, LDPE, MDPE, PEX, PEX-AL-PEX, stainless steel
routing obstructions include: structural components (beams, walls), other mechanical and electrical systems
routing conflicts include: high and low points, clearances, protection from environmental damage (extreme heat or cold), protection from mechanical damage (overhead doors, forklifts, machinery)
high points include: air vents, valves, bleeders
low points include: drains
tools and equipment include: hand tools, power tools and equipment, lifting equipment, grooving machines, threading machines, welding equipment, pipe and tube bending equipment
joining methods include: flanging, threading, grooving, crimping, grooving, crimping, welding, soldering, solvent cement, fusion, brazing, mechanical joints
piping supports include: rollers, hangers, clamps, brackets, stands, anchors, guides
allowances for contraction and expansion include: expansion joints, expansion loops, swing joints

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-23.02.01K	demonstrate knowledge of heat recovery ***piping configurations***, their ***applications*** and operation	explain the ***applications*** of heat recovery ***piping configurations***
		identify types of ***piping*** and ***piping components*** for heat recovery systems, and describe their purpose and operation
		interpret information pertaining to heat recovery piping found on drawings and specifications

		explain the effects of electrolysis when connecting dissimilar metals on heat recovery piping and components
		explain the effects of expansion and contraction on piping in heat recovery systems
		explain the effects of trapped air in heat recovery piping systems and describe the procedures to prevent it
		identify the ***considerations*** for selecting piping system components for heat recovery systems
		calculate pitch or grade in order to ensure system efficiency and functionality
F-23.02.02K	demonstrate knowledge of the procedures used to install piping and components for heat recovery systems	describe the procedures used to install piping and components for heat recovery systems
		describe the procedures used to ***protect*** and restrain heat recovery system piping and components

RANGE OF VARIABLES

heat recovery ***piping configurations*** include: open loop, closed loop

applications include: residential heating, ICI heating, process

piping includes: carbon steel, copper, HDPE, LDPE, MDPE, PEX, PEX-AL-PEX, stainless steel

piping components include: heat exchangers, pump trim, manual and automatic valves, expansion joints, flexible connectors, strainers, check valves

considerations include: insulation requirements, type of supports, shoes and sleeves, expansion, contraction

protection includes: protection from mechanical damage, seismic activity, environmental conditions

F-23.03 Tests heat recovery systems

Essential Skills	Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-23.03.01P	perform a visual pre-check inspection of system to check for possible obstructions and deficiencies	punch list is completed to confirm components are installed
F-23.03.02P	determine type of ***test, testing equipment and components,*** and test parameters	type of ***test*** and the test parameters are determined to match system application and requirements according to engineered specifications
F-23.03.03P	determine ***test medium*** to be used for test, and the ***method of filling, draining or purging*** the system	***test medium*** to be used is determined based on type of test selected, and ***method of filling, draining or purging*** is determined by the medium
F-23.03.04P	assemble testing equipment and components	assembled testing equipment allows the test to be completed
F-23.03.05P	lock out and tag out system	system components are locked and tagged out to prevent activation during testing
F-23.03.06P	install ***isolation components*** to protect sensitive equipment and ensure the system is in a zero energy state	***isolation components*** are installed, sensitive equipment is protected from test pressures and ***confirmation of zero energy state*** is completed
F-23.03.07P	install ***testing equipment and components***	***testing equipment and components*** are connected following the test procedures
F-23.03.08P	perform test on system to verify the integrity of the system	test medium is introduced to the system and results of test are recorded for the purpose of obtaining sign-off once there are no defects
F-23.03.09P	remove test medium from system	test medium is removed and either recycled or disposed of depending on type of test medium
F-23.03.10P	remove lock-out and tag-out from components and piping system	locks and tags are removed
F-23.03.11P	reinstate system	isolation components and testing equipment are removed and original components are reinstalled (may or may not include filling)
F-23.03.12P	complete documentation	required documents are completed, signed off by the ***appropriate parties*** and final copies distributed

