

Red Seal Occupational Standard

Machinist



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RED SEAL
OCCUPATIONAL
STANDARD
MACHINIST



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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 Machinist trade.

Background

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

Standards have the following objectives:

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

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

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

STRUCTURE OF THE OCCUPATIONAL STANDARD

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

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

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

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

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

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

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

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

Task Matrix: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard

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

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

Task Descriptor: a general description of the task

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

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

Skills:

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

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

Knowledge:

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

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

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

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

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

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

DESCRIPTION OF THE MACHINIST TRADE

“Machinist” is this trade’s official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by machinists 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
General Machinist						■							
Machinist	■	■	■	■	■		■	■	■	■	■	■	■

Fully qualified machinists possess the knowledge and abilities to set up and machine using conventional, portable and Computer Numerical Control (CNC) machines that cut or grind metal and other materials into products with precise dimensions. These machines include lathes, milling machines, saws, grinding machines, drilling machines, boring machines, electrical discharge machines (EDM), line borers and portable milling machines.

Machinists work from drawings, specifications and their own measurements to calculate dimensions, tolerances and types of fit. Precise measurements are critical to machinists’ work. They must be knowledgeable about the properties of metals and non-metallic materials.

Machinists may work in industries where machines are manufactured, repaired or used. These may include industries that manufacture machinery equipment, motor vehicle or aerospace parts. Machinists produce precision parts that are used in all aspects of manufacturing. They may also work in shipyards, rail yards, refineries, pulp and paper mills, mines, smelters, metal fabricating and repair shops. Some sectors that employ machinists may include oil and gas, medical, research and development and forestry. Shiftwork is common in some companies. Machinists tend to work indoors.

Safety is important at all times. There are risks of injury working with moving machine parts, sharp edges, flying debris and extreme temperatures from heated or chilled materials. Precautions are required while working with manufacturing chemicals and airborne irritants.

Key attributes for people entering this trade are: communication skills, mechanical aptitude, hand-eye coordination, manual dexterity, an ability to work independently and knowledge of mathematics and physics. The work often requires considerable standing and the handling of heavy objects. This standard recognizes similarities or overlaps with the work of other tradespeople such as tool and die makers, mould makers, welders and industrial mechanics (millwrights).

Experienced machinists may move into mentoring or supervisory positions. They may transfer their skills to related occupations such as tool and die maker, mould maker, industrial mechanic (millwright) or CNC programmer.

TRENDS IN THE MACHINIST TRADE

TECHNOLOGY

Conventional machining skills continue to form the basis of the trade and are pre-requisite to being able to set up and program CNC machine-tools safely and efficiently.

Hybrid machines, which combine conventional and CNC features, continue to be part of the market.

Many advances in machine-tool configuration and technology, in particular CNC, as well as advances in cutting tools and fluids have increased efficiency and accuracy.

Quick change and modular tooling allows for easier and faster tool changes during setup and CNC machine operation. It allows for increased spindle uptime and simple tool pre-setting outside of the machine.

Additive manufacturing is a relatively new process that may open a lot of doors for manufacturing of complex components that were previously impossible or cost prohibitive to manufacture. Parts can be “grown” to near net size with complex internal porting and passages. Often, very little machining is required to bring these parts to their finished state. This technology is still being developed and as yet is not a prominent part of the machinist trade.

Most large scale manufacturers use some type of advanced data analysis to track factors such as whether machines are online or offline, number of parts produced, percentage of parts meeting requirements and whether delivery schedules are being met. Currently, this type of system is mainly implemented in high production environments.

Robotics continues to be a great asset in a high production atmosphere. They can be used to load and unload parts, sort components and assist in quality control. Their cost and complexity of setup may be a deterrent for smaller operations with lower production numbers.

Single setup machining uses multiple axes to reduce lead times and increase efficiency.

High-speed machining has the potential to revolutionize certain machining operations. By using specialized cutters and higher than conventional cutting speeds and feed rates, dramatically higher metal removal rates can be achieved while reducing heat in the cut as well as reducing cutting pressure.

Flexible manufacturing systems have been introduced; these machining systems can handle varying levels of manufacturing with a quickly changing machining environment. This method of producing goods is readily adaptable to changes in the product being manufactured.

Machinists may use computer-aided design (CAD) and/or computer-aided manufacturing (CAM) software to program CNC machines to cut parts. Stand-alone toolpath verification software can provide a solution for detecting and avoiding tool and machine collisions. It can also verify NC codes.

Tool inventory systems allow for real time inventory status of all tools and instant assignment to particular jobs/tasks. With automation and development of wireless technology, tool management can go directly to the machine and machine operator. It improves security, storage and inventory control.

WORK PRACTICES

Workcells are areas set up within a manufacturing facility. They are part of the Lean Manufacturing Process. They are task focused and logically laid out to optimize resources, improve workflow and quality, and reduce waste.

SAFETY AND ENVIRONMENTAL

Enforcement and penalties for safety violations are becoming more stringent across Canada. These cover mandatory access to inspectors and stop work orders imposed until safety issues are resolved.

More stringent environmental regulations are having an impact on manufacturing processes across Canada.

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: <https://www.canada.ca/en/employment-social-development/programs/essential-skills/profiles.html>.

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 <http://www.red-seal.ca/>.

READING

Machinists require strong reading skills to gather information from forms and labels. They also need to read longer texts such as notes, letters, process sheets, manuals (*Machinery's Handbook*), specifications, regulations, reports, data collection, books and charts.

DOCUMENT USE

Document use is a significant essential skill for this trade. Machinists need to be able to refer to and interpret several types of documents such as inspection reports, work orders, charts, sketches, drawings, set-up sheets and job travellers. They also need to be able to enter information or create these documents.

WRITING

Writing skills are used by machinists to record job procedures, write work-related requests, record tooling lists and setup sheets, and record work instructions and process sheets.

ORAL COMMUNICATION

Some tasks performed by machinists require oral communication skills, including exchanging technical information with co-workers in their trade and other trades, discussing work with supervisors, interacting with clients and instructing less-experienced machinists and apprentices.

NUMERACY

Numeracy skills are very important in the everyday work of machinists. Machinists frequently calculate measurements and dimensions of raw materials and finished products to make sure they match specifications. They must calculate speeds and feeds for the machines that they operate. Layout of workpieces requires strong geometry and trigonometry skills.

THINKING

Machinists must plan, make allowances and corrections, and determine the best sequence of work processes. They use problem solving skills to assess and adjust machining processes according to unforeseen circumstances. Machinists must make decisions and use critical thinking about the materials, processes or tools to use for specific jobs. They may initiate design changes. They may be responsible for scheduling and delegating tasks to apprentices or junior machinists.

WORKING WITH OTHERS

Much of machinists' work may be done independently such as interpreting, planning, producing and repairing parts. Machinists may work with other machinists to carry out new or complex tasks, or work on larger jobs. They may also work with engineering staff and computer programming staff.

DIGITAL TECHNOLOGY

Machinists may use computers and CAD software in their work. They may use computers to access database information, reference electronic manuals and resources, communicate with others or perform Internet research. Certain equipment such as CMM and CNC machines require digital technology skills.

CONTINUOUS LEARNING

Machinists are required to stay abreast of new technologies, products and trends in the machining industry.

Roles and Opportunities for Skilled Trades in a Sustainable Future

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

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

For example:

- Construction tradespeople need to consider the materials they are using, building methods, and improvements to mechanical and electrical installations. There are important changes to codes and standards to help meet the climate change goals and commitments set for 2030 and 2050. Retrofits and new construction of low-energy buildings provide enormous opportunities for workers in this sector. Concepts, such as energy efficiency and regarding buildings as systems are foundational.
- Automotive and mechanical trades are seeing a shift towards the electrification of vehicles and equipment. As a result, new skills and knowledge will be required for tradespeople working in this sector. There are mandates for sales of new light-duty zero-emission vehicles (ZEV) in Canada, with the goal of achieving 100% ZEV sales by 2035. Due to this mandate, the demand for these vehicles is growing quickly among consumers and fleets. With this escalating demand, the need for skilled workers to maintain and repair these vehicles is also increasing.
- In industrial and resource sectors, there is pressure to move towards increased electrification of industrial processes. Many industrial and commercial facilities are also being upgraded to improve energy efficiency in areas such as lighting systems, and new production processes and technologies. There are also opportunities in carbon capture, utilization and storage (CCUS), as well as the production and export of low-carbon hydrogen.
- Trades in the service sector may also need to be aware of responsible sourcing, as well as efficient use of products and materials. New ways of working better are always a part of the job.

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

- The National Energy Code of Canada for Buildings (NECB).
- The Canadian Net-Zero Emissions Accountability Act (CNZEAA).
- programs that encourage sustainable building design and construction such as Leadership in Energy and Environmental Design (LEED) and the Zero Carbon Building (ZCB) standards.

- the Montreal Protocol for phasing out R22 refrigerants.
- energy efficiency programs such as ENERGY STAR.
- principles of the United Nations Declaration for the Rights of Indigenous Peoples pertaining to energy sector development.

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

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

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

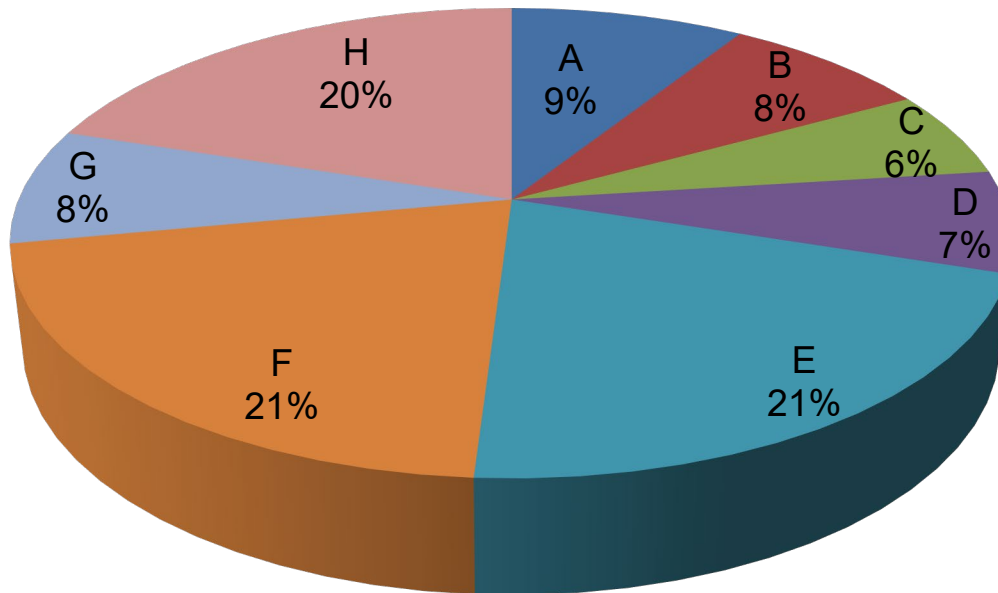
INDUSTRY EXPECTED PERFORMANCE

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

LANGUAGE REQUIREMENTS

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

PIE CHART OF RED SEAL EXAMINATION WEIGHTINGS



MWA A	Performs common occupational skills	9%
MWA B	Performs benchwork	8%
MWA C	Machines using power saws	6%
MWA D	Machines using drill presses	7%
MWA E	Machines using conventional lathes	21%
MWA F	Machines using conventional milling machines	21%
MWA G	Machines using precision grinding machines	8%
MWA H	Machines using computer numerical control (CNC) machines	20%

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

MACHINIST

TASK MATRIX

A – Performs common occupational skills

9%

Task A-1 Performs safety-related tasks 16%	1.01 Maintains safe work environment	1.02 Uses personal protective equipment (PPE) and safety equipment	
Task A-2 Organizes work 25%	2.01 Interprets documentation	2.02 Plans sequence of operations	
Task A-3 Uses communication and mentoring techniques 14%	3.01 Uses communication techniques	3.02 Uses mentoring techniques	
Task A-4 Processes workpiece material 27%	4.01 Selects workpiece material	4.02 Uses hoisting, lifting and rigging equipment	4.03 Marks workpiece for identification
	4.04 Performs heat treatment	4.05 Performs quality control of workpiece	4.06 Deburrs workpiece
	4.07 Sketches parts		

Task A-5
Maintains machines, tooling and inspection equipment
18%

5.01 Cleans machines	5.02 Lubricates machines	5.03 Sharpens tooling
5.04 Applies cutting fluid and coolant	5.05 Troubleshoots equipment	5.06 Maintains machine alignment
5.07 Maintains inspection equipment		

B – Performs benchwork

8%

Task B-6
Performs hand processes
69%

6.01 Performs layout	6.02 Saws workpiece	6.03 Files workpiece
6.04 Performs hole making operations	6.05 Performs threading operations	6.06 Installs thread inserts
6.07 Broaches workpiece	6.08 Performs pressing operations	6.09 Forms workpiece
6.10 Finishes workpiece		

Task B-7 Refurbishes components
31%

7.01 Disassembles components	7.02 Analyzes components	7.03 Assembles components
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C – Machines using power saws

6%

Task C-8 Sets up power saws 63%	8.01 Selects power saw types	8.02 Selects saw blades	8.03 Installs saw blades
	8.04 Selects power saw speeds and feeds	8.05 Makes power saw adjustments	8.06 Sets up workpiece on power saw
Task C-9 Operates power saws 37%	9.01 Saws straight and angle cuts	9.02 Cuts irregular shapes	

D – Machines using drill presses

7%

Task D-10 Sets up drill presses 56%	10.01 Selects drill press types	10.02 Plans operation of drill presses	10.03 Selects drill press speeds and feeds
	10.04 Sets up jigs, fixtures and work holding devices for drill presses	10.05 Sets up tooling for drill presses	
Task D-11 Operates drill presses 44%	11.01 Drills holes using a drill press	11.02 Cuts countersinks, counterbores, chamfers and spot faces using a drill press	11.03 Performs tapping using a drill press
	11.04 Finishes holes using a drill press		

E – Machines using conventional lathes

21%

Task E-12
Sets up conventional lathes
50%

12.01 Selects conventional lathe types	12.02 Plans operation of conventional lathes	12.03 Sets up work holding devices for conventional lathes
12.04 Sets up tooling for conventional lathes	12.05 Sets up conventional lathe accessories	12.06 Sets up workpiece on conventional lathe
12.07 Selects conventional lathe speeds and feeds		

Task E-13
Operates conventional lathes
50%

13.01 Faces surfaces using a conventional lathe	13.02 Turns external surfaces using a conventional lathe	13.03 Drills using a conventional lathe
13.04 Bores holes using a conventional lathe	13.05 Reams holes using a conventional lathe	13.06 Turns tapers using a conventional lathe
13.07 Knurls using a conventional lathe	13.08 Cuts grooves using a conventional lathe	13.09 Cuts threads using a conventional lathe
13.10 Parts off workpiece using a conventional lathe		

F – Machines using conventional milling machines

21%

Task F-14
Sets up conventional milling machines
53%

14.01 Selects conventional milling machine types	14.02 Plans operation of milling machines	14.03 Sets up work holding devices for conventional milling machines
14.04 Sets up tooling for conventional milling machines	14.05 Sets up milling accessories	14.06 Sets up workpiece on a conventional milling machine
14.07 Selects conventional milling machine speeds and feeds		

Task F-15
Operates conventional milling machines
47%

15.01 Mills surfaces using a conventional milling machine	15.02 Mills profiles and pockets using a conventional milling machine	15.03 Mills slots, grooves and keyways using a conventional milling machine
15.04 Cuts gears and splines using a conventional milling machine	15.05 Drills holes using a conventional milling machine	15.06 Reams holes using a conventional milling machine
15.07 Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine	15.08 Performs tapping using a conventional milling machine	15.09 Bores holes using a conventional milling machine

G – Machines using precision grinding machines

8%

Task G-16 Sets up precision grinding machines 59%	16.01 Selects precision grinding machine types	16.02 Plans operation of grinding machines	16.03 Sets up work holding devices for precision grinding machines
	16.04 Mounts grinding wheel	16.05 Sets up grinding accessories	16.06 Sets up workpiece on precision grinding machines
	16.07 Selects precision grinding machine speeds and feeds		
Task G-17 Operates precision grinding machines 41%	17.01 Grinds flat surfaces using a surface grinder	17.02 Grinds profiles	17.03 Grinds internal and external cylindrical and tapered surfaces
	17.04 Grinds tools and cutters	17.05 Finishes holes using a honing machine	

H – Machines using computer numerical control (CNC) machines

20%

Task H-18 Performs CNC programming 43%	18.01 Creates process documentation	18.02 Creates manual input program	18.03 Transfers program to and from control memory
	18.04 Optimizes program	18.05 Creates 2D and 3D models	18.06 Programs using computer-aided manufacturing (CAM)
Task H-19 Sets up CNC machines 31%	19.01 Selects tooling and tool holders for CNC machines	19.02 Sets up tooling and tool holders on CNC machines	19.03 Sets up workpieces on CNC machines
	19.04 Establishes work datum	19.05 Verifies program	
Task H-20 Operates CNC machines 26%	20.01 Adjusts offsets	20.02 Monitors machining processes	20.03 Interrupts program cycle
	20.04 Restarts program cycle		

Harmonization of Apprenticeship Training

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

1. Trade name

The official Red Seal name for this trade is Machinist.

2. Number of Levels of Apprenticeship

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

3. Total Training Hours During Apprenticeship Training

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

4. Sequencing Topics and Related Sub-tasks

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

Level 1	Level 2	Level 3	Level 4
	Organizes Work	Organizes Work	Organizes Work
	Communication and Mentoring	Communication and Mentoring	Communication and Mentoring
	Hand Processes		
			Machine and Tooling Maintenance
		Component Refurbishment	Component Refurbishment
Safety-Related Tasks 1.01 Maintain safe work environment 1.02 Use PPE and safety equipment	Safety-Related Tasks 1.01 Maintain safe work environment	Safety-Related Tasks 1.01 Maintain safe work environment	Safety-Related Tasks 1.01 Maintain safe work environment
Organizes Work 2.01 Interprets documentation 2.02 Plans sequence of operation			
Communication and Mentoring 3.01 Uses communication techniques 3.02 Uses mentoring techniques			

Workpiece Material Processing

- 4.01 Selects workpiece material
- 4.02 Uses hoisting, lifting and rigging equipment
- 4.03 Marks workpiece for identification
- 4.05 Performs quality control of workpiece
- 4.06 Deburrs workpiece
- 4.07 Sketches parts

Workpiece Material Processing

- 4.01 Selects workpiece material
- 4.04 Performs heat treatment
- 4.05 Performs quality control of workpiece
- 4.07 Sketches parts

Workpiece Material Processing

- 4.04 Performs heat treatment
- 4.05 Performs quality control of workpiece

Workpiece Material Processing

- 4.05 Performs quality control of workpiece

Machine and Tooling Maintenance

- 5.01 Cleans machines
- 5.02 Lubricates machines
- 5.03 Sharpens tooling
- 5.04 Applies cutting fluid and coolant
- 5.05 Troubleshoots equipment
- 5.06 Maintains machine alignment
- 5.07 Maintains inspection equipment

Machine and Tooling Maintenance

- 5.01 Cleans machines
- 5.05 Troubleshoots equipment
- 5.06 Maintains machine alignment

Machine and Tooling Maintenance

- 5.03 Sharpens tooling
- 5.05 Troubleshoots equipment

Hand Processes

- 6.01 Performs Layout
- 6.02 Saws workpiece
- 6.03 Files workpiece
- 6.04 Performs hole making operations
- 6.05 Performs threading operations
- 6.06 Installs thread inserts
- 6.07 Broaches workpiece
- 6.08 Performs pressing operations
- 6.09 Forms workpiece
- 6.10 Finishes workpiece

**Components
(Introduction)**

- 7.01 Disassembles components
- 7.02 Analyzes components

Component Refurbishment

- 7.02 Analyzes components
- 7.03 Assembles components

Power Saw Setup

- 8.01 Selects power saw types
- 8.02 Selects saw blades
- 8.03 Installs saw blades
- 8.04 Selects power saw speeds and feeds
- 8.05 Makes power saw adjustments
- 8.06 Sets up workpiece on power saw

Power Saw Operation

- 9.01 Saws straight and angle cuts
- 9.02 Cuts irregular shapes

Drill Press Setup

- 10.01 Selects drill press types
- 10.02 Plans operation of drill presses
- 10.03 Selects drill press speeds and feeds
- 10.04 Sets up jig, fixtures and work holding devices for drill presses
- 10.05 Sets up tooling for drill presses

Drill Press Operation

- 11.01 Drills holes using a drill press
- 11.02 Cuts countersinks, counterbores, chamfers and spot faces using a drill press
- 11.03 Performs tapping using a drill press
- 11.04 Finishes holes using a drill press

Conventional Lathe Setup

- 12.01 Selects conventional lathes types
- 12.02 Plans operation of conventional lathes
- 12.03 Sets up work holding devices for conventional lathes
- 12.04 Sets up tooling for conventional lathes
- 12.05 Sets up conventional lathe accessories
- 12.06 Sets up workpiece on conventional lathe
- 12.07 Selects conventional lathe speeds and feeds

Conventional Lathe Setup

- 12.02 Plans operation of conventional lathes
- 12.03 Sets up work holding devices for conventional lathes
- 12.04 Sets up tooling for conventional lathes
- 12.05 Sets up conventional lathe accessories
- 12.06 Sets up workpiece on conventional lathe

Conventional Lathe Operation

- 13.01 Faces surfaces using a conventional lathe
- 13.02 Turns external surfaces using a conventional lathe
- 13.03 Drills using a conventional lathe
- 13.04 Bores holes using a conventional lathe
- 13.05 Reams holes using a conventional lathe
- 13.06 Turns tapers using a conventional lathe
- 13.07 Knurls using a conventional lathe
- 13.08 Cuts grooves using a conventional lathe
- 13.09 Cuts threads using a conventional lathe
- 13.10 Parts off workpiece using a conventional lathe