RANGE OF VARIABLES

tests include: hydrostatic, pneumatic, NDE, vacuum

testing equipment and components include: blind flanges, calibrated pressure gauges***,*** test pumps, relief valves, gate valves, recorders, testing trees/headers, regulators

test medium includes: water, air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: spectacle 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

testing equipment and components includes: test tree and components, pressure gauges, pumps, compressors, test medium

appropriate parties include: QA/QC personnel, owner/operator, AHJ

	KNOWLEDGE	
	Learning Outcomes	**Learning Objectives**
F-23.03.01K	demonstrate knowledge of ***testing equipment and components***	identify types of ***testing equipment and components*** and describe their characteristics and applications
F-23.03.02K	demonstrate knowledge of system testing	identify types of ***tests*** and describe their applications
		identify ***test medium*** used in testing of heat recovery systems, 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 the effect of elevation and temperature on pressure when testing heat recovery systems
		explain the effects trapped air in a heat recovery system will have on testing and describe the procedures to prevent or correct it
F-23.03.03K	demonstrate knowledge of the procedures used to test heat recovery systems	describe the procedures used to perform system testing
		describe the procedures used to remove test medium from system
		describe the procedures used to reinstate system

RANGE OF VARIABLES

testing equipment and components include: test tree and components, pressure gauges, pumps, compressors, test medium

tests include: hydrostatic, pneumatic, vacuum

test medium includes: water, water/glycol mix, air, inert gases

method of filling, draining or purging includes: using hand pumps, centrifugal pumps, compressors, compressed gas cylinders

isolation components include: blind flanges, plugs and caps, temporary spool pieces

F-23.04 Maintains, troubleshoots and repairs heat recovery systems

Essential Skills	Oral Communication, Thinking Skills, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-23.04.01P	determine system issues that require investigation	system issues requiring investigation are determined by consulting with system owner/operator
F-23.04.02P	troubleshoot heat recovery systems to determine requirements for repair or replacement	perform ***testing and inspection*** of system to determine equipment or components in ***condition for repair or replacement***
F-23.04.03P	lock out and tag out system	system is locked and tagged out to prevent activation during repair and maintenance
F-23.04.04P	install ***isolation components*** and ensure the system is in a zero energy state	***isolation components*** are installed and ***confirmation of zero energy state*** is completed
F-23.04.05P	disassemble system, repair or replace the faulty equipment or components and reassemble the system	required equipment and components are removed, repaired or replaced and reassembled without damage to other components or the surrounding area
F-23.04.06P	check medium	medium quality is tested for hardness, acidity, dissolved gases and suspended particulates using a test kit including freeze protection limits (glycol)
F-23.04.07P	document the repairs	repairs are documented
F-23.04.08P	remove lock-out and tag-out from components and piping system	locks and tags are removed

F-23.04.09P	reinstate system to operating condition after completing maintenance procedures	system is filled and pressurized, bled of air or contaminants, checked for leaks, locks removed and returned to normal operating condition
F-23.04.10P	follow a predetermined maintenance schedule and complete ***required documentation***	maintenance is performed according to the predetermined schedule, ***equipment*** is free of contaminants and operating efficiently, and ***documentation*** is updated with the required information

RANGE OF VARIABLES

testing and inspection includes: sensory inspection (visual, auditory, touch), diagnostic testing, monitor system operation

conditions for repair or replacement include: abnormal temperature, leaks, corrosion, control malfunction, vibration, irregular movement

isolation components include: spectacle 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

required documentation includes: lock-out and tag-out, maintenance log, quality control reports

equipment includes: boilers, expansion tanks, buffer tanks, glycol tanks, heat exchangers, circulating pumps, transfer pumps, holding tanks, isolators, relief valves, chemical feeders, isolation valves for equipment, backflow preventers, pressure reducing valves

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-23.04.01K	demonstrate knowledge of ***testing equipment and components*** for troubleshooting heat recovery systems	identify types of ***testing equipment and components*** and describe their characteristics and applications
		identify types of ***isolation components*** and describe their characteristics and applications
		interpret information pertaining to heat recovery system troubleshooting, repair and maintenance found on drawings, specifications and equipment manuals
		explain the effect of pressure on elevation when troubleshooting heat recovery systems
		explain the effects trapped air in a heat recovery system will have on system operation and describe the procedures to prevent or correct it
F-23.04.02K	demonstrate knowledge of the procedures used to troubleshoot, repair and maintain heat recovery systems	describe the procedures used to troubleshoot heat recovery systems
		describe the procedures used to repair heat recovery systems

	describe the procedures used to maintain heat recovery systems
	describe the procedures used to complete documentation following heat recovery systems system repair or maintenance

RANGE OF VARIABLES

testing equipment and components include: multimeter, manometer, infrared thermometer, balancing equipment, chemical testing equipment

isolation components include: spectacle blinds, spades, plugs and caps, temporary spool pieces

MAJOR WORK ACTIVITY G
PERFORMS COMMISSIONING, START-UP AND TURNOVER

TASK G-24 PREPARES SYSTEM FOR COMMISSIONING, START-UP AND TURNOVER

TASK DESCRIPTOR

Steamfitters/Pipefitters must carefully pre-check and isolate the systems as necessary by 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.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

All commissioning activities must be evidenced and documented correctly according to engineering, quality control and client requirements.

At a journeyperson level of performance, tasks are usually done in coordination with supervisors, engineers and quality control personnel.

G-24.01 Flushes system

Essential Skills	Document Use, Thinking Skills, Reading

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-24.01.01P	set up pigging devices, launchers and receivers for cleaning of pipe	pigging devices, launchers and receivers are in place
G-24.01.02P	select ***recommended medium*** to use for flushing piping system and equipment	medium selected is compatible with the piping system
G-24.01.03P	install temporary pipe for delivering flushing medium	temporary pipe is securely fastened to system

G-24.01.04P	follow flushing procedure	procedures are carried out according to engineer's specifications
G-24.01.05P	drain medium from system	low point drains and high point vents are opened
G-24.01.06P	recover and dispose of flushing medium	disposal procedures meets environmental regulations and guidelines

RANGE OF VARIABLES

recommended medium includes: water, water/glycol mix, methanol, acid flush, compressed gas, steam, oil

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-24.01.01K	demonstrate knowledge of system flushing procedures	identify hazards and describe safe work practices pertaining to system flushing
		identify ***sources of information*** pertaining to system flushing
		identify tools and equipment relating to system flushing and describe their applications and procedures for use
		identify types of ***flushing medium*** and describe their applications
		describe the ***procedures used to perform system flushing***
		identify jurisdictional codes and specifications for chemical treatment and disposal of medium

RANGE OF VARIABLES

sources of information include: specifications, WHMIS information

flushing medium includes: water, water/glycol mix, methanol, acid flush, compressed gas, steam, oil

procedures used to perform system flushing include: checking vents and drains, attaching hoses, filling system

G-24.02 Chemically treats system

Essential Skills Document Use, Thinking Skills, Reading

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-24.02.01P	identify which systems require chemical treatment	system to be treated is identified by owner's request and project engineer's specifications
G-24.02.02P	follow ***chemical treatment procedures***	***procedures*** followed according to chemical engineer guidelines
G-24.02.03P	obtain a sample of the medium that will be chemically treated	sample is bottled and labelled for testing by chemical engineer
G-24.02.04P	install and disconnect temporary pipe to introduce chemical into the piping system	temporary pipe is securely fastened to system
G-24.02.05P	introduce chemicals to system and circulate	appropriate levels of chemicals in system are signed off by chemical engineer
G-24.02.06P	drain medium from system	low point drains and high point vents are opened
G-24.02.07P	recover and dispose of chemical treatment waste fluid	disposal procedures meets environmental regulations and guidelines

RANGE OF VARIABLES

chemical treatment procedures include: cycling, length of time, pressure

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-24.02.01K	demonstrate knowledge of chemical treatment procedures	identify hazards and describe safe work practices pertaining to chemical treatment
		identify ***sources of information*** pertaining to chemical treatment
		identify tools and equipment relating to chemical treatment and describe their applications and procedures for use
		describe the ***procedures used to perform chemical treatments***