Conventional Lathe Operation

- 13.02 Turns external surfaces using a conventional lathe
- 13.04 Bores holes using a conventional lathe
- 13.06 Turns tapers using a conventional lathe
- 13.08 Cuts grooves using a conventional lathe
- 13.09 Cuts threads using a conventional lathe

**Conventional Milling Machine
(Introduction)**

- 14.01 Selects conventional milling machine types**
- 14.04 Sets up tooling for conventional milling machines**

Conventional Milling Machine Setup

- 14.01 Selects conventional milling machine types**
- 14.02 Plans operation of milling machines**
- 14.03 Sets up work holding devices for conventional milling machines**
- 14.04 Sets up tooling for conventional milling machines**
- 14.05 Sets up milling accessories**
- 14.06 Sets up workpiece on a conventional milling machine**
- 14.07 Selects conventional milling machine speeds and feeds**

Conventional Milling Machine Setup

- 14.02 Plans operation of milling machines**
- 14.03 Sets up work holding devices for conventional milling machines**
- 14.04 Sets up tooling for conventional milling machines**
- 14.05 Sets up milling accessories**
- 14.06 Sets up workpiece on a conventional milling machine**
- 14.07 Selects conventional milling machine speeds and feeds**

Conventional Milling Machine Setup

- 14.05 Sets up milling accessories**

Conventional Milling Machine Operation

- 15.01 Mills surfaces using a conventional milling machine**
- 15.02 Mills profiles and pockets using a conventional milling machine**
- 15.03 Mills slots, grooves and keyways using a conventional milling machine**
- 15.04 Cuts gears and splines using a conventional milling machine (Indexing calculations)**
- 15.05 Drills holes using a conventional milling machine**
- 15.06 Reams holes using a conventional milling machine**
- 15.07 Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine**
- 15.08 Performs tapping using a conventional milling machine**
- 15.09 Bores holes using a conventional milling machine**

Conventional Milling Machine Operation

- 15.01 Mills surfaces using a conventional milling machine**
- 15.02 Mills profiles and pockets using a conventional milling machine**
- 15.03 Mills slots, grooves and keyways using a conventional milling machine**
- 15.04 Cuts gears and splines using a conventional milling machine**
- 15.09 Bores holes using a conventional milling machine**

Conventional Milling Machine Operation

- 15.04 Cuts gears and splines using a conventional milling machine**

Precision Grinding Machine Setup

- 16.01 Selects precision grinding machine types**
- 16.02 Plans operation of grinding machines**
- 16.03 Sets up work holding devices for precision grinding machines**
- 16.04 Mounts grinding wheel**
- 16.05 Sets up grinding accessories**
- 16.06 Sets up workpiece on precision grinding machines**
- 16.07 Selects precision grinding machine speeds and feeds**

Precision Grinding Machine Setup

- 16.01 Selects precision grinding machine types**
- 16.02 Plans operation of grinding machines**
- 16.03 Sets up work holding devices for precision grinding machines**
- 16.04 Mounts grinding wheel**
- 16.05 Sets up grinding accessories**
- 16.06 Sets up workpiece on precision grinding machines**
- 16.07 Selects precision grinding machine speeds and feeds**

Precision Grinding Machine Operation
17.01 Grinds flat surfaces using a surface grinder

Precision Grinding Machine Operation
17.02 Grinds profiles
17.03 Grinds internal and external cylindrical and tapered surfaces
17.04 Grinds tools and cutters
17.05 Finishes holes using a honing machine

CNC Programming
18.01 Creates process documentation
18.02 Creates manual Input program
18.03 Transfers program to and from control memory

CNC Programming
18.01 Creates process documentation
18.02 Creates manual Input program
18.04 Optimizes program
18.05 Creates 2D and 3D models
18.06 Programs using CAM

CNC Programming
18.04 Optimizes program
18.05 Creates 2D and 3D models
18.06 Programs using CAM

CNC Machine Setup
19.01 Selects tooling and tool holders for CNC machines
19.02 Sets up tooling and tool holders on CNC machines
19.03 Sets up workpiece on CNC machines
19.04 Establishes work datum
19.05 Verifies program

CNC Machine Setup
19.01 Selects tooling and tool holders for CNC machines
19.02 Sets up tooling and tool holders on CNC machines
19.03 Sets up workpiece on CNC machines
19.04 Establishes work datum

CNC Machine Setup
19.03 Sets up workpiece on CNC machines

CNC Machine Operation
20.01 Adjusts offsets
20.02 Monitors machining processes
20.03 Interrupts program cycle
20.04 Restarts program cycle

CNC Machine Operation
20.01 Adjusts offsets

CNC Machine Operation
20.01 Adjusts offsets

MAJOR WORK ACTIVITY A

Performs common occupational skills

TASK A-1 Performs safety-related tasks

TASK DESCRIPTOR

Machinists encounter various risks and hazards in the workplace environment. Properly using personal protective equipment (PPE), maintaining a safe work environment and following safe work procedures is crucial.

A-1.01 Maintains safe work environment

Essential Skills Document Use, Working with Others, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.01.01P	comply with lock-out and tag-out procedures	lock-out and tag-out procedures are complied with according to regulations and company policies
A-1.01.02P	recognize worksite hazards	worksite hazards are identified according to Occupational Health and Safety (OH&S) regulations and company policies
A-1.01.03P	recognize machine hazards	machine hazards are identified according to OH&S regulations, manufacturers' specifications and company policies
A-1.01.04P	stack and store parts and materials in designated locations and formations	parts and materials are stacked and stored in designated locations and formations according to company policies and OH&S regulations
A-1.01.05P	follow specified safety procedures	specified safety procedures are followed according to company policies and workplace safety and health regulations
A-1.01.06P	maintain a clean and tidy work area	clean and tidy work area is maintained according to company policies and workplace safety and health regulations to avoid injuries to self and others

A-1.01.07P	coordinate tasks with other workers	tasks are coordinated with other workers according to company policies to avoid injuries to self and others
A-1.01.08P	handle hazardous materials	hazardous materials are handled according to Workplace Hazardous Material Information System (WHMIS) procedures and regulations, and company policies
A-1.01.09P	participate in safety meetings and discussions	safety meetings and discussions are participated in according to job requirements

RANGE OF VARIABLES

worksite hazards include: slippery floors, tangled air lines and power cords, hazardous fumes, electrical hazards, dust, inadequate lighting

machine hazards include: hot or irregular chip formation, insecurely mounted workpiece, defective equipment, contaminated coolant, improperly secured accessories

workplace safety and health regulations include: WHMIS, provincial/territorial OH&S

WHMIS procedures include: disposal, labelling, use of PPE, training

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-1.01.01L	demonstrate knowledge of safe work practices	identify workplace hazards and describe safe work practices
A-1.01.02L	demonstrate knowledge of regulatory requirements pertaining to safety	identify and follow workplace safety and health regulations

RANGE OF VARIABLES

workplace hazards include: shop/facility (energy state awareness) (electrical and mechanical), lock-out/tag-out, ventilation/fumes, fire, environment (discharge/spills, material waste)

workplace safety and health regulations include: WHMIS, provincial/territorial OH&S

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

Document Use, Working with Others, Continuous Learning

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

SKILLS**Performance Criteria****Evidence of Attainment**

A-1.02.01P	follow specified safety procedures	specified safety procedures are followed according to OH&S and company policies
A-1.02.02P	handle hazardous materials	hazardous materials are handled according to WHMIS procedures and regulations, and company policies

KNOWLEDGE**Learning Outcomes****Learning Objectives**

A-1.02.01L	demonstrate knowledge of PPE and safety equipment, their applications, maintenance and procedures for use	identify types of PPE and safety equipment and describe their applications
		describe the procedures used to care for and maintain PPE and safety equipment
		identify types of fire extinguishing equipment and describe their applications and procedures for use

TASK A-2 Organizes work

TASK DESCRIPTOR

Machinists must be able to visualize, plan and execute processes based on a range of information and variables in order to complete work efficiently.

A-2.01 Interprets documentation

Essential Skills Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.01.01P	determine information	information is determined according to job requirements
A-2.01.02P	check drawings for information	drawings are checked for information
A-2.01.03P	visualize and analyze finished products	finished products are visualized and analyzed according to drawings
A-2.01.04P	locate information in reference materials	information is located in reference materials
A-2.01.05P	perform mathematical calculations	mathematical calculations are performed to obtain required information

RANGE OF VARIABLES

information includes: line types, projections, dimensions, notes, lay/surface finish symbols, welding symbols, material and processing specifications, machining allowances, standard and geometric dimensioning and tolerancing (GD&T), conflicting information

drawings include: engineering, isometric, orthographic, sketches, 2D and 3D geometry, process

reference materials include: *Machinery's Handbook*, material data sheets, manufacturers' specifications

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.01.01L	demonstrate knowledge of drawings and their applications	define terminology associated with drawings identify types of drawings and sketches and describe their purpose
A-2.01.02L	demonstrate knowledge of interpreting and extracting information from drawing features	interpret and extract information from drawing features

		explain the principles of orthographic projection
A-2.01.03L	demonstrate knowledge of reference materials and their use	identify types of reference materials and their use
A-2.01.04L	demonstrate knowledge of calculations	identify information from reference materials and determine the calculations

RANGE OF VARIABLES

drawings include: engineering, isometric, orthographic, sketches, 2D and 3D geometry, process

information includes: line types, projections, dimensions, notes, lay/surface finish symbols, welding symbols, material and processing specifications, machining allowances, standard and geometric dimensioning and tolerancing (GD&T), conflicting information

drawing features include: nominal size, limits and fits, tolerance, allowance, scale, symmetry, standard and GD&T

reference materials include: *Machinery's Handbook*, material data sheets, manufacturers' specifications

A-2.02 Plans sequence of operations

Essential Skills

Thinking, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.02.01P	determine factors required	factors are determined according to job requirements
A-2.02.02P	analyze material properties	material properties are analyzed to determine holding strategy, rough machining operations, finish machining operations and heat treating processes
A-2.02.03P	recognize limitations of equipment and tooling and recommend which work needs to be sent out for specialized operations	equipment and tooling limitations are recognized and work that needs to be sent out for specialized operations is recommended
A-2.02.04P	visualize process from start to finish	process from start to finish is visualised in order to make provisions for future machining processes
A-2.02.05P	determine order of operation	order of operation is determined according to workpiece, equipment and operations to be performed

RANGE OF VARIABLES

factors include: rough sizes of parts, finish allowances, tolerances required

material properties include: existing material dimensions, composition, material state

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.02.01L	demonstrate knowledge of the procedures used to plan and organize jobs	identify sources of information relevant to job planning
		identify the considerations and requirements for selecting equipment and tooling to complete specified jobs
		determine amount of materials required to complete specified jobs

RANGE OF VARIABLES

sources of information include: work orders/shop orders, technical data, reference materials, drawings, related professionals, clients, quality standards (International Standards Organization)

TASK A-3 Uses communication and mentoring techniques

TASK DESCRIPTOR

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

A-3.01 Uses communication techniques

Essential Skills Oral Communication, Working with Others, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.01.01P	demonstrate communication practices with individuals or in a group	instructions and messages are understood by all parties involved in communication
A-3.01.02P	listen using active listening practices	steps of active listening are utilized
A-3.01.03P	receive and respond to feedback on work	response to feedback indicates understanding and corrective measures are taken
A-3.01.04P	explain and provide feedback	explanation and feedback is provided and task is carried out as directed
A-3.01.05P	use questioning to improve communication	questions are asked to enhance understanding, on-the-job training and goal setting
A-3.01.06P	participate in safety and information meetings	meetings are attended, information is relayed to the workforce, and is understood and applied

RANGE OF VARIABLES

active listening includes: hearing, understanding, reflecting, responding, paraphrasing

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.01.01L	demonstrate knowledge of trade terminology	define terminology used in the trade
A-3.01.02L	demonstrate knowledge of effective communication practices	describe the importance of using effective verbal and non-verbal communication with <i>people in the workplace</i>
		identify <i>sources of information</i> to effectively communicate
		identify communication and <i>learning styles</i>
		describe effective listening and speaking skills
		identify <i>personal responsibilities and attitudes</i> that contribute to on-the-job success
		identify the value of diversity in the workplace
		identify communication that constitutes <i>harassment</i> and <i>discrimination</i>

RANGE OF VARIABLES

people in the workplace include: other tradespeople, colleagues, apprentices, supervisors, clients, authorities having jurisdiction, manufacturers

sources of information include: regulations, codes, OH&S requirements, prints, drawings, specifications, company and client documentation

learning styles include: seeing it, hearing it, trying it

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

harassment includes: objectionable conduct, comment or display made either on a one-time or continuous basis that demeans, belittles, or causes personal humiliation or embarrassment to the recipient

discrimination is prohibited based on: race, national or ethnic origin, colour, religion, age, sex, sexual orientation, marital status, family status, disability or conviction for which a pardon has been granted

A-3.02**Uses mentoring techniques****Essential Skills**

Oral Communication, Working with Others, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.02.01P	identify and communicate learning objective	learning objective is explained and communicated effectively
A-3.02.02P	link lesson to other lessons and the job	lesson order and learning opportunities are identified and applied
A-3.02.03P	demonstrates performance of a skill to an apprentice or learner	steps required to demonstrate a skill are performed
A-3.02.04P	set up conditions required for an apprentice to practice a skill	practice conditions are set up so that the skill can be practiced safely by the apprentice
A-3.02.05P	assess apprentice or learner's ability to perform tasks with increasing independence	performance of apprentice improves with practice to a point where skill can be completed with little supervision
A-3.02.06P	provide supportive and corrective feedback	apprentice adopts best practice after having been provided supportive or corrective feedback
A-3.02.07P	support apprentices in pursuing technical training opportunities	technical training is completed within timeframe prescribed by apprenticeship authority
A-3.02.08P	support equity group apprentices	workplace is harassment and discrimination-free

RANGE OF VARIABLES

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

practice conditions means: guided, limited independence, full independence

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.02.01L	demonstrate knowledge of strategies for learning skills in the workplace	describe the importance of individual experience
		describe the shared responsibilities for workplace learning
		determine one's own learning preferences and explain how these relate to learning new skills

		recognize the importance of different types of skills in the workplace
		describe the importance of essential skills in the workplace
		identify and utilize different learning styles
		identify different learning needs and develop strategies to meet learning needs
		identify strategies to assist in learning a skill
A-3.02.02L	demonstrate knowledge of strategies for teaching workplace skills	identify different roles played by a workplace mentor
		describe teaching skills
		explain the importance of identifying the point of a lesson
		identify how to choose a good time to present a lesson
		explain the importance of linking the lessons
		identify the components of the skill (the context)
		describe considerations in setting up opportunities for skill practice
		explain the importance of providing feedback
		identify techniques for giving effective feedback
		describe a skills assessment
		identify methods of assessing progress
		explain how to adjust a lesson to different situations

RANGE OF VARIABLES

essential skills are: reading, writing, document use, oral communication, numeracy, thinking, working with others, digital technology, continuous learning

learning styles include: seeing it, hearing it, trying it

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

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

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

TASK A-4 Processes workpiece material

TASK DESCRIPTOR

This task describes the workpiece processing tasks performed by a machinist that are common to general machining applications.

A-4.01 Selects workpiece material

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.01.01P	identify type of material used in original part when producing a replacement part	types of material used in original part is identified when producing a replacement part using identification techniques and original specifications
A-4.01.02P	determine size and shape, and identify mechanical properties	size and shape is determined, and mechanical properties are identified according to specifications
A-4.01.03P	identify stock material using identifying characteristics	stock material is identified using identifying characteristics
A-4.01.04P	inspect material for defects	material is inspected for defects

RANGE OF VARIABLES

identification techniques include: hardness testing, spark testing, magnetic testing, examining mechanical properties

mechanical properties include: machinability, tensile strength, wear resistance, hardness

identifying characteristics include: colour coding, surface finish, stamps

defects include: bends, cracks, size deviations, incorrect grain direction

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.01.01L	demonstrate knowledge of materials , their applications and procedures for use	identify types of materials and describe their characteristics and applications
		identify hazards and describe safe work practices pertaining to materials
		describe the properties of materials and their chemical, physical and mechanical characteristics

identify and interpret markings and documentation relating to material **identification systems**

explain the processing characteristics of **materials**

RANGE OF VARIABLES

materials include: ferrous, non-ferrous, specialty alloys, refractory metals, precious metals, non-metallic **identification systems** include: American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI), Society of Automotive Engineers (SAE), colour coding (manufacturer specific), number, Material Test Report (MTR)

A-4.02 Uses hoisting, lifting and rigging equipment

Essential Skills

Thinking, Numeracy, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.02.01P	determine approximate weight of load	approximate weight of load is determined to stay within capacity of available equipment
A-4.02.02P	select hoisting, lifting and rigging equipment	hoisting, lifting and rigging equipment is selected according to lift characteristics
A-4.02.03P	inspect hoisting, lifting and rigging equipment	hoisting, lifting and rigging equipment is inspected to identify defects and expiration dates
A-4.02.04P	determine load's approximate centre of gravity	centre of gravity is approximated using dimensional measurements, verifying documentation and performing a test lift
A-4.02.05P	perform rigging, lifting and hoisting operations	rigging, lifting and hoisting operations are performed by qualified personnel according to regulations and company policies
A-4.02.06P	store equipment	equipment is stored in clean and dry locations according to manufacturers' specifications and company policies

RANGE OF VARIABLES

hoisting equipment includes: mobile cranes, overhead cranes, jib cranes

lifting equipment includes: forklifts, pallet jacks, telescopic booms, hydraulic die table

rigging equipment includes: ropes, slings, chains, hooks, spreader bars, shackles

lift characteristics include: size, shape, orientation, location, sling points, eye bolts, lift weight

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
A-4.02.01L	demonstrate knowledge of hoisting, lifting and rigging equipment , their applications, limitations and procedures for use	define terminology associated with hoisting, lifting and rigging
		identify hazards and describe safe work practices pertaining to hoisting, lifting and rigging
A-4.02.02L	demonstrate knowledge of hoisting, lifting and rigging techniques	identify codes and regulations pertaining to hoisting, lifting and rigging training and certification requirements
		identify types of rigging equipment and describe their applications, limitations and procedures for use
		identify and interpret hand signals used for hoisting and lifting
		identify types of hoisting and lifting equipment and accessories and describe their applications, limitations and procedures for use
		describe the considerations when rigging material/equipment for lifting
		describe the procedures used to inspect, maintain and store hoisting, lifting and rigging equipment

RANGE OF VARIABLES

hoisting equipment includes: mobile cranes, overhead cranes, jib cranes

lifting equipment includes: forklifts, pallet jacks, telescopic booms, hydraulic die table

rigging equipment includes: ropes, slings, chains, hooks, spreader bars, shackles

considerations when rigging material/equipment for lifting include: load characteristics, equipment and accessories, environmental factors, anchor points, sling angles

A-4.03**Marks workpiece for identification****Essential Skills**

Document Use, Thinking, Writing

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

SKILLS**Performance Criteria****Evidence of Attainment**

A-4.03.01P	organize and maintain inventory	inventory is organized and maintained according to shop coding system
A-4.03.02P	mark workpiece with required information	required information is marked according to shop coding system

RANGE OF VARIABLES

required information includes: heat numbers, part numbers, composition, country of origin, trade name, material

KNOWLEDGE**Learning Outcomes****Learning Objectives**

A-4.03.01L	demonstrate knowledge of methods used to mark stock and workpieces	identify methods used to mark stock and workpieces for identification
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A-4.04**Performs heat treatment****Essential Skills**

Reading, Thinking, Document Use

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

SKILLS**Performance Criteria****Evidence of Attainment**

A-4.04.01P	identify heat treatment process	heat treatment process is identified according to workpiece characteristics , operations to be performed and specifications
A-4.04.02P	select and use heat treating equipment and supplies	heat treating equipment and supplies are selected and used according to workpiece characteristics , operations to be performed and specifications

A-4.04.03P	select and use material handling equipment	material handling equipment is selected and used according to workpiece characteristics , operations to be performed and specifications
A-4.04.04P	perform heat treatment process	heat treatment process is performed according to specifications
A-4.04.05P	determine temperature for each heat treatment process	temperature for each heat treatment process is determined according to reference data
A-4.04.06P	interpret tempering colours and temperatures of metals	tempering colours and temperatures of metals are interpreted using reference data

RANGE OF VARIABLES

heat treatment processes include: annealing, normalizing, hardening, tempering, quenching, case hardening

workpiece characteristics include: material, size, shape, weight, metallurgical properties

specifications include: design, standards, client, industry, manufacturers', drawings

heat treating equipment includes: torches, furnace/oven, quenching media, induction heater

material handling equipment includes: tongs, protective gloves, face shield, aprons

reference data includes: *Machinery's Handbook*, steel manufacturers' specifications, ASME, ANSI

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.04.01L	demonstrate knowledge of heat treatment and its applications	define terminology associated with heat treatment
		identify hazards and describe safe work practices pertaining to heat treatment
		identify methods used to determine the carbon content of steels
		identify heat treatment processes and describe their applications
		describe the procedures used to determine properties of metals
		identify and interpret reference data used in heat treatment
		identify methods used for quenching steel and describe the properties of the steel produced by each

RANGE OF VARIABLES

heat treatment processes include: annealing, normalizing, hardening, tempering, quenching, case hardening

properties of metals include: chemical, physical, mechanical

reference data includes: *Machinery's Handbook*, steel manufacturers' specifications, ASME, ANSI

methods used for quenching steel include: water hardening, oil hardening, air hardening

A-4.05 Performs quality control of workpiece

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.05.01P	perform hardness tests	hardness tests are performed according to process standards
A-4.05.02P	perform non-destructive testing	non-destructive testing is performed according to process standards
A-4.05.03P	perform quality inspection	quality inspection is performed to determine conformance to specifications
A-4.05.04P	interpret test results and compare to required tolerances	tests results are interpreted and compared to required tolerances according to specifications

RANGE OF VARIABLES

hardness tests include: abrasion testing, Rockwell, Brinell

non-destructive testing include: dye penetrant tests, magnetic particle tests, ultrasound, acoustic/ringing tests

quality inspection includes: semi-precision and precision dimensional measurements, surface finish

specifications include: design, standards, client, GD&T, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.05.01L	demonstrate knowledge of material testing and its applications and procedures	define terminology associated with material testing
		identify hazards and describe safe work practices pertaining to material testing
		describe the purpose and applications of material testing

		identify types of tests performed on materials and describe their applications
		identify the machines and scales used for hardness testing and describe their associated procedures
A-4.05.02L	demonstrate knowledge of quality inspection and its use	define terminology associated with quality inspection
		describe the procedures used to inspect workpieces
		identify types of precision gauges used in quality inspection and describe their applications and procedures for use
		identify types of precision measuring tools used in quality inspection and describe their applications and procedures for use
		identify types of comparators and describe their applications and procedures for use
A-4.05.03L	demonstrate knowledge of coordinate measuring machines (CMM), their applications and procedures for use	identify types of CMMs and describe their components, applications and procedures for use

RANGE OF VARIABLES

material testing includes: hardness, composition, properties

types of tests include: destructive (tensile strength, impact), non-destructive (x-ray, dye penetrant/liquid penetrant), magnetic particle, spark, file

hardness tests include: abrasion testing, Rockwell, Brinell

quality inspection includes: semi-precision and precision dimensional measurements, surface finish

precision gauges include: fixed, cylindrical, ring, taper, snap, thread

precision measuring tools include: micrometers, calipers, CMM, bevel protractor, sine bar, gauge blocks

types of comparators includes: mechanical, electronic, optical, pneumatic

A-4.06**Deburr workpiece****Essential Skills**

Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.06.01P	identify features to be deburred	features to be deburred are identified
A-4.06.02P	select and use hand and power tools for deburring	hand and power tools for deburring are selected and used according to job requirements
A-4.06.03P	mask surfaces	surfaces are protected from damage through deburring process by masking

RANGE OF VARIABLES

hand and power tools for deburring include: files, die grinders and accessories, abrasive materials

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.06.01L	demonstrate knowledge of deburring, the hand and power tools for deburring and the techniques used	identify features to be deburred
		identify hand and power tools for deburring

RANGE OF VARIABLES

hand and power tools for deburring include: files, die grinders and accessories, abrasive materials

A-4.07**Sketches parts****Essential Skills**

Document Use, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.07.01P	draw basic outline of component features	basic outline of component features are drawn to approximate proportions
A-4.07.02P	verify workpiece dimensions using <i>measuring tools</i>	workpiece dimensions are verified using <i>measuring tools</i>
A-4.07.03P	transfer dimensions to sketch	dimensions are transferred to sketch
A-4.07.04P	attach sketch to documentation and file	sketch is attached to documentation and filed for future reference according to company practices

RANGE OF VARIABLES

measuring tools include: scales, micrometers, calipers, height gauge, optical comparator

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.07.01L	demonstrate knowledge of sketching and its application	identify types of sketches and describe their purpose
		describe basic sketching techniques and types of views
		identify dimensions used in creating sketches
		describe how to interpret and extract information from parts to create a sketch

TASK A-5 Maintains machines, tooling and inspection equipment

TASK DESCRIPTOR

The maintenance of machines, tooling and inspection equipment is very important for their longevity, reliability and safe operation.

A-5.01 Cleans machines

Essential Skills Document Use, Oral Communication, Reading

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.01.01P	refer to manufacturers' documentation	manufacturers' documentation is referred to for machine-specific requirements
A-5.01.02P	identify sensitive components on machinery	sensitive components on machinery are identified according to machine-specific requirements
A-5.01.03P	determine cleaning agents to be used	cleaning agents are used according to machine-specific requirements
A-5.01.04P	select appropriate PPE	appropriate PPE is selected according to WHMIS and OH&S regulations
A-5.01.05P	apply cleaning agents	cleaning agents are applied according to instructions
A-5.01.06P	remove residue	residue is removed as needed
A-5.01.07P	clean or replace filters and screens	filters and screens are cleaned or replaced according to machine-specific requirements
A-5.01.08P	comply with maintenance schedule	maintenance schedule is complied with according to manufacturers' instructions and company policies

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.01.01L	demonstrate knowledge of cleaning agents, their applications, and procedures for use	identify cleaning agents used to clean machines
		describe process to clean machines
		describe the application of cleaning agents

A-5.02 Lubricates machines

Essential Skills Document Use, Reading, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.02.01P	refer to manufacturers' documentation	manufacturers' documentation is referred to for machine-specific requirements
A-5.02.02P	locate components to be lubricated	components to be lubricated are located
A-5.02.03P	identify and select lubricants	lubricants are identified and selected according to machine requirements
A-5.02.04P	apply lubricants	lubricants are applied to specific locations and required levels
A-5.02.05P	dispose of used lubricants	used lubricants are disposed of according to environmental regulations
A-5.02.06P	comply with maintenance schedule	maintenance schedule is complied with according to machine-specific requirements and company policies

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.02.01L	demonstrate knowledge of lubricants, their applications and procedures for use	describe the procedures used to select, apply and maintain lubricants
		describe the procedures used to handle, store and dispose of lubricants

A-5.03**Sharpens tooling****Essential Skills**

Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.03.01P	refer to reference material	reference material is referred to for tool-specific requirements
A-5.03.02P	identify tool geometry	tool geometry is identified according to reference material
A-5.03.03P	dress grinding wheel on pedestal grinder	grinding wheel on pedestal grinder is dressed using dressing tools to restore cutting properties
A-5.03.04P	grind cutting edge of tools using machines	cutting edge of tools is ground to required tool geometry
A-5.03.05P	hone cutting edges	cutting edges are honed to optimize tool performance

RANGE OF VARIABLES

reference material includes: *Machinery's Handbook*, textbooks, manufacturers' specifications

tool geometry includes: thinned web, chip breaker, primary and secondary clearances

dressing tools include: dressing stick (stone), diamond dressing tool, angle/radius dresser

machines include: pedestal grinder, bench grinder

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.03.01L	demonstrate knowledge of tool geometry	identify types of cutting tools and describe their applications describe tool geometry
A-5.03.02L	demonstrate knowledge of safe work practices and procedures related to sharpening tools	identify hazards and describe safe work practices pertaining to sharpening tools

RANGE OF VARIABLES

tool geometry includes: thinned web, chip breaker, primary and secondary clearances

A-5.04**Applies cutting fluid and coolant****Essential Skills**

Document Use, Oral Communication, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.04.01P	check coolant concentration	coolant concentration is checked using refractometer, test strips and other means
A-5.04.02P	mix cutting fluids and coolants	cutting fluids and coolants are mixed according to required ratio
A-5.04.03P	add cutting fluids and coolants to machine reservoirs	cutting fluids and coolants are added to reservoirs to required levels
A-5.04.04P	use cutting fluids and coolants	cutting fluids and coolants are used for cutting and grinding operations
A-5.04.05P	comply with maintenance schedule	compliance with maintenance schedule is ensured according to company policies or manufacturers' specifications

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.04.01L	demonstrate knowledge of cutting fluids and coolants, their applications, and procedures for use	define terminology associated with cutting fluids and coolants
		identify hazards and describe safe work practices pertaining to cutting fluids and coolants
		describe regulations pertaining to the use of cutting fluids and coolants

A-5.05**Troubleshoots equipment****Essential Skills**

Document Use, Continuous Learning, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.05.01P	refer to manufacturers' documentation	manufacturers' documentation is referred to for machine-specific requirements and parameters
A-5.05.02P	visually inspect equipment	equipment is visually inspected for potential problems
A-5.05.03P	identify and isolate problems	problems are identified and isolated as required
A-5.05.04P	comply with lock-out or tag-out procedures	lock-out or tag-out procedures are complied with according to regulations and company policies
A-5.05.05P	take corrective action	corrective action is taken according to machine-specific requirements
A-5.05.06P	verify repairs	repairs are verified by confirming normal operation

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.05.01L	demonstrate knowledge of <i>machines</i> , troubleshooting and procedures for use	identify techniques used to troubleshoot <i>machines</i> identify operating procedures for <i>machines</i>

RANGE OF VARIABLES

machines include: conventional lathes, conventional milling machines, surface grinders, cylindrical grinders, computer numerical control (CNC) machines, drilling machines, electrical discharge machines (EDM)

A-5.06**Maintains machine alignment****Essential Skills**

Document Use, Thinking, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.06.01P	refer to manufacturers' documentation	manufacturers' documentation is referred to for machine-specific requirements
A-5.06.02P	identify required alignments	required alignments are identified according to manufacturers' specifications
A-5.06.03P	identify and select tools and equipment	tools and equipment are identified and selected according to job requirements
A-5.06.04P	adjust machines	machines are adjusted to achieve required alignment

RANGE OF VARIABLES

tools and equipment include: dial indicators, precision levels, squares, test bars

machines include: conventional lathes, conventional milling machines, surface grinders, cylindrical grinders, CNC machines

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.06.01L	demonstrate knowledge of maintenance and alignment of machines	describe the procedures used to adjust and maintain machine alignment

RANGE OF VARIABLES

machines include: conventional lathes, conventional milling machines, surface grinders, cylindrical grinders, CNC machines

A-5.07**Maintains inspection equipment****Essential Skills**

Thinking, Numeracy, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.07.01P	refer to manufacturers' documentation	manufacturers' documentation is referred to for equipment-specific requirements
A-5.07.02P	clean equipment	equipment is cleaned prior to calibration
A-5.07.03P	perform basic calibration of inspection equipment	basic calibration of inspection equipment is performed in temperature-controlled environment to recognized standards
A-5.07.04P	wipe surface plates	surface plates are wiped with required cleaning agents according to manufacturers' specifications
A-5.07.05P	use procedures for care and handling of gauge blocks	procedures for care and handling of gauge blocks are used according to company policies
A-5.07.06P	comply with maintenance schedule	maintenance schedule is complied with according to company policies and manufacturers' specifications

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.07.01L	demonstrate knowledge of precision measuring equipment and its use	describe procedures used to inspect, maintain and store precision measuring equipment
A-5.07.02L	demonstrate knowledge of quality inspection and its use	identify types of precision measuring equipment used in quality inspection and describe their applications and procedures for use

MAJOR WORK ACTIVITY B

Performs benchwork

TASK B-6 Performs hand processes

TASK DESCRIPTOR

Machinists use hand tools and handheld power tools for hand processes, including sawing, drilling, tapping, assembly and disassembly. Benchwork is critical for fully qualified machinists.

B-6.01 Performs layout

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.01.01P	determine shape and requirement of layout	shape and requirement of layout is determined according to specifications
B-6.01.02P	select and use layout tools	layout tools are selected according to workpiece characteristics , operations to be performed and specifications
B-6.01.03P	mark workpiece	workpiece is marked according to specifications
B-6.01.04P	verify layout	layout is verified using measuring and inspection tools
B-6.01.05P	perform permanent layout	permanent markings conform to layout

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

workpiece characteristics include: material, size, shape, weight, metallurgical properties

measuring and inspection tools include: calipers, dividers, steel rules, height gauge

KNOWLEDGE

Learning Outcomes	Learning Objectives
B-6.01.01L demonstrate knowledge of basic layout and its application	define terminology associated with basic layout
	describe the procedures used to read and transfer sizes from a drawing
	calculate layout dimensions and reference points
	describe the procedures used to perform a basic layout
B-6.01.02L demonstrate knowledge of basic layout tools , their applications, maintenance and procedures for use	identify types of basic layout tools and describe their applications and procedures for use
	identify types of layout media/solutions and describe their applications
	describe the procedures used to inspect, maintain and store layout tools and equipment
B-6.01.03L demonstrate knowledge of precision layout and its applications	describe the procedures used to perform a precision layout
B-6.01.04L demonstrate knowledge of precision layout tools , their applications, maintenance and procedures for use	identify precision layout tools and describe their applications and procedures for use
	calculate sine bar values
	calculate angles, arcs and location from reference point
	describe the procedures used to inspect, maintain and store precision layout tools

RANGE OF VARIABLES

basic layout tools include: surface tables, angle plates, scribes, dividers and trammels, hermaphrodite calipers, squares, gauges, rulers, layout dye, surface gauges, prick punches, combination set

precision layout tools include: universal bevel protractor, sine bar, precision height gauge, gauge blocks, surface plate

B-6.02**Saws workpiece****Essential Skills**

Thinking, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.02.01P	select blade and pitch for application	blade and pitch are selected for application according to workpiece characteristics and operations to be performed
B-6.02.02P	install and tension blade in the frame	blade is installed in the frame and tensioned
B-6.02.03P	select work holding device	work holding device is selected according to workpiece characteristics and operations to be performed
B-6.02.04P	set up workpiece in work holding device	workpiece is set up in work holding device to protect material and operator
B-6.02.05P	perform sawing technique	sawing technique is performed to optimize material removal
B-6.02.06P	identify problems	problems are identified
B-6.02.07P	implement solutions	problems are eliminated
B-6.02.08P	verify workpiece	workpiece is verified that it meets specifications by using inspection equipment

RANGE OF VARIABLES

workpiece characteristics include: material, size, shape

work holding devices include: vises, soft jaws, parallel clamps, c-clamps

problems include: dull blade, worn set, broken teeth, incorrect pitch

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: precision square, combination square, steel rule, tape measure, caliper

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.02.01L	demonstrate knowledge of hand saws, their applications, maintenance and procedures for use	define terminology associated with hand saws
		identify types of hand saws and describe their applications

		identify types of sawing operations and describe their associated procedures
		identify types of blades and describe their parameters, applications and installation procedures
		identify potential problems during sawing operations and describe their causes and solutions
B-6.02.02L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to hand saws

B-6.03 Files workpiece

Essential Skills Document Use, Thinking, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.03.01P	select and use filing tools for application	filing tools are selected and used for application according to workpiece characteristics and operations to be performed
B-6.03.02P	select work holding device	work holding device is selected according to workpiece characteristics and operations to be performed
B-6.03.03P	set up workpiece in work holding device	workpiece is set up in work holding device to protect material and operator
B-6.03.04P	perform filing technique	filing technique is performed according to specifications
B-6.03.05P	measure and check feature	feature is measured and checked throughout the process to make adjustments
B-6.03.06P	identify problems	problems are identified
B-6.03.07P	implement solutions	problems are eliminated
B-6.03.08P	remove debris from file	debris from file is removed by using file card, and cutting ability of file is restored
B-6.03.09P	verify workpiece	workpiece is verified that it meets specifications by using inspection equipment

RANGE OF VARIABLES

filing tools include: single cut, double cut, needle files, handle, file card

workpiece characteristics include: material, size, shape

work holding devices include: vise, soft jaws, parallel clamp, c-clamp

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: file pinning, rounded edges, damage to file

inspection equipment includes: precision square, combination square, calipers

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.03.01L	demonstrate knowledge of filing tools , their applications, maintenance and procedures for use	identify types of filing tools and describe their applications and procedures for use
		describe the procedures used to inspect, maintain and store filing tools
B-6.03.02L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to filing tools

RANGE OF VARIABLES

filing tools include: single cut, double cut, needle files, handle, file card

B-6.04 Performs hole making operations

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.04.01P	select prick punch and centre punch	prick punch and centre punch are selected
B-6.04.02P	punch layout	layout is punched to determine drilling position
B-6.04.03P	select handheld tool and centre drill for application	handheld tool and centre drill is selected for application according to hole size
B-6.04.04P	centre drill workpiece	workpiece is centre drilled
B-6.04.05P	select drill for application	drill is selected for application according to workpiece and operations to be performed
B-6.04.06P	drill the workpiece	workpiece is drilled
B-6.04.07P	select countersink for application	countersink is selected for application

B-6.04.08P	countersink workpiece	workpiece hole is countersunk
B-6.04.09P	select reamer for application	reamer is selected for application
B-6.04.10P	ream workpiece	workpiece is reamed
B-6.04.11P	measure and check feature	feature is measured and checked throughout the process to make adjustments
B-6.04.12P	identify problems	problems are identified
B-6.04.13P	implement solutions	problems are eliminated
B-6.04.14P	verify feature	feature is verified that it meets specifications by using inspection equipment

RANGE OF VARIABLES

problems include: drill wandering, oversized holes, damage to cutting tool

inspection equipment includes: precision squares, combination squares, calipers, gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.04.01L	demonstrate knowledge of drilling, reaming and countersink operations	describe the procedures used for spotting and drilling work
		identify types of drills and hand reamers and procedures for use
		describe the procedures used for drilling and reaming work

B-6.05 Performs threading operations

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.05.01P	select taps or dies	taps or dies are selected according to specifications
B-6.05.02P	select tap handle or die stock	tap handle or die stock is selected according to tool, workpiece and operations to be performed
B-6.05.03P	select work holding device	work holding device is selected according to workpiece characteristics and operations to be performed

B-6.05.04P	set up workpiece in work holding device	workpiece is set up in work holding device to protect material and operator
B-6.05.05P	tap or thread workpiece	workpiece is tapped or threaded
B-6.05.06P	measure and check feature	feature is measured and checked throughout the process to make adjustments
B-6.05.07P	identify problems	problems are identified
B-6.05.08P	implement solutions	problems are eliminated
B-6.05.09P	verify feature	feature is verified that it meets specifications by using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

work holding devices include: vise, soft jaws, parallel clamp, c-clamp, three-jaw chuck

workpiece characteristics include: material, size, shape

problems include: damaged threads, broken taps, cross threading, improper axis alignment

inspection equipment includes: plug gauges, ring gauges, sample pieces, square

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.05.01L	demonstrate knowledge of threads and their applications	define terminology associated with threads
		identify types of threads and describe their purpose and applications
		explain thread fit, classifications and series
		identify types of thread inserts and describe their applications and installation procedures
		describe the importance of thread fit and the use of thread gauges
		identify types of thread failures and describe their causes and solutions
		describe the procedures used to produce threads using taps and dies
		identify types of taps and dies and describe their applications and procedures for use
		describe the procedure to extract broken taps
B-6.05.02L	demonstrate knowledge of the procedures used to measure and gauge threads	calculate and select tap drill sizes in metric and imperial

		identify methods used to measure and gauge threads and describe their associated procedures
B-6.05.03L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to threading

B-6.06 Installs thread inserts

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.06.01P	clean hole	hole is cleaned to ensure no contamination
B-6.06.02P	select type of thread insert	type of thread insert is selected according to size, length, application and specifications
B-6.06.03P	select installation tool	installation tool is selected according to insert size and type
B-6.06.04P	select work holding device	work holding device is selected according to workpiece characteristics
B-6.06.05P	set up workpiece in work holding device	workpiece is set up in work holding device to protect material and operator
B-6.06.06P	install thread insert	thread insert is installed to strengthen or repair the thread
B-6.06.07P	verify feature	feature is verified that it meets specifications by using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

work holding devices include: vises, soft jaws, parallel clamps, c-clamps

workpiece characteristics include: material, size, shape

inspection equipment includes: thread gauges, sample pieces

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.06.01L	demonstrate knowledge of thread inserts and their applications	identify types of thread inserts and describe their applications and installation procedures
		explain thread fit, classifications and series
		describe the importance of thread fit and the use of thread gauges
		identify types of thread insert failures and describe their causes and solutions
B-6.06.02L	demonstrate knowledge of the procedures used to measure and gauge threads	calculate and select tap drill sizes in metric and imperial
		identify methods used to measure and gauge threads and describe their associated procedures
B-6.06.03L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to threading

B-6.07 Broaches workpiece

Essential Skills Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.07.01P	select type of broach, bushing and shim	type of broach, bushing and shim is selected according to specifications
B-6.07.02P	perform broaching technique	broaching technique is performed
B-6.07.03P	measure and check feature	feature is measured and checked throughout the process to make adjustments
B-6.07.04P	identify problems	problems are identified
B-6.07.05P	implement solutions	problems are eliminated
B-6.07.06P	verify feature	feature is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: jamming, breaking broach, tapered cuts

inspection equipment includes: sample piece, go/no-go gauges, calipers

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
B-6.07.01L	demonstrate knowledge of broaches and broaching equipment, their applications, set up and procedures for use	define terminology associated with broaches and broaching equipment
		describe the procedures used to set up and operate broaching equipment
		explain the operating principles of broaching equipment
		identify types of broaching equipment and describe their components and applications
		identify types of tooling for broaching equipment and describe their applications
		describe the procedures used to hand broach keyways
B-6.07.02L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to broaches and broaching machines

B-6.08 Performs pressing operations

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS		
	Performance Criteria	Evidence of Attainment
B-6.08.01P	select press	press is selected according to workpiece characteristics and operations to be performed
B-6.08.02P	select work holding device	work holding device is selected according to workpiece characteristics and operations to be performed
B-6.08.03P	set up workpiece in work holding device	workpiece is set up in work holding device to protect material and operator

B-6.08.04P	set work table height on hydraulic press	work table height on hydraulic press is set to accommodate workpiece
B-6.08.05P	identify interference tolerances	interference tolerances for specific application are identified according to specifications
B-6.08.06P	perform pressing techniques	pressing techniques are performed
B-6.08.07P	measure and check feature	feature is measured and checked throughout the process to make adjustments
B-6.08.08P	identify problems	problems are identified
B-6.08.09P	implement solutions	problems are eliminated
B-6.08.10P	verify feature	feature is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

press includes: arbor, hydraulic

workpiece characteristics include: material, size, shape

work holding devices include: V-blocks, table blocks, collars

specifications include: design, standards, client, industry, manufacturers', drawings

pressing techniques include: using expansion/contraction, applying required adhesive or lubricant

problems include: misalignment, galling, insufficient power, seizing, bending, trapped air

inspection equipment includes: precision square, depth gauge, straight edge

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.08.01L	demonstrate knowledge of press equipment, their applications, maintenance and procedures for use	define terminology associated with press equipment
		describe the procedures used to set up and operate press equipment
		explain the operating principles of press equipment
		identify types of press equipment and describe their components and applications
B-6.08.02L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to the use of press equipment