RANGE OF VARIABLES

sources of information include: specifications, chemical engineer, WHMIS information

procedures used to perform chemical treatments include: checking vents and drains, attaching hoses, filling system

G-24.03 Pre-checks system for commissioning

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-24.03.01P	identify system to be commissioned according to engineered drawings	documentation indicates system to be commissioned matches engineered drawings and traces piping back to the equipment
G-24.03.02P	select ***tools and equipment*** for commissioning	***tools and equipment*** are appropriate to the commissioning task and situation
G-24.03.03P	perform a visual inspection of system to be commissioned to check for possible ***deficiencies***	***deficiencies*** that do not conform to P&ID, standard piping practices and specifications are identified
G-24.03.04P	complete pre-check list (punch list) for ***conditions***	components are confirmed to be installed in the system
G-24.03.05P	verify ***operating parameters***	***operating parameters*** are within manufacturers' specifications for operation and design of the system
G-24.03.06P	determine ***method*** of filling system	***method*** selected is appropriate for the size and type of the system

RANGE OF VARIABLES

tools and equipment used for commissioning include: differential pressure gauges, probes, inline flowmeters, inline filters, temperature indicators

deficiencies to inspect for include: obstructions, leaks, removal of test equipment, improperly installed equipment

conditions to be checked on a pre-check list 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

filling methods include: using hand pumps, centrifugal pumps, air compressor, gravity feed, energizing

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-24.03.01K	demonstrate knowledge of system commissioning procedures	identify hazards and describe ***safe work practices*** pertaining to system commissioning
		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 methods for charging systems to operating design pressure
		describe the ***procedures*** used to perform ***pre-checks***
		describe the ***procedures used to commission systems***

RANGE OF VARIABLES

safe work practices include: system isolation, lock-out procedures, testing medium

sources of information include: specifications, drawings

pre-check procedures 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

commission procedures include: flushing, chemical treating, start-up and documentation, reinstatement after testing

G-24.04 Selects and connects commissioning equipment

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-24.04.01P	identify design ***operating conditions***	***operating conditions*** match reference drawings, system specifications and equipment specifications
G-24.04.02P	select and use ***commissioning equipment***	***commissioning equipment*** is appropriate for the task and conditions
G-24.04.03P	select and use ***tools and equipment*** for connection	***tools and equipment*** are appropriate for the task and conditions

G-24.04.04P	perform basic check of commissioning equipment	commissioning equipment is operational and calibrated
G-24.04.05P	reinstate ***system components*** that were removed for system testing	punch list indicates components are reinstated

RANGE OF VARIABLES

operating conditions that must be considered 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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-24.04.01K	demonstrate knowledge of system commissioning procedures	identify hazards and describe ***safe work practices*** pertaining to system commissioning
		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 methods for charging systems to operating design pressure
		describe the procedures used to select and connect commissioning equipment
		describe the ***procedures used to commission systems***

RANGE OF VARIABLES

safe work practices include: system isolation, lock-out procedures, testing medium
sources of information include: specifications, drawings
commission procedures include: flushing, chemical treating, start-up and documentation, reinstatement after testing

TASK G-25 COMMISSIONS SYSTEMS

TASK DESCRIPTOR

Commissioning systems involves bringing the piping systems online. This can be done in collaboration with owners' representatives or AHJ.

Steamfitters/pipefitters must commission a system to normal operational conditions to satisfy necessary codes, regulations and quality control standards. This encompasses making repairs and adjustments along the way and documenting all findings.

INDUSTRY EXPECTED PERFORMANCE

The task must be performed according to the applicable jurisdictional codes and standards. All health and safety standards must be respected. Work should be done efficiently and at a high quality without material waste or environmental damage. All requirements of the manufacturer, client specifications and the AHJ must be met.

All commissioning activities must be evidenced and documented correctly according to engineering, quality control and client requirements.

At a journeyperson level of performance, tasks are usually done in coordination with supervisors, engineers and quality control personnel.