B-6.09**Forms workpiece****Essential Skills**

Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.09.01P	select heating equipment	heating equipment is selected according to workpiece
B-6.09.02P	set up heating equipment	heating equipment is set up
B-6.09.03P	select work holding device	work holding device is selected according to workpiece
B-6.09.04P	set up workpiece in work holding device	workpiece is set up in work holding device to protect material and operator
B-6.09.05P	determine bend allowance	bend allowance is determined
B-6.09.06P	perform heating technique	heating technique is performed if required to make workpiece malleable
B-6.09.07P	perform bending process	bending process is performed according to specifications
B-6.09.08P	measure and check feature	feature is measured and checked throughout the process to make adjustments
B-6.09.09P	identify problems	problems are identified
B-6.09.10P	implement solutions	problems are eliminated
B-6.09.11P	verify feature	feature is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

heating equipment includes: oxy-fuel torches, propane torches, induction heaters

work holding devices include: vise, tongs, anvil

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: excessive and insufficient heat, bending force and speeds

inspection equipment includes: precision squares, combination squares, calipers, protractors, templates, dial indicator

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.09.01L	demonstrate knowledge of heating processes used in machining operations and their applications	define terminology associated with heating processes
		identify heating processes and describe their characteristics and applications
		identify types of heating equipment and describe their applications
		describe the procedures used to inspect and store heating equipment
B-6.09.02L	demonstrate knowledge of bending processes used in machining operations and their applications	define terminology associated with bending processes
		identify bending processes and describe their characteristics and applications
		identify types of bending equipment and describe their applications
B-6.09.03L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to heating and bending processes

RANGE OF VARIABLES

heating equipment includes: oxy-fuel torches, propane torches, induction heaters

bending equipment includes: vises, hammers, presses, mandrels, templates

B-6.10 Finishes workpiece

Essential Skills Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.10.01P	select finishing process	finishing process is selected according to specifications
B-6.10.02P	clean workpiece	workpiece is cleaned
B-6.10.03P	select abrasives	abrasives are selected according to workpiece characteristics and operations to be performed

B-6.10.04P	select work holding device	work holding device is selected according to workpiece characteristics and operations to be performed
B-6.10.05P	set up workpiece in work holding device	workpiece is set up in work holding device to protect material and operator
B-6.10.06P	perform finishing technique	finishing technique is performed to achieve required finish
B-6.10.07P	measure workpiece	workpiece is measured throughout the process to make finish adjustments
B-6.10.08P	identify problems	problems are identified
B-6.10.09P	implement solutions	problems are eliminated
B-6.10.10P	clean workpiece	workpiece is cleaned to remove debris
B-6.10.11P	verify workpiece	workpiece is verified that it meets specifications using inspection equipment
B-6.10.12P	protect finished workpiece	finished workpiece is protected using material

RANGE OF VARIABLES

finishing processes include: lapping, honing, deburring, polishing, scraping, filing, stoning

specifications include: design, standards, client, industry, manufacturers', drawings

abrasives include: hones, stones, lapping compounds, emery papers, fibres

workpiece characteristics include: material, size, shape

work holding devices include: vises, soft jaws, parallel clamps, c-clamps

problems include: scratching, rounded edges, damage to hone, surface finish deficiencies

inspection equipment includes: precision squares, surface finish comparators, profilometers

materials include: rust inhibitors, paper, crating, packing

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.10.01L	demonstrate knowledge of abrasives, their applications and procedures for use	define terminology associated with abrasive finishing identify types of abrasives and describe their characteristics and applications
B-6.10.02L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to abrasives
B-6.10.03L	demonstrate knowledge of abrasive finishing techniques	describe the procedures used to shape or finish a workpiece using abrasive techniques identify types of materials and equipment used to lap and hone workpieces identify lapping and honing techniques and describe their associated procedures

identify types of materials and equipment used to buff and polish workpieces

identify polishing and blending techniques and describe their associated procedures

TASK B-7 Refurbishes components

TASK DESCRIPTOR

Machinists refurbish components by disassembling, analyzing, repairing and reassembling them. Refurbishment is performed to accomplish a mechanical repair rather than replacing items with new ones.

B-7.01 Disassembles components

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.01.01P	read documentation	documentation is read to assess required disassembly
B-7.01.02P	select and use tools	tools are selected and used according to workpiece characteristics and operations to be performed
B-7.01.03P	record disassembly	records of disassembly are kept
B-7.01.04P	mark components	components are marked to aid reassembly
B-7.01.05P	remove necessary components	necessary components are removed according to workpiece characteristics and operations to be performed

RANGE OF VARIABLES

tools include: pullers, hex keys, snap-ring pliers, wrenches, presses

workpiece characteristics include: material, size, shape

records of disassembly include: photos, sketches, notes

components include: bearings, seals, threaded inserts, adapters/bushings, gears and pulleys, fasteners, snap rings, shafts, gears

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-7.01.01L	demonstrate knowledge of the procedures used for refurbishing components	identify types of fits, clearances, tolerances and serviceable limits
		identify types of components and describe their disassembly procedures
		identify types of tools used in refurbishing and describe their procedures for use
		interpret documentation pertaining to refurbishing components
		describe the order of operations used to disassemble components

RANGE OF VARIABLES

components include: bearings, seals, threaded inserts, adapters/bushings, gears and pulleys, fasteners, snap rings, shafts, gears

tools include: pullers, hex keys, snap-ring pliers, wrenches, presses

B-7.02 Analyzes components

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.02.01P	identify components	components are identified
B-7.02.02P	clean components	components are cleaned to remove debris and undesired substances
B-7.02.03P	inspect components	components are visually inspected for defects
B-7.02.04P	measure components	components are measured according to specifications using inspection equipment
B-7.02.05P	analyze and document findings	findings are analyzed and documented according to specifications
B-7.02.06P	determine need for replacement or repair of faulty components	need for repair or replacement of faulty components is determined according to analysis

RANGE OF VARIABLES

components include: bearings, seals, threaded inserts, adapters/bushings, gears and pulleys, fasteners, snap rings, shafts, gears

defects include: breakage, cracks, excessive wear, damaged seals

inspection equipment includes: dial indicators, bore gauges, calipers, micrometers, height gauges

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
B-7.02.01L	demonstrate knowledge of the procedures used to analyze components	describe the procedures used to clean components describe the procedures used to inspect components identify inspection equipment used to inspect components
B-7.02.02L	demonstrate knowledge of calculations required to measure components	calculate and measure component features
B-7.02.03L	demonstrate knowledge of procedures used to prepare documentation	describe the procedures used to prepare documentation

RANGE OF VARIABLES

components include: bearings, seals, threaded inserts, adapters/bushings, gears and pulleys, fasteners, snap rings, shafts, gears

inspection equipment includes: dial indicators, bore gauges, calipers, micrometers, height gauges

B-7.03 Assembles components

Essential Skills Numeracy, Document Use, Thinking

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

SKILLS		
	Performance Criteria	Evidence of Attainment
B-7.03.01P	replace or repair faulty components	faulty components are repaired or replaced
B-7.03.02P	read documentation	documentation is read to assess required assembly
B-7.03.03P	select and use tools	tools are selected and used according to operations to be performed
B-7.03.04P	lay out and verify components	components are laid out and verified before assembly

B-7.03.05P	fit components	components are fitted according to specifications using techniques
B-7.03.06P	measure and check fit	fit is measured and checked throughout the process to make adjustments
B-7.03.07P	identify problems	problems are identified
B-7.03.08P	implement solutions	problems are eliminated
B-7.03.09P	verify repaired assembly	repaired assembly is verified according to specifications

RANGE OF VARIABLES

components include: bearings, seals, threaded inserts, adapters/bushings, gears and pulleys, fasteners, snap rings, shafts, gears

tools include: feeler gauges, wrenches, hex keys, snap-ring pliers, presses, pullers

specifications include: design, standards, client, industry, manufacturers', drawings

techniques include: lapping, honing, scraping, filing

problems include: misalignment, incorrect fits, incorrect torque values

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-7.03.01L	demonstrate knowledge of the procedures used for assembling components	describe the procedures used to repair or replace mechanical components
		identify types of materials used to fit and assemble components and describe their applications and procedures for use
		describe the procedures used to fit and assemble components
		describe the order of operations used to assemble components
		identify tools used to assemble components
B-7.03.02L	demonstrate knowledge of calculations required to measure components	calculate and measure component features

RANGE OF VARIABLES

components include: bearings, seals, threaded inserts, adapters/bushings, gears and pulleys, fasteners, snap rings, shafts, gears

materials include: adhesives, sealants, lubricants

tools include: feeler gauges, wrenches, hex keys, snap-ring pliers, presses, pullers

MAJOR WORK ACTIVITY C

Machines using power saws

TASK C-8 Sets up power saws

TASK DESCRIPTOR

Horizontal and vertical power saws are used to cut material for other machining processes. Vertical countering band saws are used for sawing contours close to a finish size. Typically, workpieces are then finished using other machining operations.

C-8.01 Selects power saw types

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.01.01P	determine machining requirements	machining requirements are determined according to specifications
C-8.01.02P	determine and select power saw	power saw is determined and selected according to workpiece characteristics and operations to be performed

RANGE OF VARIABLES

requirements include: finish, allowances

specifications include: design, standards, client, industry, manufacturers', drawings

power saws include: vertical, horizontal, reciprocating/power hacksaws, cold circular, abrasive, cutoff, contour, friction

workpiece characteristics include: material, size, shape

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.01.01L	demonstrate knowledge of power saws , their applications, maintenance and safe procedures for use	define terminology associated with power saws
		identify types of power saws and attachments and describe their applications
		identify size and capacity of power saw

RANGE OF VARIABLES

power saws include: vertical, horizontal, reciprocating/power hacksaws, cold circular, abrasive, cutoff, contour, friction

attachments include: work stop, rip fence, vertical bandsaw mechanical feed, workpiece support

C-8.02

Selects saw blades

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.02.01P	determine and select saw blade	saw blade is determined and selected according to workpiece characteristics and operations to be performed
C-8.02.02P	check blade pitch and set	blade pitch and set is checked according to job requirements
C-8.02.03P	determine and select saw blade width and gauge	saw blade width and gauge are determined and selected according to cut

RANGE OF VARIABLES

workpiece characteristics include: material, size, shape

job requirements include: material cross-sectional thickness, type of material to be cut

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.02.01L	demonstrate knowledge of saw blades, their applications, maintenance and procedures for use	identify types of blades and describe their parameters, applications and installation procedures
		describe the procedures used to adjust a saw blade

C-8.03

Installs saw blades

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.03.01P	install blade on drive wheel and idler wheel(s)	blade is placed on drive wheel and idler wheel(s) according to specifications
C-8.03.02P	match saw guides to blade width and gauge on vertical and horizontal band saws	saw guides are matched to blade width and gauge on vertical and horizontal band saws to prevent damage to blades and guides and to ensure required cut
C-8.03.03P	adjust blade tension	blade tension is adjusted according to specifications
C-8.03.04P	check blade tracking	blade tracking is checked to avoid damage to the blade and saw
C-8.03.05P	secure blade of power hacksaw	blade of power hacksaw is secured using locating pins
C-8.03.06P	verify cutting direction of blade	cutting direction of blade is verified after installation
C-8.03.07P	weld and grind vertical band saw blades to saw internal contours	vertical band saw blades are welded and ground to saw internal contours
C-8.03.08P	break-in new saw blades to increase blade life	new saw blades are broken-in to increase blade life

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.03.01L	demonstrate knowledge of saw blades, their applications, maintenance and procedures for use	identify types of blades and describe their parameters, applications and installation procedures
		describe the procedures used to butt weld bandsaw blades

C-8.04

Selects power saw speeds and feeds

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.04.01P	calculate speeds	speeds are calculated according to <i>specifications</i>
C-8.04.02P	select speeds and feeds	speeds and feeds are selected according to material to be cut, <i>job requirements</i> and <i>specifications</i>
C-8.04.03P	adjust speeds and feeds	speeds and feeds are adjusted according to <i>job requirements</i>

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

job requirements include: thin wall sections, I-beams, tubing, solids

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-8.04.01L	demonstrate knowledge of power saws, their applications, maintenance and procedures for use	calculate speed and feed requirements
		describe the procedures used to adjust speeds and feeds

C-8.05**Makes power saw adjustments****Essential Skills**

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.05.01P	adjust guide arms	guide arms are adjusted according to workpiece characteristics and specifications
C-8.05.02P	adjust blade guides	blade guides are adjusted to ensure adequate blade support according to specifications
C-8.05.03P	adjust vise pressure	vise pressure is adjusted according to job requirements and specifications to ensure workpiece is secure and not damaged and distorted
C-8.05.04P	adjust table angles	table angles are adjusted according to specifications when using vertical band saw
C-8.05.05P	adjust vertical band saw's fence	vertical band saw's fence is adjusted according to specifications
C-8.05.06P	adjust length stop	length stop is adjusted according to specifications
C-8.05.07P	adjust coolant	coolant is adjusted according to job requirements

RANGE OF VARIABLES**workpiece characteristics** include: material, size, shape**specifications** include: design, standards, client, industry, manufacturers', drawings**KNOWLEDGE**

	Learning Outcomes	Learning Objectives
C-8.05.01L	demonstrate knowledge of power saws, their applications, maintenance and procedures for use	describe the procedures used to adjust power saws
		define terminology associated with power saws

C-8.06**Sets up workpiece on power saw****Essential Skills**

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-8.06.01P	position and secure workpiece on saw table	workpiece is positioned and secured on saw table
C-8.06.02P	verify length and contour to be cut	length and contour to be cut is verified according to specifications
C-8.06.03P	use power saw accessories	power saw accessories are used for securing and guiding workpiece
C-8.06.04P	adjust table angle	table angle is adjusted according to specifications

RANGE OF VARIABLES**specifications** include: design, standards, client, industry, manufacturers', drawings**accessories** include: push block, clamps, guard, air blast, workpiece support, work stop**KNOWLEDGE**

	Learning Outcomes	Learning Objectives
C-8.06.01L	demonstrate knowledge of power saws, their applications, maintenance and procedures for use	describe the procedures used to secure workpiece on power saws
		identify types of power saw accessories
		describe the procedures used to adjust table angle
C-8.06.02L	demonstrate knowledge of use of measuring devices	calculate and measure workpiece to be cut

RANGE OF VARIABLES**accessories** include: push block, clamps, guard, air blast, workpiece support, work stop

TASK C-9 Operates power saws

TASK DESCRIPTOR

Horizontal and vertical power saws are used to cut material for other machining processes. Vertical countering band saws are used for sawing contours close to a finish size. Typically, workpieces are then finished using other machining operations.

C-9.01 Saws straight and angle cuts

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.01.01P	guide workpiece into vertical band saw blade	workpiece is guided into vertical band saw blade using accessories with consistent cutting pressure to protect blade and provide an efficient cut
C-9.01.02P	adjust angle of saw	angle of saw is adjusted according to required angle of cut
C-9.01.03P	square off end of material (reference cut)	end of material (reference cut) is squared off to ensure an accurate measurement
C-9.01.04P	identify problems	problems are identified
C-9.01.05P	implement solutions	problems are eliminated
C-9.01.06P	complete cut from opposite side when blade becomes damaged	cut is completed from opposite side when blade becomes damaged
C-9.01.07P	verify workpiece meets specifications	workpiece is verified that it meets specifications and finish allowances using inspection equipment

RANGE OF VARIABLES

accessories include: push block, clamps, guard, air blast

problems include: incorrect speeds and feeds, binding and overheating blade, wandering

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: protractors, tape measures, squares, calipers, steel rule

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-9.01.01L	demonstrate knowledge of power saws, their applications, maintenance and procedures for use	identify types of sawing operations and describe their associated procedures
		identify potential problems during sawing operations and describe their causes and solutions
		identify types of saws and accessories and describe their applications
C-9.01.02L	demonstrate knowledge of safe work practices and procedures related to the use of power saws and saw blades	identify hazards and describe safe work practices pertaining to power saws and saw blades

RANGE OF VARIABLES

problems include: incorrect speeds and feeds, binding and overheating blade, wandering

accessories include: push block, clamps, guard, air blast

C-9.02 Cuts irregular shapes

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-9.02.01P	guide workpiece into vertical band saw blade	workpiece is guided into vertical band saw blade using accessories with consistent cutting pressure to protect blade and provide an efficient cut
C-9.02.02P	monitor profile of cut	profile of cut is monitored during cutting process
C-9.02.03P	identify problems	problems are identified
C-9.02.04P	implement solutions	problems are eliminated
C-9.02.05P	verify workpiece meets specifications	workpiece is verified according to specifications using inspection equipment

RANGE OF VARIABLES

accessories include: push block, clamps, guard, air blast, coolant pumps, mechanical feed

problems include: incorrect speeds and feeds, binding and overheating blade, incorrect pitch of blade, lack of lubrication

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: templates, radius gauges

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
C-9.02.01L	demonstrate knowledge of power saws , their applications, maintenance and procedures for use	define terminology associated with power saws
		identify the components and accessories of power saws and describe their characteristics and applications
		identify types of blades and describe their characteristics and applications
		calculate speed and feed requirements
		describe the procedures used to inspect and maintain power saws
		identify potential problems and describe their causes and solutions
C-9.02.02L	demonstrate knowledge of safe work practices and procedures related to the use of power saws	identify hazards and describe safe work practices pertaining to power saws

RANGE OF VARIABLES

power saws include: vertical, contour

problems include: incorrect speeds and feeds, binding and overheating blade, incorrect pitch of blade, lack of lubrication

MAJOR WORK ACTIVITY D

Machines using drill presses

TASK D-10 Sets up drill presses

TASK DESCRIPTOR

Machinists use drill presses to drill, ream, bore and tap holes. Drill presses are also used to perform cutting operations such as countersinking, counterboring, chamfering and spot facing. Drill presses are an integral part of a machine shop. Comprehensive drill press skills are essential for fully qualified machinists.

Setting up drill presses is an important task which must be done to maximize quality and efficiency.

D-10.01 Selects drill press types

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-10.01.01P	read documentation	documentation is read to determine operations to be performed
D-10.01.02P	determine type of drill press	type of drill press is determined according to workpiece and operations to be performed

RANGE OF VARIABLES

documentation includes: prints, job traveller

drill presses include: sensitive, upright, radial arm, magnetic base

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-10.01.01L	demonstrate knowledge of drill press tooling and drill presses , their applications, maintenance and procedures for use	define terminology associated with drill press tooling and drill presses
		identify types of drill press tooling and describe their applications
		identify types of drill presses and describe their components and applications

RANGE OF VARIABLES

drill press tooling includes: twist drills, reamers, taps, countersinks, counterbores, hole saws, gun drill

drill presses include: sensitive, upright, radial arm, magnetic base

D-10.02 Plans operation of drill presses

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-10.02.01P	read documentation	documentation is read to assess operations and order of operations is determined
D-10.02.02P	select drill press tooling	drill press tooling is selected according to workpiece characteristics and operations to be performed
D-10.02.03P	determine orientation of workpiece	orientation of workpiece on the table is determined according to operation to be performed
D-10.02.04P	select jigs, fixtures and work holding devices	jigs, fixtures and work holding devices are selected according to workpiece characteristics and operations to be performed
D-10.02.05P	determine sequence of operation	sequence of operation is determined according to specifications

RANGE OF VARIABLES

drill press tooling includes: twist drills, reamers, taps, countersinks, counterbores, hole saws, gun drill
workpiece characteristics include: material, size, shape
work holding devices include: vices (plain, angular, tilt), parallel clamps, c-clamps

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-10.02.01L	demonstrate knowledge of drill press tooling and drill presses , their applications, maintenance and procedures for use	define terminology associated with drill press tooling and drill presses
		describe the procedures used to set up and perform drill press operations

RANGE OF VARIABLES

drill press tooling includes: twist drills, reamers, taps, countersinks, counterbores, hole saws, gun drill
drill presses include: sensitive, upright, radial arm, magnetic base
set up procedures include: alignment, positioning, adjustments
drill press operations include: drilling, counterboring, countersinking, tapping, reaming

D-10.03 Selects drill press speeds and feeds

Essential Skills Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-10.03.01P	determine type of material	type of material is determined according to specifications and material test report (MTR) of material to be drilled
D-10.03.02P	determine surface speed	surface speed is determined according to material type and cutting tool type
D-10.03.03P	determine spindle speed	spindle speed is determined according to diameter of cutter, cutting tool material, workpiece material and surface speed
D-10.03.04P	determine feed rate	feed rate is determined according to cutting tool and surface finish requirements

D-10.03.05P	adjust machine controls	machine controls are adjusted according to calculated settings
D-10.03.06P	readjust machine controls	machine controls are readjusted according to cutting performance

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-10.03.01L	demonstrate knowledge of drill press tooling and drill presses , their applications, maintenance and procedures for use	define terminology associated with drill press tooling and drill presses
		describe the considerations to determine speed, feed and depth of cut for drill press operations

RANGE OF VARIABLES

drill press tooling includes: twist drills, reamers, taps, countersinks, counterbores, hole saws, gun drill

drill presses include: sensitive, upright, radial arm, magnetic base

considerations include: workpiece material, cutting tool material, manufacturers' specifications, formulas

D-10.04 Sets up jigs, fixtures and work holding devices for drill presses

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-10.04.01P	mount, align and secure jigs, fixtures and work holding devices	jigs, fixtures and work holding devices are mounted, aligned and secured
D-10.04.02P	clamp workpiece into jig or fixture	workpiece is clamped into jig or fixture according to operation to be performed
D-10.04.03P	adjust table and column height	table and column height are adjusted to maximize rigidity

RANGE OF VARIABLES

work holding devices include: vices (plain, angular, tilt), parallel clamps, c-clamps

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-10.04.01L	demonstrate knowledge of jigs, fixtures and work holding devices , their applications, maintenance and procedures for use	define terminology associated with jigs, fixtures and work holding devices
		identify jigs, fixtures and work holding devices and describe their applications and procedures for use

RANGE OF VARIABLES

work holding devices include: vices (plain, angular, tilt), parallel clamps, c-clamps

D-10.05 Sets up tooling for drill presses

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-10.05.01P	inspect tooling	tooling is inspected for wear
D-10.05.02P	inspect and clean tooling mounting surfaces	tooling mounting surfaces are clean and free of nicks and burrs
D-10.05.03P	install tool in spindle	tool is installed in spindle securely and true
D-10.05.04P	adjust stop to required tool depth	stop is adjusted to required tool depth according to specifications and operation to be performed
D-10.05.05P	verify drill process by performing first-off inspection	first-off inspection is completed and adjustments are made as necessary

RANGE OF VARIABLES

wear includes: chipped or damaged cutting edges and margins

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-10.05.01L	demonstrate knowledge of drill press tooling and drill presses , their applications, maintenance and procedures for use	define terminology associated with drill press tooling and drill presses
		describe the procedures used to inspect and maintain drill press tooling and drill presses
		describe the procedures used to install tool in spindle

RANGE OF VARIABLES

drill press tooling includes: twist drills, reamers, taps, countersinks, counterbores, hole saws, gun drill
drill presses include: sensitive, upright, radial arm, magnetic base

TASK D-11 Operates drill presses

TASK DESCRIPTOR

Machinists operate drill presses to drill, ream, bore and tap holes. Drill presses are also used for form cutting operations such as countersinking, counterboring, chamfering and spot facing. Drill presses are an integral part of a machine shop. Comprehensive drill press skills are essential for fully qualified machinists to ensure quality and efficiency.