G-25.01 Secures commissioning area

Essential Skills	Writing, Oral Communication, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-25.01.01P	arrange for ***approvals*** to work in commissioning area	written documentation and permits are valid
G-25.01.02P	***communicate*** and coordinate scheduled commissioning with others	other trades are given written documentation of scheduled commissioning
G-25.01.03P	rope off test area and clear area of personnel	area is cleared of unauthorized personnel after a walk-through inspection
G-25.01.04P	remove locks from system being commissioned	lock removal is documented

RANGE OF VARIABLES

approvals to be obtained include: operating permits, AHJ permission

communication includes: written, electronic, radio, cell phones

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-25.01.01K	demonstrate knowledge of system commissioning and its associated procedures	identify hazards and describe ***safe work practices*** pertaining to system commissioning
		identify ***sources of information*** pertaining to system commissioning
		identify tools and equipment relating to system commissioning and describe their applications and procedures for use

RANGE OF VARIABLES

safe work practices include: system re-energizing, procedures for removal of lock-outs, safe handling of system medium

sources of information include: specifications, drawings, operating conditions

G-25.02 Pressurizes system

Essential Skills	Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-25.02.01P	fill system and vent	drains are closed, air is removed and system is filled to the high point vent
G-25.02.02P	increase pressure in a controlled manner to operating pressure	***pressure measuring devices*** show operating pressures are to engineering specifications and jurisdictional requirements

RANGE OF VARIABLES

pressure measuring devices include: pressure transducers, gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-25.02.01K	demonstrate knowledge of system commissioning and its associated procedures	identify hazards and describe ***safe work practices*** pertaining to system commissioning
		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 permits and approvals required to perform pressurization
		describe the ***procedures used to perform pressurization***

RANGE OF VARIABLES

safe work practices include: system re-energizing, procedures for removal of lock-outs, safe handling of system medium

sources of information include: specifications, drawings, operating conditions

procedures used to perform pressurization include: filling, venting, increasing pressure in a controlled manner

G-25.03 Inspects system

Essential Skills	Document Use, Thinking Skills, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-25.03.01P	perform visual inspection of system for ***faulty conditions***	***faulty conditions*** are identified, reported and documented
G-25.03.02P	detect ***defects*** in system	***defects*** are identified, reported and documented
G-25.03.03P	analyze defect in order to recommend repair	required repairs to defects are identified and resolved

RANGE OF VARIABLES

faulty conditions include: leaks, freezing temperatures and overheating, improper pressure

defects include: faulty gaskets, loose packing nuts, missing or loose plugs, faulty valves

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-25.03.01K	demonstrate knowledge of system inspection and its associated procedures	identify hazards and describe ***safe work practices*** pertaining to system inspection
		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 piping and equipment in system being inspected

RANGE OF VARIABLES

safe work practices include: use of PPE (respirator, face shield), barricading, H_2S training
sources of information include: specifications, drawings, operating conditions

G-25.04 Corrects faulty conditions

Essential Skills Document Use, Thinking Skills, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-25.04.01P	lock out system prior to de-pressurizing	locks are placed on system or equipment being worked on according to work permit
G-25.04.02P	depressurize system	vents and drains are opened and pressure instruments read zero
G-25.04.03P	***repair leaks*** using ***procedures***	leak is repaired
G-25.04.04P	remove and replace faulty ***components***	replaced ***components*** function to specification
G-25.04.05P	repair faulty ***joints***	visual inspection of joints indicates that they are repaired

RANGE OF VARIABLES

leak repair procedures include: tightening and torquing flanges, cutting in unions, replacing pipe spools, changing gaskets
components to be replaced include: valves, flanges, gaskets, fittings
components to be replaced include: valves, flanges, gaskets, fittings
joints that can be repaired include: welded, mechanical, fused, threaded

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-25.04.01K	demonstrate knowledge of repair and replacement procedures	identify hazards and describe ***safe work practices*** pertaining to repair
		identify ***sources of information*** pertaining to repair
		identify tools and equipment relating to repair and describe their applications and procedures for use
		identify piping and equipment in system being repaired
		describe the procedures used to perform repairs

RANGE OF VARIABLES

safe work practices include: acquiring permits, applying lock-outs, using PPE
sources of information include: specifications, drawings, operating conditions

G-25.05 Participates in start-up and turnover procedures

Essential Skills Document Use, Oral Communication, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-25.05.01P	select and use ***tools and equipment*** for start-up	***tools and equipment*** are being used for their intended purpose and according to safe work practices
G-25.05.02P	follow start-up procedure list	equipment operates according to design and functional performance requirements
G-25.05.03P	check equipment/trim function and safety features	equipment and trim operational requirements are identified
G-25.05.04P	demonstrate system operation with the owner's representative	documentation is completed and signed off by owner representative
G-25.05.05P	balance system by adjusting ***components***	***components*** meet operational requirements
G-25.05.06P	perform final ***maintenance*** of components at start-up	components are maintained for optimal operation of equipment
G-25.05.07P	remove ***commissioning equipment***	commissioning equipment is removed without damage, leakage or spillage
G-25.05.08P	remove signage and barricades	signage and barricades are removed when work location is safe to access

G-25.05.09P	place and review valve identification tags	valve tag list is completed and tags hung on valves at correct locations
G-25.05.10P	apply pipe markings to identify flow and medium	pipe markings accurately indicate flow and medium

RANGE OF VARIABLES

tools and equipment used for start-up include: balancing equipment, laptops, radios, analysers
components include: flow control devices, pressure reducing valves, regulators, flow switches, level switches
maintenance includes: cleaning strainers, changing filters
commissioning equipment includes: balancing instruments, analysers

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-25.05.01K	demonstrate knowledge of start-up procedures	identify hazards and describe ***safe work practices*** pertaining to start-up
		identify ***sources of information*** pertaining to start-up
		identify tools and equipment relating to start-up and describe their applications and procedures for use
		identify piping and equipment in system being started up
		describe the ***procedures*** used to perform start-up

RANGE OF VARIABLES

safe work practices include: acquiring permits, removing lock-outs, using PPE
sources of information include: manufacturers' recommendations, specifications, drawings, operating conditions
procedures for start-up include: organizing inspection date, notifying client, checking connections, verifying parameters, performing operational tests, making final adjustments

APPENDIX A
ACRONYMS

ABS	acrylonitrile butadiene styrene
ACR	air-conditioning and refrigeration
AHJ	authority having jurisdiction
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
BIM	Building Information Management
CAD	computer-aided design
CFC	chlorofluorocarbon
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
FLRA	field level risk assessments
FRP	fibreglass reinforced plastic
GA	general arrangement
GFRP	glass fibreglass reinforced plastic
GMAW	gas metal arc welding
GRE	glass reinforced epoxy
GSHP	ground source heat pump
GTAW	gas tungsten arc welding
HCFC	hydrofluorocarbon
HDPE	high density polyethylene
HRV	heat recovery ventilators
HVACR	heating, ventilation and air conditioning and refrigeration
ICI	industrial, commercial and institutional
JSA	job safety analysis
LEED	Leadership in Energy and Environmental Design
LDPE	low density polyethylene
LWCO	low water cut-offs
MAPP	methylacetylene-propadiene propane
MDPE	medium density polyethylene
MIG	metal inert gas
MSS	Manufacturers Standardization Society
NDE	non-destructive examination
OH&S	Occupational Health and Safety
P&ID	process and instrumentation drawings

PE-PP	polyethylene-polypropylene
PEX	cross linked polyethylene
PPE	personal protective equipment
PVC	polyvinyl chloride
QA/QC	quality assurance and quality control
RFI	Request for Information
SDS	Safety Data Sheet
SMAW	shielded metal arc welding
SPA	safety plan of action
SWL	safe working load
TIG	tungsten inert gas
WHMIS	Workplace Hazardous Materials Information System
WPS	welding procedures specifications