D-11.01 Drills holes using a drill press

Essential Skills Thinking, Document Use, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-11.01.01P	select centre drill	centre drill is selected for application
D-11.01.02P	centre drill the workpiece	workpiece is centre drilled according to workpiece, hole size and operation to be performed
D-11.01.03P	install drill	drill is installed securely
D-11.01.04P	drill hole in workpiece	drill is fed into workpiece to produce hole

D-11.01.05P	measure and check hole	hole is measured and checked throughout the process to make adjustments
D-11.01.06P	identify problems	problems are identified
D-11.01.07P	implement solutions	problems are eliminated
D-11.01.08P	verify feature meets specifications	feature is verified according to specifications using inspection equipment

RANGE OF VARIABLES

problems include: drill wandering, oversized holes, damage to cutting tool, out of specification surface finish

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: telescopic gauges, small hole gauge, calipers, micrometers, limit gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-11.01.01L	demonstrate knowledge of drill press tooling and drill presses , their applications, maintenance and procedures for use	define terminology associated with drill press tooling and drill presses
		identify types of drill press tooling and describe their applications
		identify types of drill presses and describe their components and applications
		identify jigs, fixtures and work holding devices and describe their applications and procedures for use
D-11.01.02L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to drill presses
D-11.01.03L	demonstrate knowledge of measurements pertaining to drilling operations	identify methods of measuring workpiece
D-11.01.04L	demonstrate knowledge of calculations pertaining to drilling operations	identify calculations to verify depth, sizing and positions

RANGE OF VARIABLES

drill press tooling includes: twist drills, reamers, taps, countersinks, counterbores, hole saws, gun drill

drill presses include: sensitive, upright, radial arm, magnetic base

work holding devices include: vices (plain, angular, tilt), parallel clamps, c-clamps

D-11.02**Cuts countersinks, counterbores, chamfers and spot faces using a drill press****Essential Skills**

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-11.02.01P	install required drill press tooling	required drill press tooling is installed according to process
D-11.02.02P	use drill press tooling to produce feature	drill press tooling is fed into workpiece to produce feature
D-11.02.03P	complete operation to required dimensions	operation is completed to dimensions according to specifications
D-11.02.04P	measure and check hole	hole is measured and checked throughout the process to make adjustments
D-11.02.05P	verify feature meets specifications	feature is verified according to specifications using inspection equipment
D-11.02.06P	identify problems	problems are identified
D-11.02.07P	implement solutions	problems are eliminated

RANGE OF VARIABLES

drill press tooling includes: twist drills, reamers, taps, countersinks, counterbores, hole saws, gun drill

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: sample piece, depth micrometer, calipers, pin gauges, optical comparator

problems include: chatter, damage to cutting tool, burring, insufficient depth

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-11.02.01L	demonstrate knowledge of drill press tooling and drill presses , their applications, maintenance and procedures for use	define terminology associated with drill press tooling and drill presses
		identify types of drill press tooling and describe their applications
D-11.02.02L	demonstrate knowledge of measurements pertaining to countersinks, counterbores, chamfers and spot faces	identify methods of measuring workpiece
D-11.02.03L	demonstrate knowledge of calculations pertaining to countersinks, counterbores, chamfers and spot faces	identify calculations required to verify sizing and positions of countersinks, counterbores, chamfers and spot faces

RANGE OF VARIABLES

drill press tooling includes: twist drills, reamers, taps, countersinks, counterbores, hole saws, gun drill

drill presses include: sensitive, upright, radial arm, magnetic base

D-11.03 Performs tapping using a drill press

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-11.03.01P	select taps	taps are selected according to specifications, workpiece characteristics and operations to be performed
D-11.03.02P	select tap drill size	tap drill size is verified to meet specifications
D-11.03.03P	drill workpiece	workpiece is drilled using selected tap drill
D-11.03.04P	set up taps in drill press using tapping tooling	taps are set up in drill press securely
D-11.03.05P	tap hole	hole is tapped and threads are produced
D-11.03.06P	identify problems	problems are identified
D-11.03.07P	implement solutions	problems are eliminated
D-11.03.08P	verify feature meets specifications	feature is verified according to specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

workpiece characteristics include: material, size, shape

tapping tooling includes: centre, drill, tapping heads, collets, chucks, cutting and forming taps, countersinks

problems include: damaged threads, broken taps, cross threading

inspection equipment includes: plug gauges, sample piece, pin gauges, calipers

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-11.03.01L	demonstrate knowledge of drill press tapping tooling , its applications, maintenance and procedures for use	define terminology associated with drill press tapping tooling
		identify types of drill press tapping tooling and describe their applications
		identify thread types and class of fit

RANGE OF VARIABLES

tapping tooling includes: centre, drill, tapping heads, collets, chucks, cutting and forming taps, countersinks

thread types include: metric, unified, Acme, buttress, left-handed, pipe

D-11.04

Finishes holes using a drill press

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-11.04.01P	set up hole finishing tooling	hole finishing tooling is set up according to workpiece characteristics and operation to be performed
D-11.04.02P	measure and check hole	hole is measured and checked throughout the process and adjustments are made
D-11.04.03P	use hole finishing tooling	hole is produced according to specifications
D-11.04.04P	identify problems	problems are identified
D-11.04.05P	implement solutions	problems are eliminated
D-11.04.06P	verify hole meets specifications	hole is verified according to specifications using inspection equipment

RANGE OF VARIABLES

hole finishing tooling includes: drills, reamers, boring bars

workpiece characteristics include: material, size, shape

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: surface finish defects, under/oversized holes, damage to cutting tool

inspection equipment includes: bore gauges, telescopic gauges, calipers, inside micrometers, plug gauges

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
D-11.04.01L	demonstrate knowledge of hole finishing tooling , their applications, maintenance and procedures for use	define terminology associated with hole finishing tooling
		identify types of hole finishing tooling and describe their applications
D-11.04.02L	demonstrate knowledge of measurements pertaining to hole finishing operations	identify methods of measuring workpiece
D-11.04.03L	demonstrate knowledge of calculations pertaining to hole finishing operations	identify calculations required to verify sizing and positions

RANGE OF VARIABLES

hole finishing tooling includes: drills, reamers, boring bars

MAJOR WORK ACTIVITY E

Machines using conventional lathes

TASK E-12 Sets up conventional lathes

TASK DESCRIPTOR

Machinists set up conventional lathes including engine lathes, turret lathes and vertical lathes for operations such as turning, boring and threading. Comprehensive lathe skills are essential for fully qualified machinists.

E-12.01 Selects conventional lathe types

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.01.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-12.01.02P	determine lathe	lathe is determined according to workpiece characteristics and operations to be performed

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

workpiece characteristics include: material, size, shape

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.01.01L	demonstrate knowledge of conventional lathes, their accessories, attachments and applications	define terminology associated with conventional lathes
		identify types of conventional lathes and describe their operating principles and applications

RANGE OF VARIABLES

types of conventional lathes include: engine, turret, vertical turret, vertical boring mill, multispindle

E-12.02 Plans operation of conventional lathes

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.02.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-12.02.02P	determine sequence of operations	sequence of operations is determined according to specifications and company policies
E-12.02.03P	select work holding device	work holding device is selected according to workpiece characteristics and operations
E-12.02.04P	select conventional lathe tools and accessories	conventional lathe tools and accessories are selected according to workpiece characteristics and operations

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

work holding devices include: three-jaw chuck, four-jaw chuck, faceplate, collet chuck, between centers, magnetic chuck

workpiece characteristics include: material, size, shape

conventional lathe tools and accessories include: steady rest, taper attachment, lathe dog, turning tool, centres, follower rest

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.02.01L	demonstrate knowledge of conventional lathes, their maintenance and procedures for use	identify the components and controls of conventional lathes and describe their purpose and operation
		identify types of work holding devices and describe their applications
		identify types of tool holding devices and describe their applications

E-12.02.02L	demonstrate knowledge of conventional lathe tools and accessories , and their applications	identify conventional lathe tools and accessories and describe their applications
		identify the considerations and requirements for selecting conventional lathe tools and accessories for specific operations

RANGE OF VARIABLES

work holding devices include: three-jaw chuck, four-jaw chuck, faceplate, collet chuck, between centers, magnetic chuck

conventional lathe tools and accessories include: steady rest, taper attachment, lathe dog, turning tool, centres, follower rest

E-12.03 Sets up work holding devices for conventional lathes

Essential Skills Oral Communication, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.03.01P	clean and check spindle and work holding device	spindle and work holding device is cleaned and checked for damage and debris
E-12.03.02P	protect bedways	bedways are protected according to company policies
E-12.03.03P	mount work holding device	work holding device is mounted manually or using hoisting and rigging equipment
E-12.03.04P	secure work holding device	work holding device is secured using tools required to set up work holding devices
E-12.03.05P	install and use spindle stops	spindle stops are installed and used when required

RANGE OF VARIABLES

work holding devices include: three-jaw chuck, four-jaw chuck, face plate, collet chuck

hoisting and rigging equipment includes: chain block, crane, lifting eye, sling

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.03.01L	demonstrate knowledge of work holding devices , their maintenance and procedures for use	identify types of work holding devices and describe their applications
		describe the procedures used to set up work holding devices on lathes
		identify tools required to set up work holding devices on lathes
		identify potential setup problems and describe their causes and solutions

RANGE OF VARIABLES

work holding devices include: three-jaw chuck, four-jaw chuck, face plate, collet chuck

tools include: wrenches, keys, hook spanners, chuck wrenches

E-12.04 Sets up tooling for conventional lathes

Essential Skills Oral Communication, Reading, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.04.01P	check for clearance	clearance is checked to ensure safe operation
E-12.04.02P	adjust cutting tool angle	cutting tool angle is adjusted according to workpiece characteristics and operations to be performed
E-12.04.03P	adjust cutting tool to machine centre height	cutting tool is adjusted to machine centre height

RANGE OF VARIABLES

cutting tools include: turning tool, boring bar, threading tool, knurling tool, part-off blade

workpiece characteristics include: material, size, shape

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.04.01L	demonstrate knowledge of cutting tools , their maintenance and procedures for use	identify types of cutting tools and describe their applications
		describe the procedures used to set up cutting tools on lathes
		identify potential setup problems and describe their causes and solutions

RANGE OF VARIABLES

cutting tools include: turning tool, boring bar, threading tool, knurling tool, part-off blade

E-12.05 Sets up conventional lathe accessories

Essential Skills Thinking, Numeracy, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.05.01P	inspect and clean conventional lathe accessories	conventional lathe accessories are inspected for damage and cleaned to ensure accuracy
E-12.05.02P	adjust, position and secure conventional lathe accessories	conventional lathe accessories are adjusted, positioned and secured
E-12.05.03P	identify problems	problems are identified
E-12.05.04P	implement solutions	problems are eliminated

RANGE OF VARIABLES

conventional lathe accessories include: taper attachments, steady rests, follower rests, centres

problems include: misalignment, run-out, insufficient clearance, improper adjustments

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.05.01L	demonstrate knowledge of conventional lathe accessories , their maintenance and procedures for use	identify conventional lathe accessories and describe their applications
		describe the procedures used to set up conventional lathe accessories

describe the procedures used to inspect and clean **conventional lathe accessories**

identify potential setup **problems** and describe their causes and solutions

RANGE OF VARIABLES

conventional lathe accessories include: taper attachments, steady rests, follower rests, centres

problems include: misalignment, run-out, insufficient clearance, improper adjustments

E-12.06 Sets up workpiece on conventional lathe

Essential Skills

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.06.01P	place workpiece in position	workpiece is placed in position
E-12.06.02P	secure workpiece with work holding device	workpiece is secured with work holding device
E-12.06.03P	check and adjust workpiece	workpiece is checked for run-out and distortion using inspection equipment , and is adjusted accordingly
E-12.06.04P	counterbalance setup	setup is balanced if required

RANGE OF VARIABLES

work holding devices include: three-jaw chuck, four-jaw chuck, face plate, collet chuck, centres

inspection equipment includes: dial indicators, micrometers, surface gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.06.01L	demonstrate knowledge of workpiece setup	identify types of work holding devices and describe their applications
		describe the procedures used to set up work holding devices on lathes
		identify types of inspection equipment and describe their use

describe the procedures used to set up eccentrics on conventional lathes

describe the procedures used to ensure parts run true

RANGE OF VARIABLES

work holding devices include: three-jaw chuck, four-jaw chuck, face plate, collet chuck, centres

inspection equipment includes: dial indicators, micrometers, surface gauges

E-12.07 Selects conventional lathe speeds and feeds

Essential Skills

Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-12.07.01P	identify type of material to be turned	type of material to be turned is identified according to specifications
E-12.07.02P	determine surface speed	surface speed is determined according to reference material
E-12.07.03P	calculate spindle speed	spindle speed is calculated according to cutting speed of material and workpiece diameters
E-12.07.04P	determine feed rate	feed rate is determined according to depth of cut and surface finish
E-12.07.05P	adjust machine controls	machine controls are adjusted according to calculated settings
E-12.07.06P	readjust machine controls	machine controls are readjusted according to cutting performance

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

reference materials include: cutting tool manufacturers' specifications, charts, *Machinery's Handbook*

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-12.07.01L	demonstrate knowledge of lathe speeds and feeds	describe the considerations to determine speed, feed and depth of cut
E-12.07.02L	demonstrate knowledge of calculations required to adjust machine controls	identify calculations for speed, feed and depth of cut

TASK E-13 Operates conventional lathes

TASK DESCRIPTOR

Machinists operate conventional lathes including engine lathes, turret lathes and vertical lathes for operations such as turning, boring and threading. Comprehensive lathe skills are essential for fully qualified machinists.

E-13.01 Faces surfaces using a conventional lathe

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.01.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.01.02P	touch off tool on workpiece	tool is touched off on workpiece
E-13.01.03P	cut and measure workpiece	workpiece is cut and measured to establish starting length
E-13.01.04P	rough face workpiece	workpiece is rough faced to remove excess material
E-13.01.05P	measure workpiece throughout the process	workpiece is measured throughout the process to make adjustments
E-13.01.06P	identify problems	problems are identified
E-13.01.07P	implement solutions	problems are eliminated
E-13.01.08P	finish face workpiece	workpiece is finish faced according to specifications
E-13.01.09P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: chatter, tool wear, incorrect tool height setting, chip management

inspection equipment includes: precision square, straight edge, caliper, dial indicator, digital read out

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
E-13.01.01L	demonstrate knowledge of facing operations	describe the considerations to determine speed, feed and depth of cut for conventional lathe operations
		identify cutting fluids and coolants used during conventional lathe operations
		describe the procedures used to set speeds and feeds
		identify hazards and describe safe work practices pertaining to conventional lathes
		identify types of facing tools and describe their applications and procedures for use
		describe the procedures used for facing work on a conventional lathe
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

problems include: chatter, tool wear, incorrect tool height setting, chip management

E-13.02 Turns external surfaces using a conventional lathe

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS		
	Performance Criteria	Evidence of Attainment
E-13.02.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.02.02P	touch off tool on workpiece	tool is touched off on workpiece
E-13.02.03P	perform starting turn and measure workpiece	starting turn is performed and workpiece is measured
E-13.02.04P	rough turn workpiece	workpiece is rough turned to remove excess material

E-13.02.05P	measure workpiece throughout the process	workpiece is measured throughout the process to make adjustments
E-13.02.06P	identify problems	problems are identified
E-13.02.07P	implement solutions	problems are eliminated
E-13.02.08P	finish turn workpiece	workpiece is finish turned according to specifications
E-13.02.09P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: chatter, tool deflection, taper, run-out

inspection equipment includes: micrometers, depth micrometers, dial indicators, calipers, gauges, digital read out

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.02.01L	demonstrate knowledge of turning operations	describe the considerations to determine speed, feed and depth of cut for conventional lathe operations
		identify cutting fluids and coolants used during conventional lathe operations
		describe the procedures used to set speeds and feeds
		identify hazards and describe safe work practices pertaining to conventional lathes
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

problems include: chatter, tool deflection, taper, run-out

E-13.03**Drills using a conventional lathe****Essential Skills**

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.03.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.03.02P	install centre drill	centre drill is installed
E-13.03.03P	centre drill the workpiece	workpiece is centre drilled
E-13.03.04P	install drill for application	drill for application is installed according to specifications
E-13.03.05P	drill workpiece	workpiece is drilled
E-13.03.06P	measure and check hole	hole is measured and checked according to specifications
E-13.03.07P	identify problems	problems are identified
E-13.03.08P	implement solutions	problems are eliminated
E-13.03.09P	verify feature meets specifications	feature is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: drill wandering, oversized holes, misalignment of tail stock/turret, damage to cutting tool, chip management, incorrect drill geometry

inspection equipment includes: pin gauges, go/no-go gauges, calipers, telescopic gauges, small hole gauges, digital read out

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.03.01L	demonstrate knowledge of drilling operations using a conventional lathe	describe the procedures used for centre drilling and drilling on a conventional lathe
		describe the procedures used for installing drills
		identify hazards and describe safe work practices pertaining to conventional lathes
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

problems include: drill wandering, oversized holes, misalignment of tail stock/turret, damage to cutting tool, chip management, incorrect drill geometry

E-13.04 Bores holes using a conventional lathe

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.04.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.04.02P	touch off tool on workpiece	tool is touched off on workpiece
E-13.04.03P	cut and measure workpiece	workpiece is cut and measured to establish starting diameter
E-13.04.04P	rough bore workpiece	workpiece is rough bored to remove excess material
E-13.04.05P	measure workpiece throughout the process	workpiece is measured throughout the process to make adjustments
E-13.04.06P	identify problems	problems are identified
E-13.04.07P	implement solutions	problems are eliminated
E-13.04.08P	finish bore workpiece	workpiece is finish bored according to specifications
E-13.04.09P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: insufficient chip and tool clearance, chatter, tool deflection, taper, run-out

inspection equipment includes: inside micrometers, depth micrometers, dial indicators, bore gauges, calipers, telescoping gauges, digital read out

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.04.01L	demonstrate knowledge of boring operations	describe the considerations to determine speed, feed and depth of cut for conventional lathe operations
		identify cutting fluids and coolants used

	describe the procedures used to set speeds and feeds
	identify hazards and describe safe work practices pertaining to conventional lathes
	identify types of boring tools and describe their applications and procedures for use
	describe the procedures used for boring work on a conventional lathe
	describe the procedures used for counterboring and chamfering work on a conventional lathe
	identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

problems include: insufficient chip and tool clearance, chatter, tool deflection, taper, run-out

E-13.05 Reams holes using a conventional lathe

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.05.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.05.02P	install reamer in tail stock/turret	reamer is installed in tail stock/turret
E-13.05.03P	feed reamer into workpiece	reamer is fed into workpiece to create a finished hole
E-13.05.04P	identify problems	problems are identified
E-13.05.05P	implement solutions	problems are eliminated
E-13.05.06P	verify feature meets specifications	feature is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: chatter, oversized holes, misalignment of tail stock/turret, damage to cutting tool, bell-mouth

inspection equipment includes: go/no-go gauges, bore gauges, telescopic gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.05.01L	demonstrate knowledge of reaming operations	describe the procedures used for reaming work on a conventional lathe
		describe the procedures used for installing reamers
		describe speed and feed for conventional lathe operations
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

problems include: chatter, oversized holes, misalignment of tail stock/turret, damage to cutting tool, bell-mouth

E-13.06 Turns tapers using a conventional lathe

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.06.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.06.02P	set compound rest, taper attachment or tailstock offset	compound rest, taper attachment or tailstock offset are set to achieve required angle
E-13.06.03P	check angle for accuracy	angle is checked for accuracy using inspection equipment
E-13.06.04P	touch off tool on workpiece	tool on workpiece is touched off to establish primary reference point
E-13.06.05P	rough turn or bore workpiece	workpiece is rough turned or bored to remove excess material