APPENDIX B
TOOLS AND EQUIPMENT

Hand Tools

alignment clamps – external and internal
angle finder
bending tools – hand and hydraulic
bolt cutter
bolt die
bolt tap
C-clamp
calculator
centre punch
chain pipe tongs
coil fin straightener
cold chisels
computer
contour markers
drafting accessories
files
flange alignment pins
flange spreader (jacks)
flaring tool
freeze pack
gasket cutter
hacksaws – hand, portable band, large band
hammers – ball peen, chipping, sledge, soft-face
hand beveller
hi-lo gauge
hole punch
levels – laser, standard, builders, digital (smart)
marking tool
pin punch
pinch bars
pipe cutters– single-wheel, multi-wheel pipe/tube cutters
pipe reamer – spiral, fluted
pipe tap
pipe threader
pipe vises – chain and yokes, tri-stand and bench, power vise (power drive)
PEX tools
pliers
prying tool
ratchet
screwdrivers
shear
shrink-fit device
spacing tool
strapping device
swaging tool
tip cleaner
tube cleaner
tube bender
wheel and bearing pullers
wrap-around
wrenches – adjustable, chain, combination (open-/closed-end), hammer, hex-key, non-spark, pin, pipe, socket, torque

Power Tools

air compressor

bevelling tools – electric drive, pneumatic, oxy-fuel

bending machine

bolt tensioner

drills – electric, pneumatic, hammer, bench or stand press, mag

facing tool

grinders (electric or pneumatic) angle, bench, die, pedestal

grooving machine

hydraulic flange spreaders

hydraulic jacks

hydraulic torque wrench

hydrostatic pump

impact driver

portable end-prep milling – pneumatic, electric

powder-actuated tools

saws – circular, cut-off, jig, sabre

threading machine

Measuring and Testing Tools and Devices

ampere probe

calculator

callipers

centre finder

chart recorders

compass

dead weights

feeler gauge

gauges – temperature, pressure, liquid, vacuum, specialty

holiday detector (GEEP™ tester)

geometry set

hydrostatic test pump

infrared temperature sensor

levels – laser, standard, builders (transit), digital (smart)

measuring tape

manometer

micrometer

multimeter

plumb bob

rulers

scales

squares – standard 24-in., combination, flange straightedge, rigging

string line

thermometer

Rigging and Hoisting Equipment

beam clamps
cable clips
cable puller
chain block
chain fall
chain puller
come-along
cranes
D ring
equalizer beam
eye bolts
forklift
grip hoist (Tirfor®)
hooks
jacks (hydraulic, ram and piston)
plate clamp
rope
shackle
slings (nylon, wire rope, wire mesh)
snatch block
softeners
spreader bar
tag line
tugger

Welding, Soldering and Brazing Equipment

arc welders (electric, fuel)
compressed gas cylinders (purge, shield, cutting)
fusion welding equipment
flashback arrestor
hot air welding machine
orbital welder
plasma cutters
propane tiger torches (preheating)
regulator
torches (oxy-fuel cutting, heating and welding)
welding machines (SMAW, GMAW, TIG)

Ladders, Stands and Platforms

combination ladder
extension ladder
manlifts – electrical, hydraulic, pneumatic, winch (hand and power), one-man, platform, scissor lift, articulating boom
material lifts
scaffolding (staging)
pipe racks
pipe stands – roller and V type
platform ladder
step ladder

Personal Protective Equipment (PPE) and Safety Equipment

air quality monitors
anti-vibration gloves
breathing apparatus
chemical protective clothing
coveralls (standard and fire retardant)
dust mask
ear protection
face shield
fall arrest harness
fire extinguisher
first aid kit