E-13.06.06P	measure workpiece throughout the process	workpiece is measured throughout the process to make adjustments using inspection equipment
E-13.06.07P	identify problems	problems are identified
E-13.06.08P	implement solutions	problems are eliminated
E-13.06.09P	finish turn or bore workpiece	workpiece is finish turned or bored according to specifications
E-13.06.10P	verify workpiece meets specifications	workpiece is verified that it meets specifications by using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: taper gauges, dial indicators, micrometers, protractors, parallels and pins, sine bars, digital read out

problems include: insufficient chip and tool clearance, chatter, tool deflection, incorrect taper, run-out

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.06.01L	demonstrate knowledge of tapers, their applications and machining operations	identify types of tapers and describe their applications
		identify types of taper attachments and describe their applications and procedures for use
		identify calculations required for tapers
		identify methods used to check tapers and describe their associated procedures
		identify methods used to turn tapers and describe their associated procedures
		define terminology associated with taper turning
		identify hazards and describe safe work practices pertaining to taper turning
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

types of tapers include: Morse taper, taper pin, pipe thread taper, machine taper, Jacobs taper

taper attachments include: plain, telescopic

methods used to check tapers include: plug gauge, parallels and pins, ring gauge, sine bar, layout lines, dial indicator, Prussian Blue, digital read out

methods used to turn tapers include: taper attachment, tailstock offset, compound rest, form tool

problems include: insufficient chip and tool clearance, chatter, tool deflection, incorrect taper, run-out

E-13.07**Knurls using a conventional lathe****Essential Skills**

Continuous Learning, Thinking, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.07.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.07.02P	select knurling tool	knurling tool is selected according to specifications
E-13.07.03P	engage tool to workpiece	tool is engaged to workpiece by hand feeding cross-slide
E-13.07.04P	feed tool along required length of knurl	tool is fed along required length of knurl
E-13.07.05P	visually inspect workpiece throughout the process	workpiece is visually inspected throughout the process
E-13.07.06P	identify problems	problems are identified
E-13.07.07P	implement solutions	problems are eliminated
E-13.07.08P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: galling, flaking, incorrect form, workpiece deflection, insufficient lubrication, double cutting

inspection equipment includes: sample piece, calipers, microscope

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.07.01L	demonstrate knowledge of knurling operations	describe the considerations to determine speed and feed for knurling operations
		identify cutting fluids and coolants used during conventional lathe operations
		identify hazards and describe safe work practices pertaining to knurling
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

problems include: galling, flaking, incorrect form, workpiece deflection, insufficient lubrication, double cutting

E-13.08 Cuts grooves using a conventional lathe

Essential Skills Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.08.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.08.02P	confirm the centre height and alignment of tool	centre height and alignment of tool is confirmed
E-13.08.03P	touch off tool on workpiece	tool is touched off on workpiece to establish reference point
E-13.08.04P	establish tool location from reference point	tool location from reference point is established
E-13.08.05P	feed tool into workpiece	tool is fed into workpiece
E-13.08.06P	measure and check groove throughout the process	groove is measured and checked throughout the process to make adjustments according to specifications
E-13.08.07P	identify problems	problems are identified
E-13.08.08P	implement solutions	problems are eliminated
E-13.08.09P	finish grooving operation	grooving operation is finished according to specifications
E-13.08.10P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: chattering, galling, tool wandering, tool wear, chip management

inspection equipment includes: gauge blocks, groove micrometers, calipers, radius gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.08.01L	demonstrate knowledge of grooving operations	describe the considerations to determine speed and feed for conventional lathe operations
		identify cutting fluids and coolants used during conventional lathe operations
		describe the procedures used to set speeds and feeds
		identify hazards and describe safe work practices pertaining to conventional lathes
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

problems include: chattering, galling, tool wandering, tool wear, chip management

E-13.09 Cuts threads using a conventional lathe

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.09.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.09.02P	set quick-change gear box	quick-change gear box is set to required thread pitch
E-13.09.03P	calculate and set-up required gear train	gear train is calculated and set to required thread pitch
E-13.09.04P	confirm the centre height and alignment of tool	centre height and alignment of tool is confirmed
E-13.09.05P	touch off tool on workpiece	tool is touched off on workpiece to establish starting diameter
E-13.09.06P	machine test pass	test pass is machined to verify thread pitch
E-13.09.07P	measure thread pitch	thread pitch is measured using inspection equipment
E-13.09.08P	machine workpiece	workpiece is machined according to specifications

E-13.09.09P	deburr threaded workpiece	threaded workpiece is deburred to remove sharp edges
E-13.09.10P	identify problems	problems are identified
E-13.09.11P	implement solutions	problems are eliminated
E-13.09.12P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: thread wires, thread micrometers, thread gauges, sample pieces, outside micrometers, calipers, pitch gauges, centre gauge

problems include: chatter, tool deflection, taper, tool misalignment

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.09.01L	demonstrate knowledge of threading operations	identify methods used to cut threads and describe their associated procedures
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used
		describe the procedures used to set speeds and feeds
		identify methods used to cut multiple start threads and describe their associated procedures
		describe the procedures used to deburr a workpiece
		identify potential problems and describe their causes and solutions
		describe the procedures used to check and measure threads using inspection equipment
		identify types of threads, and describe their purpose, characteristics and applications

RANGE OF VARIABLES

methods used to cut threads include: slotted drive or faceplate, indexing of the spindle gear, use of thread chasing dial, compound rest method

problems include: chatter, tool deflection, taper, tool misalignment

inspection equipment includes: thread wires, thread micrometers, thread gauges, sample pieces, outside micrometers, calipers, pitch gauges, centre gauge

E-13.10**Parts off workpiece using a conventional lathe****Essential Skills**

Numeracy, Document Use, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
E-13.10.01P	determine operations to be performed	operations to be performed are determined according to specifications
E-13.10.02P	confirm the centre height and alignment of tool	centre height and alignment of tool is confirmed
E-13.10.03P	touch off tool on workpiece	tool is touched off on workpiece to establish reference point
E-13.10.04P	establish tool location from reference point	tool location from reference point is established
E-13.10.05P	feed tool into workpiece and retrieve part	tool is fed into workpiece and part is retrieved
E-13.10.06P	identify problems	problems are identified
E-13.10.07P	implement solutions	problems are eliminated
E-13.10.08P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: chattering, galling, tool wandering, chip management, tool misalignment, incorrect tool height

inspection equipment includes: micrometers, straight edges, calipers, precision square

KNOWLEDGE

	Learning Outcomes	Learning Objectives
E-13.10.01L	demonstrate knowledge of parting off operations	describe the considerations to determine speed and feed for conventional lathe operations
		identify cutting fluids and coolants used during conventional lathe operations
		describe the procedures used to set speeds and feeds

identify hazards and describe safe work practices pertaining to conventional lathes

identify potential **problems** and describe their causes and solutions

RANGE OF VARIABLES

problems include: chattering, galling, tool wandering, chip management, tool misalignment, incorrect tool height

MAJOR WORK ACTIVITY F

Machines using conventional milling machines

TASK F-14 Sets up conventional milling machines

TASK DESCRIPTOR

A machinist uses conventional milling machines to make precision parts. Conventional milling machines are used for repair work, prototypes and tool room work.

F-14.01 Selects conventional milling machine types

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-14.01.01P	identify machining requirements	machining requirements are identified according to specifications
F-14.01.02P	select machine type	machine type is selected according to workpiece characteristics

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

workpiece characteristics include: material, size, shape

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-14.01.01L	demonstrate knowledge of conventional milling machine types, parts, accessories, attachments, and applications	define terminology associated with conventional milling machines
		identify types of conventional milling machines and describe their applications

identify the components and controls of **conventional milling machines** and describe their purpose and operation

identify hazards and describe safe work practices pertaining to **conventional milling machines**

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

F-14.02 Plans operation of milling machines

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-14.02.01P	identify milling operations	milling operations are identified according to specifications
F-14.02.02P	determine sequence of milling operations	sequence of milling operations is identified according to specifications
F-14.02.03P	select work holding device	work holding device is selected according to workpiece characteristics and operations to be performed
F-14.02.04P	determine tooling requirements	tooling requirements are determined according to workpiece characteristics and operations to be performed

RANGE OF VARIABLES

milling operations include: contouring, facing, keyways, straddle, gang, t-slot, end milling, slitting, slotting, dovetail, boring, drilling

specifications include: design, standards, client, industry, manufacturers', drawings

work holding devices include: chucks, vises, dividing head, rotary table, fixtures, clamping kits

workpiece characteristics include: material, size, shape

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-14.02.01L	demonstrate knowledge of conventional milling machines and accessories and their applications	identify types of conventional milling machine accessories and attachments and describe their applications
		identify types of tool holding devices and describe their applications
		identify types of work holding devices and describe their applications
		identify types of cutting tools and describe their applications
		identify hazards and describe safe work practices pertaining to conventional milling machines
		identify potential setup problems and describe their causes and solutions
		identify the considerations and requirements for selecting tools and accessories for milling operations
		describe the procedures used to set up conventional milling machines to perform basic milling operations
		describe the procedures used to perform milling operations on conventional milling machines

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

tool holding devices include: drill chuck, collet chuck, end mill holders, side lock holders, shell mill holders, arbors, boring head

work holding devices include: chucks, vises, dividing head, rotary table, fixtures, clamping kits

milling operations include: contouring, facing, keyways, straddle, gang, t-slot, end milling, slitting, slotting, dovetail, boring, drilling

F-14.03**Sets up work holding devices for conventional milling machines****Essential Skills**

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-14.03.01P	inspect and clean table and work holding device and correct deficiencies	table and work holding device are inspected, cleaned and corrected for deficiencies
F-14.03.02P	perform required alignments	required alignments are performed using measuring devices according to specifications
F-14.03.03P	adjust and secure work holding device	work holding device is adjusted and secured using required clamping forces

RANGE OF VARIABLES

work holding devices include: chucks, vises, fixtures, dividing head, rotary table, clamping kits

measuring devices include: dial indicators, squares, gauge blocks, edge finder

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-14.03.01L	demonstrate knowledge of conventional milling machines , their setup and procedures for use	identify hazards and describe safe work practices pertaining to conventional milling machines
		describe the procedures used to align conventional milling machine heads and table
		describe the procedures used to set up conventional milling machines to perform milling operations
		describe the procedures used to align workpieces
F-14.03.02L	demonstrate knowledge of work holding devices , their setup, and applications	identify types of work holding devices
		describe the procedures used to secure and align work holding devices

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

work holding devices include: chucks, vises, fixtures, dividing head, rotary table, clamping kits

F-14.04 Sets up tooling for conventional milling machines

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-14.04.01P	select tooling	tooling is selected according to workpiece characteristics and operations to be performed
F-14.04.02P	inspect tooling	tooling is inspected for wear and cleaned to ensure accuracy
F-14.04.03P	install tooling	tooling is installed and secured by using required tool holding devices

RANGE OF VARIABLES

tooling includes: end mills, shell mills, indexable carbide tooling, boring bars, face mills

workpiece characteristics include: material, size, shape

tool holding devices include: drill chuck, collet chuck, end mill holders, side lock holders, shell mill holders, arbors, boring heads

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-14.04.01L	demonstrate knowledge of conventional milling machines , their setup and procedures for use	describe the procedures used to install tooling and tool holding devices
		identify the considerations and requirements used for selecting tooling and tool holding devices for milling operations

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

tool holding devices include: drill chuck, collet chuck, end mill holders, side lock holders, shell mill holders, arbors, boring heads

F-14.05 Sets up milling accessories

Essential Skills

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-14.05.01P	select accessories	accessories are selected according to workpiece characteristics and operations to be performed
F-14.05.02P	clean and inspect accessories for wear	accessories are cleaned and inspected for wear to ensure accuracy
F-14.05.03P	align accessories	accessories are aligned using inspection equipment
F-14.05.04P	install and secure accessories	accessories are installed and secured using appropriate clamping methods

RANGE OF VARIABLES

accessories include: dividing head, rotary table, angle plates, parallels, edge finder

workpiece characteristics include: material, size, shape

inspection equipment includes: dial indicators, squares, gauge blocks

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-14.05.01L	demonstrate knowledge of conventional milling machines and their setup	identify the considerations and requirements used for selecting accessories for milling operations
		identify types of rotary tables and describe their construction, applications and procedures for use
		identify types of dividing heads and describe their characteristics and applications

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

accessories include: dividing head, rotary table, angle plates, parallels, edge finder

milling operations include: contouring, facing, keyways, straddle, gang, t-slot, end milling, slitting, slotting, dovetail, boring, drilling

F-14.06 Sets up workpiece on a conventional milling machine

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-14.06.01P	prepare workpiece	workpiece is prepared by eliminating burrs and debris
F-14.06.02P	install and secure workpiece in work holding device or directly on conventional milling machine table	workpiece is installed and secured in work holding device or directly on conventional milling machine table
F-14.06.03P	check alignment of workpiece	workpiece is checked for alignment using inspection equipment
F-14.06.04P	establish workpiece datum	workpiece datum is established using inspection equipment

RANGE OF VARIABLES

work holding devices include: chucks, vises, indexing heads, rotary tables, fixtures, clamp kits

inspection equipment includes: dial indicators, squares, gauge blocks, edge finder

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-14.06.01L	demonstrate knowledge of conventional milling machines and their setup	identify the considerations and requirements used for setting up a workpiece
		describe the procedures used to set up a workpiece
		describe the procedures used to align a workpiece
		describe the procedures used to establish workpiece datums

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

F-14.07 Selects conventional milling machine speeds and feeds

Essential Skills

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-14.07.01P	determine type of material to be cut	type of material to be cut is determined according to specifications
F-14.07.02P	determine surface speed	surface speed is determined according to reference material
F-14.07.03P	calculate spindle speed (rpm)	spindle speed (rpm) is calculated according to diameter of cutter and surface speed
F-14.07.04P	calculate feed rate	feed rate is calculated using rpm, number of cutter teeth and chip load per tooth according to reference material
F-14.07.05P	adjust machine controls	machine controls are adjusted according to calculated settings
F-14.07.06P	readjust machine controls based on cutting performance	machine controls are readjusted based on cutting performance

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

reference material includes: cutting tool manufacturers' specifications, charts, *Machinery's Handbook*

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-14.07.01L	demonstrate knowledge of conventional milling machines and their setup	describe the considerations used to determine speed, feed and depth of cut for milling machine operations
		interpret tables and charts of speeds and feeds
		calculate speed, feed and depth of cut

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

TASK F-15 Operates conventional milling machines

TASK DESCRIPTOR

A machinist uses conventional milling machines to make precision parts. Conventional milling machines are used for repair work, prototypes and tool room work.

F-15.01 Mills surfaces using a conventional milling machine

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-15.01.01P	measure workpiece	workpiece is measured to determine amount of excess material using measuring devices
F-15.01.02P	touch off milling cutter to workpiece surface	workpiece surface is touched off by milling cutter to establish a reference point
F-15.01.03P	remove excess material	excess material is removed to meet specifications
F-15.01.04P	identify problems	problems are identified
F-15.01.05P	implement solutions	problems are eliminated
F-15.01.06P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

measuring devices include: dial indicators, squares, gauge blocks, edge finder

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: incorrect speeds and feeds, wrong depth of cut, incorrect cutter geometry, tool wear, lack of lubrication, improper work holding device, tool deflection, backlash

inspection equipment includes: dial indicators, squares, gauge blocks, calipers, micrometers, depth micrometers, height gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.01.01L	demonstrate knowledge of conventional milling machines , their setup and procedures for use	describe the procedures used to perform milling operations
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used
		describe the procedures used to set speeds and feeds
		identify calculations required to determine amount of excess material
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

milling operations include: facing, straddle, gang

problems include: incorrect speeds and feeds, wrong depth of cut, incorrect cutter geometry, tool wear, lack of lubrication, improper work holding device, tool deflection, backlash

F-15.02 Mills profiles and pockets using a conventional milling machine

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-15.02.01P	measure workpiece	workpiece is measured to determine amount of excess material using inspection equipment
F-15.02.02P	touch off milling cutter to workpiece surface	workpiece surface is touched off by milling cutter to establish a reference point
F-15.02.03P	rough out workpiece	workpiece is roughed out to remove excess material
F-15.02.04P	measure roughed out workpiece	roughed out workpiece is measured to make finish adjustments
F-15.02.05P	identify problems	problems are identified
F-15.02.06P	implement solutions	problems are eliminated

F-15.02.07P	finish workpiece	workpiece is finished according to specifications
F-15.02.08P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

inspection equipment include: dial indicators, squares, gauge blocks, calipers, micrometers, depth micrometers, height gauges, profile gauges

problems include: incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient coolant, chip evacuation, deflection, backlash

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.02.01L	demonstrate knowledge of conventional milling machines , their setup and procedures for use	describe the procedures used to perform milling operations
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used
		describe the procedures used to set speeds and feeds
		identify calculations required to determine amount of excess material
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

conventional milling machines include: vertical, horizontal/universal, ram and turret, horizontal boring mill, jig borer

milling operations include: contouring, pocketing, plunging

problems include: incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient coolant, chip evacuation, deflection, backlash

F-15.03**Mills slots, grooves and keyways using a conventional milling machine****Essential Skills**

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-15.03.01P	measure workpiece	workpiece is measured to determine amount of excess material using inspection equipment
F-15.03.02P	locate datum surface	datum surface is located using inspection equipment
F-15.03.03P	touch off milling cutter to workpiece surface	workpiece surface is touched off by milling cutter to establish a reference point
F-15.03.04P	rough out workpiece	workpiece is roughed out by removing excess material
F-15.03.05P	measure roughed out workpiece	roughed out workpiece is measured to make final adjustments using inspection equipment
F-15.03.06P	identify problems	problems are identified
F-15.03.07P	implement solutions	problems are eliminated
F-15.03.08P	finish workpiece	workpiece is finished according to specifications
F-15.03.09P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

inspection equipment includes: dial indicators, squares, gauge blocks, edge finder

problems include: incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient coolant, chip evacuation, backlash

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.03.01L	demonstrate knowledge of milling machines, their setup and procedures for use	describe the procedures used to perform milling operations
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used

	describe the procedures used to set speeds and feeds
	identify calculations required to determine amount of excess material
	identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

milling operations include: keyways, gang, t-slot, slitting, slotting, dovetail

problems include: incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient coolant, chip evacuation, backlash

F-15.04 Cuts gears and splines using a conventional milling machine

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-15.04.01P	measure workpiece	workpiece is measured to determine amount of excess material using inspection equipment
F-15.04.02P	determine gear and spline dimensions and select form cutter	gear and spline dimensions are determined by performing calculations and form cutter is selected according to reference material
F-15.04.03P	calculate indexing requirements	indexing requirements are calculated according to number of teeth or splines to be cut
F-15.04.04P	locate datum surface	datum surface is located using inspection equipment
F-15.04.05P	touch off milling cutter to workpiece surface	workpiece surface is touched off by milling cutter to establish a reference point
F-15.04.06P	rough out workpiece	workpiece is roughed out using form cutter
F-15.04.07P	measure roughed out workpiece	roughed out workpiece is measured to make final adjustments using inspection equipment
F-15.04.08P	identify problems	problems are identified
F-15.04.09P	implement solutions	problems are eliminated

F-15.04.10P	finish workpiece	workpiece is finished according to specifications
F-15.04.11P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

inspection equipment includes: dial indicators, squares, gauge blocks, gear-tooth caliper, calipers, wires/pins, micrometers

reference material includes: *Machinery's Handbook*, machine documentation, American Gear Manufacturers Association (AGMA)

problems include: incorrect speeds and feeds, incorrect depth of cut, improper cutter geometry, tool wear, lack of lubrication, chip evacuation, backlash

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.04.01L	demonstrate knowledge of milling machines, their setup and procedures for use	describe the procedures used to perform milling operations
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used
		describe the procedures used to set speeds and feeds
		identify calculations required to determine amount of excess material
		identify potential problems and describe their causes and solutions
F-15.04.02L	demonstrate knowledge of gears and splines	identify tooling required for cutting gears and splines
		identify machines and accessories used for cutting gears and splines
		define terminology associated with gears and splines
		identify hazards and describe safe work practices pertaining to gears and splines
		explain the principles of gears and splines, and describe their purpose and operation
		identify types of gears and splines, and describe their characteristics and applications

F-15.04.03L	demonstrate knowledge of gear measurement	identify procedures to measure gear tooth and splines
		identify calculations required to determine gear and spline cutting requirements
		identify calculations required to determine ratios for simple and compound gear trains

RANGE OF VARIABLES

milling operations include: slitting, slotting, form cutting, single point, straddle milling

problems include: incorrect speeds and feeds, incorrect depth of cut, improper cutter geometry, tool wear, lack of lubrication, chip evacuation, backlash

tooling includes: involute cutter, tapered end mill, form tool

accessories include: dividing head, rotary table, footstock, arbor

F-15.05 Drills holes using a conventional milling machine

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-15.05.01P	determine reference point	reference point is determined using tooling
F-15.05.02P	determine tooling	tooling is determined by assessing hole requirements
F-15.05.03P	center-drill (spot-drill) workpiece	workpiece is center-drilled (spot-drilled) according to specifications
F-15.05.04P	touch off drill to workpiece surface	workpiece surface is touched off by drill to establish a reference point
F-15.05.05P	pre-drill workpiece if required	workpiece is pre-drilled according to size to be drilled and specifications
F-15.05.06P	identify problems	problems are identified
F-15.05.07P	implement solutions	problems are eliminated

F-15.05.08P	complete operation	operation is completed according to specifications
F-15.05.09P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

tooling includes: centre drills, spot drills, drills, edge finders

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: incorrect speeds and feeds, wrong depth of cut, incorrect cutter geometry, tool wear, lack of cutting fluid, chip evacuation

inspection equipment includes: micrometers, calipers, telescopic gauges, hole gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.05.01L	demonstrate knowledge of milling machines, their setup and procedures for use	describe the procedures used to perform drilling operations
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used
		describe the procedures used to set speeds and feeds
		identify potential problems and describe their causes and solutions
		identify tooling required for drilling holes
		identify accessories used for drilling holes

RANGE OF VARIABLES

problems include: incorrect speeds and feeds, wrong depth of cut, incorrect cutter geometry, tool wear, lack of cutting fluid, chip evacuation

tooling includes: centre drills, spot drills, drills, edge finders

accessories include: dividing head, rotary table, angle plates, parallels

F-15.06**Reams holes using a conventional milling machine****Essential Skills**

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-15.06.01P	verify existing hole size	existing hole size is verified according to reaming allowance and reference materials
F-15.06.02P	adjust speeds and feeds	speeds and feeds are adjusted according to reference materials
F-15.06.03P	touch off reamer to workpiece surface	reamer is touched off to workpiece to establish a reference point
F-15.06.04P	perform reaming operations	reaming operations are performed
F-15.06.05P	identify problems	problems are identified
F-15.06.06P	implement solutions	problems are eliminated
F-15.06.07P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

reference materials include: *Machinery's Handbook*, manufacturers' specifications

problems include: incorrect speeds and feeds, incorrect cutter geometry, tool wear, insufficient cutting fluid, chip evacuation

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: dial indicators, calipers, telescopic gauges, hole gauges, micrometers

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.06.01L	demonstrate knowledge of milling machines, their setup and procedures for use	describe the procedures used to perform reaming operations
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used
		describe the procedures used to set speeds and feeds
		identify reaming allowance
		identify potential problems and describe their causes and solutions

identify **tooling** required for reaming

identify process to measure reamed hole

RANGE OF VARIABLES

problems include: incorrect speeds and feeds, incorrect cutter geometry, tool wear, insufficient cutting fluid, chip evacuation

tooling includes: tapered reamer, rose reamer, straight reamer, expansion reamer

F-15.07 Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine

Essential Skills

Document Use, Numeracy, Thinking

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

SKILLS

Performance Criteria

Evidence of Attainment

F-15.07.01P	determine tooling	tooling is determined according to specifications, workpiece characteristics and operations to be performed
F-15.07.02P	touch off tool to workpiece surface	tool is touched off to workpiece to establish a reference point
F-15.07.03P	drill workpiece, if required	workpiece is drilled to size according to specifications , if required
F-15.07.04P	identify problems	problems are identified
F-15.07.05P	implement solutions	problems are eliminated
F-15.07.06P	complete operation	operation is completed according to specifications
F-15.07.07P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

tooling includes: countersinks, counterbores, chamfering tool, spot faces, drills

specifications include: design, standards, client, industry, manufacturers', drawings

workpiece characteristics include: material, size, shape

problems include: chatter, vibration, incorrect depth, incorrect cutter geometry, tool wear, insufficient cutting fluid, chip evacuation

inspection equipment includes: calipers, telescopic gauges, hole gauges, micrometers, depth micrometers, protractors

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.07.01L	demonstrate knowledge of milling machines, their setup and procedures for use	describe the procedures used to perform milling operations
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used
		describe the procedures used to set speeds and feeds
		identify potential problems and describe their causes and solutions
		identify tooling required for milling operations
		identify accessories used for milling operations
		identify process to assess size of features according to specifications

RANGE OF VARIABLES

milling operations include: countersinking, counterboring, chamfering, spot facing

problems include: chatter, vibration, incorrect depth, incorrect cutter geometry, tool wear, insufficient cutting fluid, chip evacuation

tooling includes: countersinks, counterbores, chamfering tool, spot faces, drills

accessories include: dividing head, rotary table, angle plates, parallels, vises

specifications include: design, standards, client, industry, manufacturers', drawings

F-15.08 Performs tapping using a conventional milling machine

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-15.08.01P	determine tooling	tooling is determined according to specifications
F-15.08.02P	drill workpiece, if required	workpiece is drilled to size according to specifications , if required
F-15.08.03P	touch off tool to workpiece surface	tool is touched off to workpiece to establish a reference point

F-15.08.04P	perform tapping operation	tapping operation is performed
F-15.08.05P	identify problems	problems are identified
F-15.08.06P	implement solutions	problems are eliminated
F-15.08.07P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

tooling includes: centre drills, tap drills, taps, tapping heads, collets, chucks

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: incorrect speeds and feeds, incorrect tap geometry, incorrect tap drill size, cross-threading, tool wear, incorrect or insufficient cutting fluid, chip evacuation

inspection equipment includes: thread gauges, calipers, go/no-go gauges, pitch gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.08.01L	demonstrate knowledge of milling machines, their setup and procedures for use	describe the procedures used to perform tapping operations
		identify potential problems and describe their causes and solutions
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used
		describe the procedures used to set speeds and feeds
		identify tooling required for tapping
		identify accessories used for tapping
		identify thread classifications and inspection equipment

RANGE OF VARIABLES

problems include: incorrect speeds and feeds, incorrect tap geometry, incorrect tap drill size, cross-threading, tool wear, incorrect or insufficient cutting fluid, chip evacuation

tooling includes: centre drills, tap drills, taps, tapping heads, collets, chucks

accessories include: angle plates, parallels, tap wrench, guide centre

inspection equipment includes: thread gauges, calipers, go/no-go gauges, pitch gauges

F-15.09**Bores holes using a conventional milling machine****Essential Skills**

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
F-15.09.01P	determine tooling	tooling is determined according to specifications
F-15.09.02P	drill workpiece, if required	workpiece is drilled to size according to specifications , if required
F-15.09.03P	measure hole size throughout operation	hole is measured throughout operation using inspection equipment
F-15.09.04P	touch off tool to workpiece surface	tool is touched off to workpiece to establish a reference point
F-15.09.05P	perform boring operation	boring operation is performed according to specifications
F-15.09.06P	identify problems	problems are identified
F-15.09.07P	implement solutions	problems are eliminated
F-15.09.08P	complete operation	operation is completed according to specifications
F-15.09.09P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

tooling includes: centre drills, drills, boring heads, indexable tooling, boring bar

specifications include: design, standards, client, industry, manufacturers', drawings

inspection equipment includes: telescopic gauges, inside micrometers, bore gauges, calipers, surface finish comparators

problems include: incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, lack of lubrication, chip evacuation

KNOWLEDGE

	Learning Outcomes	Learning Objectives
F-15.09.01L	demonstrate knowledge of milling machines, their setup and procedures for use	describe the procedures used to perform boring operations
		describe the considerations to determine speed and feed
		identify cutting fluids and coolants used

	describe the procedures used to set speeds and feeds
	identify tooling required to bore holes
	identify problems and solutions
	identify inspection equipment and procedures for use

RANGE OF VARIABLES

tooling includes: centre drills, drills, boring heads, indexable tooling, boring bar

problems include: incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, lack of lubrication, chip evacuation

inspection equipment includes: telescopic gauges, inside micrometers, bore gauges, calipers, surface finish comparators

MAJOR WORK ACTIVITY G

Machines using precision grinding machines

TASK G-16 Sets up precision grinding machines

TASK DESCRIPTOR

Machinists select, plan and set up precision grinding machines and their accessories to achieve requirements such as tight tolerances and high quality surface finishes.

G-16.01 Selects precision grinding machine types

Essential Skills Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-16.01.01P	determine machining requirements	machining requirements are determined according to workpiece characteristics and operations to be performed
G-16.01.02P	determine grinder required	grinder required is selected according to workpiece characteristics and operations to be performed

RANGE OF VARIABLES

workpiece characteristics include: material, size, shape

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-16.01.01L	demonstrate knowledge of grinding machines and accessories , their applications, and procedures for use	define terminology associated with grinding machines
		identify types of grinding machines and accessories and describe their applications

interpret documentation pertaining to the material to be ground

describe grinding operations to be performed

RANGE OF VARIABLES

grinding machines and accessories include: surface, cylindrical, centreless, tool and cutter, dressing stone, coolant systems, angle/radius dresser, wheel dressers, conditioning stone

G-16.02 Plans operation of grinding machines

Essential Skills

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-16.02.01P	identify grinding procedures	grinding procedures are identified according to workpiece characteristics and operations to be performed
G-16.02.02P	establish order of procedures	order of procedures is established according to workpiece characteristics and operations to be performed
G-16.02.03P	determine work holding devices	work holding devices are determined according to workpiece characteristics and operations to be performed
G-16.02.04P	determine type and dimensions of material to be ground	type and dimensions of material to be ground are determined according to specifications
G-16.02.05P	determine types, size and grades of grinding wheel	types, size and grades of grinding wheel are determined according to workpiece characteristics and operations to be performed
G-16.02.06P	select honing stones	honing stones are selected according to specifications
G-16.02.07P	determine workpiece setup procedure for surface grinder	workpiece setup procedure for surface grinder is determined according to specifications
G-16.02.08P	determine workpiece setup procedure for cylindrical grinder	workpiece setup procedure for cylindrical grinder is determined according to specifications

G-16.02.09P	determine workpiece setup procedure for tool and cutter grinder	workpiece setup procedure for tool and cutter grinder is determined according to specifications
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RANGE OF VARIABLES

grinding procedures include: surface grinding, cylindrical grinding, tool and cutter grinding

workpiece characteristics include: material, size, shape

work holding devices include: face plate, fixtures, magnetic chucks, chucks

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-16.02.01L	demonstrate knowledge of grinding machines, their applications, and procedures for use	define terminology associated with grinding machines
		identify types of grinding machines and accessories and describe their applications
		interpret documentation pertaining to the material to be ground
		identify types of work holding devices and describe their applications and maintenance
		identify sequence of grinding operations

RANGE OF VARIABLES

grinding machines and accessories include: surface, cylindrical, centreless, tool and cutter, dressing stone, coolant systems

work holding devices include: face plate, fixtures, magnetic chucks, chucks

G-16.03**Sets up work holding devices for precision grinding machines****Essential Skills**

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-16.03.01P	position work holding devices	work holding devices are positioned to accommodate workpiece and operation
G-16.03.02P	align workpiece and work holding devices	workpiece and work holding devices are aligned according to specifications
G-16.03.03P	secure work holding devices	work holding devices are secured

RANGE OF VARIABLES

work holding devices include: chucks, face plate, fixtures, magnetic chucks, angle plates, precision vises

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-16.03.01L	demonstrate knowledge of grinding machines, their applications, and procedures for use	describe the procedures used to set up grinding machines and accessories
		identify types of work holding devices and describe their applications and maintenance
		describe the procedures used to align a workpiece and work holding devices
		identify potential setup problems and describe their causes and solutions

RANGE OF VARIABLES

grinding machines and accessories include: surface, cylindrical, centreless, tool and cutter, dressing stone, coolant systems

work holding devices include: chucks, face plate, fixtures, magnetic chucks, angle plates, precision vises

G-16.04 Mounts grinding wheel

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-16.04.01P	inspect and ring test grinding wheel	grinding wheel is inspected and ring tested for defects
G-16.04.02P	secure wheel on adapters	wheel is secured on adapters using blotters and flanges
G-16.04.03P	balance grinding wheel	grinding wheel is balanced using wheel balancing equipment
G-16.04.04P	install balanced wheel assembly on machine	balanced wheel assembly is installed on machine according to specifications
G-16.04.05P	true and dress mounted grinding wheel	mounted grinding wheel is trued and dressed using dressing tools
G-16.04.06P	assess further balancing requirements and adjust, if required	further balancing requirements are assessed and required adjustments are made

RANGE OF VARIABLES

defects include: cracks, stains, gouges

wheel balancing equipment includes: mandrels, weights

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-16.04.01L	demonstrate knowledge of grinding machines, their applications, and procedures for use	describe the procedures used to set up and mount wheels on grinding machines
		identify types of wheel dressers and describe their applications
		describe the procedures used to true and dress grinding wheels
		describe procedures used to balance grinding wheels
		describe the procedures used to inspect, maintain and store grinding wheels

G-16.05 Sets up grinding accessories

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-16.05.01P	select accessories	accessories are selected according to specifications, workpiece characteristics and operations to be performed
G-16.05.02P	inspect accessories	accessories are inspected for damage and defects
G-16.05.03P	clean and check accessories and mounting surface	accessories and mounting surface are cleaned and checked to ensure accuracy
G-16.05.04P	position, fasten and adjust accessories	accessories are positioned, fastened and adjusted to accommodate workpiece, machine and specifications

RANGE OF VARIABLES

accessories include: angle plate, collets, steady rest, chucks, drive dogs, mandrels
specifications include: design, standards, client, industry, manufacturers', drawings
workpiece characteristics include: material, size, shape

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-16.05.01L	demonstrate knowledge of grinding accessories, their applications, and procedures for use	identify types of accessories used for grinding operations and describe their applications
		describe the procedures used to set up grinding machines and accessories
		describe the procedures used to inspect and maintain grinding machine accessories

RANGE OF VARIABLES

accessories include: angle plate, collets, steady rest, chucks, drive dogs, mandrels
grinding machines and accessories include: surface, cylindrical, centreless, tool and cutter, dressing stone, coolant systems

G-16.06**Sets up workpiece on precision grinding machines****Essential Skills**

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-16.06.01P	prepare workpiece and mounting surfaces	workpiece and mounting surfaces are prepared by eliminating burrs and debris
G-16.06.02P	secure workpiece on surface grinder	workpiece is secured on surface grinder using surface grinder accessories
G-16.06.03P	secure workpiece on cylindrical grinder	workpiece is secured on cylindrical grinder using cylindrical grinder accessories
G-16.06.04P	secure workpiece on tool and cutter grinder	workpiece is secured on tool and cutter grinder using tool and cutter grinder accessories
G-16.06.05P	check alignment of workpiece before grinding	alignment of workpiece is checked before grinding using inspection equipment to ensure accuracy
G-16.06.06P	shim workpiece, if required	workpiece is shimmed to eliminate stressing of the material, if required

RANGE OF VARIABLES**surface grinder accessories** include: magnetic chuck, vise, fixture**cylindrical grinder accessories** include: magnetic chuck, chucks, centres with drive dogs**tool and cutter grinder accessories** include: centres, universal vise, collets**inspection equipment** includes: dial indicator, taper gauge, gauge blocks, precision squares**KNOWLEDGE**

	Learning Outcomes	Learning Objectives
G-16.06.01L	demonstrate knowledge of grinding machines, their applications, and procedures for use	describe the procedures used to set up workpieces on grinders using accessories
		describe the procedures used to check alignment of workpieces

G-16.07 Selects precision grinding machine speeds and feeds

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-16.07.01P	identify type of material	type of material is identified according to specifications
G-16.07.02P	determine and calculate precision grinding machine speeds	precision grinding machine speeds are determined and calculated according to factors
G-16.07.03P	adjust feed control	feed control is adjusted to required rate
G-16.07.04P	readjust machine controls	machine controls are readjusted according to cutting performance

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

factors include: wheel size, part diameter, material

feed control includes: hydraulic, servo-drive controls

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-16.07.01L	demonstrate knowledge of precision grinding machines, their applications, and procedures for use	describe the factors used to determine feed and depth of cut for grinding operations
		describe the calculations used to determine speed

RANGE OF VARIABLES

factors include: wheel size, part diameter, material

TASK G-17 Operates precision grinding machines

TASK DESCRIPTOR

Machinists operate precision grinding machines to achieve tight tolerances and high quality surface finishes.

G-17.01 Grinds flat surfaces using a surface grinder

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-17.01.01P	touch off grinding wheel on workpiece surface	grinding wheel is touched off on workpiece surface to establish a reference point
G-17.01.02P	measure workpiece	workpiece is measured using inspection equipment to determine amount of excess material
G-17.01.03P	remove excess material	excess material is removed according to specifications
G-17.01.04P	identify problems	problems are identified
G-17.01.05P	implement solutions	problems are eliminated
G-17.01.06P	verify flat surface meets specifications	flat surface is verified to meet specifications using inspection equipment

RANGE OF VARIABLES

inspection equipment includes: micrometers, gauge blocks, dial indicators, profilometers, surface finish comparators, depth micrometers

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: incorrect speeds and feeds, incorrect depth of cut, wheel glazing or loading, incorrect consistency of coolant

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-17.01.01L	demonstrate knowledge of surface grinders, their setup, maintenance and procedures for use	describe the procedures used to adjust and maintain surface grinding machines
		describe the procedures used to perform surface grinding operations
		identify potential problems and describe their causes and solutions
G-17.01.02L	demonstrate knowledge of safety practices and procedures related to surface grinding	identify hazards and describe safe work practices pertaining to surface grinding

RANGE OF VARIABLES

problems include: incorrect speeds and feeds, incorrect depth of cut, wheel glazing or loading, incorrect consistency of coolant

G-17.02

Grinds profiles

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-17.02.01P	dress grinding wheel	grinding wheel is dressed to desired profile using tools
G-17.02.02P	touch off grinding wheel on workpiece surface	grinding wheel is touched off on workpiece surface to establish a reference point
G-17.02.03P	measure workpiece	workpiece is measured to determine amount of excess material using inspection equipment
G-17.02.04P	rough out workpiece profile	workpiece profile is roughed out to remove excess material leaving a finish grinding allowance
G-17.02.05P	re-dress wheel	wheel is re-dressed to desired profile using tools

G-17.02.06P	finish grind	grind is finished according to specifications
G-17.02.07P	verify profile meets specifications	profile is verified according to specifications using inspection equipment

RANGE OF VARIABLES

tools include: radius dressing attachment, dressing stick (stone), diamond dressing tool

inspection equipment includes: depth micrometers, contour and profile gauge, dial indicators, surface finish comparators

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-17.02.01L	demonstrate knowledge of grinders, their setup, maintenance and procedures for use	describe the procedures used to calculate the amount of excess material
		describe the procedures used to grind profiles
		identify techniques used to troubleshoot profile grinding operations and describe their associated procedures
G-17.02.02L	demonstrate knowledge of grinding wheels, their applications, maintenance and procedures for use	identify types of grinding wheels and describe their characteristics and applications
		identify types of wheel dressers and describe their applications
		describe the procedures used to true and dress grinding wheels
		identify the considerations and requirements for selecting a grinding wheel for profile grinding

RANGE OF VARIABLES

considerations and requirements for selecting a grinding wheel include: operations, abrasive, grain, grade, structure, bond

G-17.03**Grinds internal and external cylindrical and tapered surfaces****Essential Skills**

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-17.03.01P	dress grinding wheel	grinding wheel is dressed using tools
G-17.03.02P	adjust table	table is adjusted according to required orientation
G-17.03.03P	touch off grinding wheel on workpiece surface	grinding wheel is touched off on workpiece surface to establish a reference point
G-17.03.04P	measure workpiece	workpiece is measured to determine amount of excess material using inspection equipment
G-17.03.05P	rough out workpiece	workpiece is roughed out to remove excess material leaving a finish grinding allowance
G-17.03.06P	re-dress wheel	wheel is re-dressed using tools
G-17.03.07P	finish grind	grind is finished according to specifications
G-17.03.08P	re-measure workpiece	workpiece is re-measured to confirm specifications are met using inspection equipment

RANGE OF VARIABLES

tools include: dressing stick (stone), diamond dressing tool

orientation includes: taper, parallelism

inspection equipment includes: micrometers, sine bars, dial indicators, bore gauges, surface finish comparators, taper gauges, Prussian blue

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-17.03.01L	demonstrate knowledge of cylindrical grinders, their setup, maintenance and procedures for use	describe the procedures used to align workpieces
		describe the procedures used to perform calculations to determine amount of excess material

		describe the procedures used to perform cylindrical grinding operations
		describe the procedures used to calculate feed and depth of cut
		identify techniques used to troubleshoot cylindrical grinding operations and describe their associated procedures
		describe the procedures used to inspect and maintain cylindrical grinding machines
G-17.03.02L	demonstrate knowledge of safety practices and procedures related to cylindrical grinding	identify hazards and describe safe work practices pertaining to cylindrical grinding
G-17.03.03L	demonstrate knowledge of cylindrical grinding wheels, their applications, maintenance and procedures for use	identify types of cylindrical grinding wheels and describe their characteristics and applications
		identify types of wheel dressers and describe their applications
		describe the procedures used to true and dress grinding wheels
		identify the considerations and requirements for selecting a grinding wheel for cylindrical grinding
		describe the procedures used to mount and balance cylindrical grinding wheels
		describe the procedures used to inspect, maintain and store cylindrical grinding wheels

RANGE OF VARIABLES

considerations and requirements for selecting a grinding wheel include: operations, abrasive, grain, grade, structure, bond

G-17.04**Grinds tools and cutters****Essential Skills**

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-17.04.01P	dress grinding wheel	grinding wheel is dressed using tools
G-17.04.02P	mount cutting tools	cutting tools are mounted according to operations
G-17.04.03P	set cutting tool rest	cutting tool rest is set to establish required relief angle and clearance according to specifications
G-17.04.04P	touch off grinding wheel on workpiece surface	grinding wheel is touched off on workpiece surface to establish a reference point
G-17.04.05P	grind cutting edge of tools	cutting edge of tools are ground to establish required tool geometry

RANGE OF VARIABLES**tools** include: dressing stick (stone), diamond dressing tool**cutting tools** include: end mills, reamers, form relief cutters**specifications** include: design, standards, client, industry, manufacturers', drawings**KNOWLEDGE**

	Learning Outcomes	Learning Objectives
G-17.04.01L	demonstrate knowledge of tool and cutter grinders, their setup, maintenance and procedures for use	describe the procedures used to set up tool and cutter grinders and accessories
		identify types of cutting tools and describe their applications
		describe the procedures used to align cutting tools
G-17.04.02L	demonstrate knowledge of tool and cutter grinding wheels, their applications, maintenance and procedures for use	identify types of tool and cutter grinding wheels and describe their characteristics and applications
		identify types of wheel dressers and describe their applications
		describe the procedures used to true and dress grinding wheels

identify the **considerations and requirements for selecting a grinding wheel** for tool and cutter grinding

describe the procedures used to mount and balance tool and cutter grinding wheels

describe the procedures used to inspect, maintain and store tool and cutter grinding wheels

RANGE OF VARIABLES

cutting tools include: end mills, reamers, form relief cutters

considerations and requirements for selecting a grinding wheel include: operations, abrasive, grain, grade, structure, bond

G-17.05 Finishes holes using a honing machine

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
G-17.05.01P	identify type of material to be honed	type of material to be honed is identified according to specifications
G-17.05.02P	monitor stone pressure	stone pressure is monitored to eliminate distortion and optimize material removal
G-17.05.03P	match stroke to rpm	stroke is matched to rpm to achieve finish according to specifications
G-17.05.04P	identify problems	problems are identified
G-17.05.05P	implement solutions	problems are eliminated
G-17.05.06P	check dimension of holes	dimension of holes is checked according to specifications using inspection equipment

RANGE OF VARIABLES

material includes: steel, cast iron, bronze

specifications include: design, standards, client, industry, manufacturers', drawings

problems include: bell mouth, lack of cylindricity, chatter, lack of lubrication, glazing

inspection equipment includes: bore gauges, inside micrometers, telescopic gauge

KNOWLEDGE

	Learning Outcomes	Learning Objectives
G-17.05.01L	demonstrates knowledge of <i>honing machines</i> , their setup, maintenance and procedures for use	identify types of <i>honing machines</i> , their setup and maintenance
		identify types of tooling required for honing
		identify honing techniques and describe their associated procedures
		identify potential <i>problems</i> and describe their causes and solutions

RANGE OF VARIABLES

honing machines include: horizontal, vertical, CNC

problems include: bell mouth, lack of cylindricity, chatter, lack of lubrication, glazing

MAJOR WORK ACTIVITY H

Machines using computer numerical control (CNC) machines

TASK H-18 Performs CNC programming

TASK DESCRIPTOR

Fully qualified machinists use CNC machines for machining that would be difficult or time-consuming on conventional machining equipment. Programming this equipment requires knowledge of conventional machining methods as well as CNC programming skills and an understanding of machine controls.