APPENDIX C
GLOSSARY

backflow preventer	a device or a method that prevents a reverse flow from the normal direction of flow in a piping system
balancing valve	valve used to add artificial resistance where required to achieve design flow rate
blowdown	a connection at the bottom or lowest portion of a gauge glass, low water cutoff, automatic water feeder, cast iron water column, etc., to facilitate cleaning out or testing of the equipment
boiler	equipment used to heat water or generate steam
boiler trim	the controls, equipment and accessories connected to a boiler for its safe and efficient operation
butt fusion	a joining method that requires ends of pipe to be joined by direct heat application on material such as steel or plastic
CAD	computer aided design; used for drawing, altering and recalling views and details on a computer
chilled water cooling system	piping systems for cooling buildings, equipment or processes by circulating chilled water
circuit	the piping path from a heat exchanger to a heat transfer unit and back to the heat exchanger
condensate return system	a piping arrangement designated to return condensate to a steam generator
contour marker	instrument used in the fabrication of pipe that will trace lines for the cutting of tees, wyes and laterals
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
controller	device with a sensing element which takes measurements and adjusts the setting of a preselected component accordingly
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)
de-aerator	a device used to remove temporary hardness and unwanted gases (such as oxygen and carbon dioxide) from the make-up water

desuperheater	a device which uses water as a cooling medium to lower the temperature of the superheated steam
direct return	a two-pipe heating system (hydronic system) in which the first unit supplied has the shortest return to the boiler
double-block-and-bleed	a valving system wherein a full flow vent valve is located on piping between two shut-off valves in series for the purpose of bleeding to the atmosphere excess pressure between valves
dry return	a condensate return line which is located above the water line of the boiler and carries condensate and air
equalizer beam	usually used on dual hoist lines to make tandem lifts, but can also be used to equalize the load on sling legs. They are connected with a crane hook connected directly to the beam.
expansion joint	a manufactured, mechanical device to take up or to compensate for the expansion and contraction of a pipe line due to temperature change
feed water	water that is fed into a boiler or systems
flashback	flashback always occurs in the line carrying the lower pressure and will always occur beyond the mixer, and may include the hose and regulator as well. It is usually a devastating explosion or series of explosions, leaving the equipment in shambles
heat exchanger	a device for transferring heat from one fluid to another without mixing the two fluids
heat transfer unit	a device used to transfer heat from a fluid to a space for conduction, convection or radiation
high temperature hot-water system	a system which has hot water above 350°F (180°C)
HVAC system	heating, ventilation and air-conditioning system
indicator	an instrument that shows a measurement, but makes no permanent record, e.g. pressure gauge
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 and/or vibration
low water cut off (LWCO)	a device which shuts off the automatic fuel control valve when the water falls below a safe level in the boiler
make-up water	water supplied to a system that replaces system fluid that has been lost through evaporation, leakage, etc.

pin indexing	refers to a fail-safe design by which end connections for specific gases can only be connected to other ends intended for use with the same gas; for example, equipment intended to utilize oxygen cannot physically be connected to a nitrous oxide gas supply
post heating	use of a heat source to heat an area after a process such as welding takes place
preheating	use of a heat source to heat an area before a process such as welding takes place
resin	a bonding agent used in the fibreglass process; used because of its resistance to acids and alkalines
safety relief valve	a safety device that will open before a dangerous pressure or temperature is reached
saturated steam	steam which is at the same temperature as the boiling water from which it was formed (dry saturated; wet saturated)
single-seated control valve	a control valve with a single seat and a single plug or disc
solvent fusion	joining plastic pipe by the use of a solvent which dissolves the surface of the pipe and forms a continuous bond upon evaporation
spool sheets	detail views of a piping system identifying specific piping and pieces to be fabricated
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.
spreaders	a set of chokers or slings of equal length used to lift a load
steam separator	a device used to remove entrained moisture present in steam
steam tracing	a pipe or tube which is placed along or around pipe, vessels and pumps and is filled with steam to control the primary pipe's medium's temperature
steam trap	an automatic device which allows the passage of air and condensate but prevents the passage of steam
straightening vanes	device used to take the turbulence out of liquids and gases flowing in pipes so measuring instruments can get an accurate reading
superheated steam	saturated steam with the addition of sensible heat; an increase in temperature of saturated steam without an increase in pressure
superheater	a device used to ~~re~~heat dry or wet-saturated steam and increase the temperature without increasing the pressure of the steam
vacuum pump	a device used to lower atmospheric pressure inside a vessel or piping system

wrap-around	a coil of gasket material used to wrap around pipe, when in the process of marking a pipe