H-18.01 Creates process documentation

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-18.01.01P	interpret workpiece documentation	workpiece documentation is interpreted
H-18.01.02P	identify information required for CNC machining	information required for CNC machining is identified

RANGE OF VARIABLES

documentation includes: drawings, computer-aided design (CAD) files, machine manuals

information includes: part origin and orientation, location and type of work holding devices, tool list

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-18.01.01L	demonstrate knowledge of CNC machines, their setup, maintenance and procedures for use	define terminology associated with CNC machines
		identify CNC control units and describe their purpose
		interpret documentation pertaining to the machining of workpieces

RANGE OF VARIABLES

documentation includes: drawings, computer-aided design (CAD) files, machine manuals

H-18.02 Creates manual input program

Essential Skills Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-18.02.01P	determine types of cutting tools	types of cutting tools to be used in machining operation are determined
H-18.02.02P	calculate program points	program points are calculated using trigonometry and Cartesian Coordinate System
H-18.02.03P	establish safety blocks of code	safety blocks of code are established in order to cancel previous code and initialize machine at a start point
H-18.02.04P	plan entry and exit moves	entry and exit moves are planned to avoid collisions
H-18.02.05P	use programming codes	programming codes are used to manually produce program
H-18.02.06P	compensate for tool nose radius and cutter radius	tool nose radius and cutter radius are compensated for
H-18.02.07P	interpret and review codes from program	codes from program are interpreted and reviewed

RANGE OF VARIABLES

programming codes include : G-codes, M-codes, coordinates

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-18.02.01L	demonstrate knowledge of CNC programming	identify types of programming codes and describe their applications
		define the differences between centerline programming and cutter radius compensation (CRC) programming
		identify reference points and their location

describe the procedures used to calculate speed, feed and depth of cuts

identify potential setup problems and describe their causes and solutions

identify the hazards and describe safe work practices pertaining to CNC machines

RANGE OF VARIABLES

programming codes include : G-codes, M-codes, coordinates

H-18.03 Transfers program to and from control memory

Essential Skills Reading, Continuous Learning, Writing

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

SKILLS

Performance Criteria

Evidence of Attainment

H-18.03.01P	use <i>edit functions</i>	<i>edit functions</i> are used according to specifications
H-18.03.02P	transfer program	program is transferred to and from CNC machine and computer, network or storage device

RANGE OF VARIABLES

edit functions include: insert, alter, delete, copy, paste, export

KNOWLEDGE

Learning Outcomes

Learning Objectives

H-18.03.01L	demonstrate knowledge of transferring CNC programs	identify types of <i>edit functions</i> used and describe their applications
		describe the procedures used to transfer programs to and from the CNC machine and computer, network or storage device

RANGE OF VARIABLES

edit functions include: insert, alter, delete, copy, paste, export

H-18.04 Optimizes program

Essential Skills Thinking, Numeracy, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-18.04.01P	adjust speed and feed overrides	speed and feed overrides are adjusted to ensure peak program efficiency and surface finish quality
H-18.04.02P	record changes to speed and feed overrides	changes to speed and feed overrides are recorded
H-18.04.03P	modify cutting and tool paths	cutting and tool paths are modified to ensure most efficient removal of material
H-18.04.04P	save optimized program on storage media	optimized program is saved on storage media for future reference

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-18.04.01L	demonstrate knowledge of CNC programming	identify types of programming codes and describe their applications
		describe the procedures used to perform CNC programming

RANGE OF VARIABLES

programming codes include : G-codes, M-codes

H-18.05 Creates 2D and 3D models

Essential Skills Numeracy, Digital Technology, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-18.05.01P	identify datum	datum is identified to obtain reference point for machining
H-18.05.02P	create geometry	geometry is created using lines, arcs, points and CAD tools according to specifications

RANGE OF VARIABLES**geometry** includes: lines, arcs, points, surfaces, solids**specifications** include: design, standards, client, industry, manufacturers', drawings**KNOWLEDGE**

	Learning Outcomes	Learning Objectives
H-18.05.01L	demonstrate knowledge of geometry creation	describe process to create geometry using CAD software
		identify dimensioning tools in CAD software

RANGE OF VARIABLES**geometry** includes: lines, arcs, points, surfaces, solids

H-18.06 Programs using computer-aided manufacturing (CAM)

Essential Skills Digital Technology, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-18.06.01P	import geometry	geometry is imported to proper location and orientation
H-18.06.02P	plan sequence of operations	sequence of operations is planned according to machining practices
H-18.06.03P	select tooling	tooling is selected for the operation
H-18.06.04P	select machining operations	machining operations are selected according to planned sequence
H-18.06.05P	generate tool paths	tool paths are generated using software
H-18.06.06P	generate program	program is generated
H-18.06.07P	review program	program is reviewed to ensure that required code is generated

RANGE OF VARIABLES

geometry includes: lines, arcs, points, surfaces, solids

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-18.06.01L	demonstrate knowledge of CAM software	identify cutting tools in CAM software library
		define types of CAM operations and tool paths
		identify machine post processors in CAM software
		identify the hazards and describe safe work practices pertaining to CNC machines

TASK H-19 Sets up CNC machines

TASK DESCRIPTOR

Fully qualified machinists use CNC machines for machining that would be difficult or time-consuming on conventional machining equipment. Setting up this equipment requires knowledge of conventional machining methods as well as CNC programming skills and an understanding of machine controls.

H-19.01 Selects tooling and tool holders for CNC machines

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-19.01.01P	read documentation for information	documentation is read for information
H-19.01.02P	determine if tool and tool holder will allow for clearance	clearance for tool and tool holder is determined
H-19.01.03P	assess tooling properties	tooling properties are assessed according to operation to be performed
H-19.01.04P	match tool holder taper and pull-stud to machining centre	tool holder taper and pull-stud are matched to machining centre
H-19.01.05P	match tool shank sizes to turning centres	tool shank sizes are matched to turning centres in order to ensure accurate centre height

RANGE OF VARIABLES

documentation includes: setup sheet, tooling list, drawings

information includes: tooling offsets, tooling required, tool holders

tooling properties include: rigidity, reach, composition, size, shape

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-19.01.01L	demonstrate knowledge of CNC machines and tooling, their accessories, attachments and applications	define terminology associated with CNC machines and tooling
		identify types of CNC machines and tooling, and describe their characteristics and applications
		identify types of accessories and tool changers used with CNC machines and describe their applications

identify types of tool holders and work holding devices used with CNC machines and describe their applications

identify the hazards and describe safe work practices pertaining to CNC machines

H-19.02 Sets up tooling and tool holders on CNC machines

Essential Skills Numeracy, Thinking, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-19.02.01P	check mounting surfaces	mounting surfaces are checked to ensure they are clean and free of damage
H-19.02.02P	locate and secure tooling in tool holder	tooling is located and secured in tool holder to ensure access to all part features and adequate clearances
H-19.02.03P	arrange tooling to avoid interference	tooling is arranged to avoid interference with work holding devices, workpieces and other tools in CNC machines
H-19.02.04P	arrange tooling for efficient tool changes	tooling is arranged for efficient tool changes
H-19.02.05P	match tool to programmed tool location	tool is matched to programmed tool location
H-19.02.06P	install tool and tool holder	tool and tool holder are installed in orientation according to specific machining process
H-19.02.07P	determine tool offsets	tool offsets are determined using methods
H-19.02.08P	input tool offsets into offset register	tool offsets are confirmed

RANGE OF VARIABLES

methods include: using tool presetters, touching off tool on workpiece surface, measuring and cutting tools, probing

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-19.02.01L	demonstrate knowledge of CNC machines, their setup, maintenance and procedures for use	identify CNC axes and describe the relationship between them
		identify CNC control units and describe their purpose
		identify the hazards and describe safe work practices pertaining to CNC machines
		describe the procedures used to set up tooling and tool holders on CNC machines
		describe methods for determining tool offsets

RANGE OF VARIABLES

methods include: using tool presetters, touching off tool on workpiece surface, measuring and cutting tools, probing

H-19.03 Sets up workpieces on CNC machines

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-19.03.01P	select work holding device	work holding device is selected according to setup sheet for operation to be performed
H-19.03.02P	clean and deburr workpiece and remove chips and debris	workpiece is cleaned and deburred, and chips and debris are removed to maintain part locating accuracy on work holding device
H-19.03.03P	machine soft jaws, if required	soft jaws are machined to match workpiece requirements, if required
H-19.03.04P	adjust clamping pressure	clamping pressure is adjusted according to workpiece requirements and to prevent damage to workpiece
H-19.03.05P	install workpiece in correct orientation	workpiece is installed in correct orientation according to setup sheet and machining requirements

H-19.03.06P	mount workpiece according to support and pressure points	workpiece is mounted using methods to ensure contact between part and locating surface
H-19.03.07P	set up accessories	accessories are set up according to setup sheet and machining requirements

RANGE OF VARIABLES

work holding devices include: vises, fixtures, clamps, soft jaws, hard jaws, chucks

methods include: using feeler gauges, performing visual inspection

accessories include: tail stock, steady rest, fourth axis

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-19.03.01L	demonstrate knowledge of CNC machines, their setup, maintenance and procedures for use	identify CNC control units and describe their purpose
		describe the procedures used to set up workpieces in CNC machines
		identify the hazards and describe safe work practices pertaining to CNC machines

H-19.04 Establishes work datum

Essential Skills Numeracy, Thinking, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-19.04.01P	verify location of work datum	location of work datum is verified according to setup sheet, workpiece characteristics and specifications
H-19.04.02P	touch off on designated datum surfaces of workpieces	designated datum surfaces of workpieces are touched off using tools
H-19.04.03P	input datum information into specific machine offset register	datum information is input into specific machine offset register according to setup sheet

RANGE OF VARIABLES

workpiece characteristics include: material, size, shape

tools include: probes, edge finders, dial indicator

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-19.04.01L	demonstrate knowledge of CNC machines, their setup and procedures for use	describe the procedures used to touch off datum surfaces
		describe the procedures used to input datum information
		identify the hazards and describe safe work practices pertaining to CNC machines

H-19.05 Verifies program

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-19.05.01P	confirm program reference number	program reference number is confirmed
H-19.05.02P	identify and prevent interferences	interferences are identified and prevented
H-19.05.03P	perform dry run or graphic simulation of program	dry run or graphic simulation of program is performed to verify datum, tool path and tool sequence
H-19.05.04P	use features to step through program	features to step through program are used to identify interferences and errors
H-19.05.05P	confirm and retain program modifications	program modifications are confirmed and retained
H-19.05.06P	update master file	master file is updated

RANGE OF VARIABLES

features include: single block mode, distance to go, feed hold, feed and rapid override

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-19.05.01L	demonstrate knowledge of CNC programming	describe the procedures used to download programs into CNC machines
		describe the procedures used to perform dry run or graphic simulation of a program
		define features for stepping through program
		describe the procedures used to perform CNC programming
		describe the procedures for saving modified program into master file
		identify the hazards and describe safe work practices pertaining to CNC machines

RANGE OF VARIABLES

features include: single block mode, distance to go, feed hold, feed and rapid override

TASK H-20 Operates CNC machines

TASK DESCRIPTOR

Fully qualified machinists use CNC machines for machining that would be difficult or time-consuming on conventional machining equipment. Operating this equipment requires knowledge of conventional machining methods as well as CNC programming skills and an understanding of machine controls.

H-20.01 Adjusts offsets

Essential Skills Numeracy, Thinking, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-20.01.01P	leave extra material on workpiece	extra material is left on workpiece to verify size
H-20.01.02P	measure workpiece dimensions	workpiece dimensions are measured to compare actual dimensions to planned dimensions

H-20.01.03P	calculate deviations	deviations are calculated according to measurements, specifications and machine configuration
H-20.01.04P	enter offset changes into tool offset register	offset changes are entered into tool offset register

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-20.01.01L	demonstrate knowledge of CNC machines and their procedures for use	describe the procedures used to operate CNC machines
		describe the procedures used to adjust offsets
		identify the hazards and describe safe work practices pertaining to CNC machines
H-20.01.02L	demonstrate knowledge of calculations required to calculate deviations	calculate deviations from specifications

RANGE OF VARIABLES

specifications include: design, standards, client, industry, manufacturers', drawings

H-20.02 Monitors machining processes

Essential Skills Thinking, Document Use, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-20.02.01P	verify clamping force	clamping force is verified by checking if workpiece is moving in the work holding device or is distorted
H-20.02.02P	verify required coolant flow	required coolant flow is verified to maintain required surface finish and tool life
H-20.02.03P	observe operating conditions	operating conditions are observed to identify potential problems and inefficiencies

H-20.02.04P	monitor tool wear	tool wear is monitored by using procedures
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RANGE OF VARIABLES

operating conditions include: sound, vibrations, abnormal chip formations, chip evacuation

procedures include: visual inspection, reading spindle and drive axis load meters, checking surface finish and workpiece sizes

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-20.02.01L	demonstrate knowledge of CNC machines, their maintenance and procedures for use	describe the procedures used to operate CNC machines
		describe the procedures used to inspect and maintain CNC machines
		identify issues with operating conditions
		identify the hazards and describe safe work practices pertaining to CNC machines

RANGE OF VARIABLES

operating conditions include: sound, vibrations, abnormal chip formations, chip evacuation

H-20.03 Interrupts program cycle

Essential Skills Thinking, Digital Technology, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
H-20.03.01P	determine level of urgency requiring a stop	level of urgency requiring a stop is determined
H-20.03.02P	recognize points in program where interruptions are not safe	points in program where interruptions are not safe are recognized
H-20.03.03P	use control features	control features are used according to level of urgency
H-20.03.04P	use emergency stop feature	emergency stop feature is used to prevent equipment damage and personal injuries

RANGE OF VARIABLES

control features include: single block mode, feed override, feed hold, reset

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
H-20.03.01L	demonstrate knowledge of CNC machine operations	identify CNC-related reference points and their location
		describe the procedures used to operate CNC machines
		identify levels of urgency requiring a type of stop
		define control features
		identify the hazards and describe safe work practices pertaining to CNC machines

RANGE OF VARIABLES

control features include: single block mode, feed override, feed hold, reset

H-20.04 Restarts program cycle

Essential Skills Thinking, Digital Technology, Continuous Learning

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

SKILLS		
	Performance Criteria	Evidence of Attainment
H-20.04.01P	position tool to avoid collision	tool is positioned to avoid collision
H-20.04.02P	clear machine control's temporary memory (buffer)	machine control's temporary memory (buffer) is cleared to prevent unexpected machine movements upon restart
H-20.04.03P	identify and execute required elements of program code	required elements of program code are identified and executed in order to safely restart program
H-20.04.04P	restart program at correct tool and program location	program is restarted at correct tool and program location
H-20.04.05P	monitor distance to go to prevent collisions	distance to go is monitored to prevent collisions

KNOWLEDGE

	Learning Outcomes	Learning Objectives
H-20.04.01L	demonstrate knowledge of CNC programming and operations	identify CNC-related reference points and their location
		describe the procedures used to restart program
		describe the procedures used to perform CNC programming
		describe the procedures used to operate CNC machines
		identify hazards and describe safe work practices pertaining to CNC machines

APPENDIX A

ACRONYMS

AGMA	American Gear Manufacturers Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CAD	computer-aided design
CAM	computer-aided manufacturing
CMM	coordinate measuring machine
CNC	computer numerical control
CRC	cutter radius compensation
GD&T	geometric dimensioning and tolerancing
MTR	material test report
PPE	personal protective equipment
SAE	Society of Automotive Engineers
SDS	safety data sheet
WHMIS	Workplace Hazardous Materials Information System

APPENDIX B

TOOLS AND EQUIPMENT / OUTILS ET ÉQUIPEMENT

Safety Equipment / Équipement de sécurité

automated external defibrillator (AED)	défibrillateur externe automatisé (DEA)
dust mask	masque antipoussières
eye wash station	douche oculaire
face shield	écran facial
fall arrest equipment	équipement antichute
fire blanket	couverture antifeu
fire extinguishers	extincteurs
fire hoses	tuyaux d'incendie
first aid station	poste de premiers soins
goggles/safety glasses	lunettes de protection et lunettes de sécurité
hand protection	gants de protection
hearing protection	protecteurs auriculaires
heat treatment oven mitts/gloves	gants isolants pour four de traitement thermique
portable gas detector	détecteur de gaz portatif
protective head gear	casques protecteurs
respirators	appareils respiratoires
safety barrier tapes	ruban de sécurité
safety boots	bottes de sécurité
lock-out and tag-out devices	dispositifs de cadenassage et d'étiquetage

Hand Tools / Outils à main

oxy-fuel torch	chalumeau oxyacétylénique
arbor press	presse à mandriner
bearing extractor	extracteur de paliers
brushes	brosses
buffing wheels	meules à polir
chisels (flat cold, diamond, round nose, cape, side)	ciseaux (plat à froid, à pointe de diamant, à pointe ronde, bédane, biseau)
chuck key	clé de mandrin
deburrers	outils d'ébavurage
die stock	porte-filière
dressing stick	bâton à dresser
drill drift	chasse-foret
drill gauge	calibre à foret
file cards	cardes à lime
file handles	manches de lime
files (flat file, half round file, hand file, knife file, general purpose file, pillar file, round file, square file, three square file, lathe file)	limes (lime plate, lime demi-ronde, lime à main, lime couteau, lime à usage général, lime plate à chants parallèles, lime ronde, lime carrée, lime triangulaire, lime de tour)
grease guns	pistolets graisseurs
hacksaws and blades	scies à métaux et lames

hammers/mallets (ball peen, dead blow, sledge, cross peen, straight peen)

hand broaches

hand reamers (solid, expansion, adjustable, taper, roughing, finishing taper)

hex keys

honing stones

lapping plate

metal stamps

oil cans/guns

pliers (standard, tongue and groove, needle nose, locking, side cutters)

punches and bars (pin punch, prick punch, centre punch, aligning punch, pry bar, transfer punch, brass drifts)

scrapers (flat, three cornered)

screwdrivers (straight or flat, Phillips, Robertson, Torx)

soft jaws

spotting blue (Prussian blue)

tap extractors

tap wrenches

tin snips

torch tip lighters

utility knife

vises (bench, machinist's)

wheel dressers (hand held)

wrenches (open-end, box end, sockets, adjustable, hex socket, torque, pipe, chain, strap, spanner)

maroteaux et maillets (maroteau à panne ronde, maroteau à amortisseur, masse, maroteau à panne en travers, maroteau à panne droit)

broches à main

alésours à main (alésour monobloc, alésour expansible, alésour réglable, alésour conique, alésour-ébaucheur, alésour finisseur conique)

clés hexagonales

pierres à roder

plaque de rodage

étampes à métal

burettes et pistolets à huile

pincés (pince standard, pince multiprise, pince à bec pointu, pince-étou, pince à tranchant latéral)

poinçons et barres (chasse-goupille, pointeau de traçage, pointeau centreur, poinçon aligneur, levier, poinçon de transfert, chasse-goupille en laiton)

grattoirs (plats, triangulaires)

tournevis (droit ou plat, Phillips, Robertson, Torx)

mors doux

bleu de pointage (bleu de Prusse)

extracteurs de taraud

tourne-à-gauche

cisaille de ferblantier

allumoirs de chalumeau

couteau tout usage

étaux (d'établi, de machiniste)

dresse-meules (à main)

clés (à fourche, polygonales, à douilles, ajustables, pour vis à six pans creux, dynamométriques, à tuyaux, à chaîne, à courroie, à ergots)

Power Tools / Outils mécaniques

air grinder

belt sander

angle grinder

bench grinder

buffing tools

cold saw

die grinder

disk grinder

line boring equipment

magnetic drill press

nibbler

portable band saw

portable drill

portable key seat cutter

abrasive blast cabinet

orbital sander

vibrating drum sander

high temperature oven

meuleuse pneumatique

ponceuse à courroie

meuleuse d'angle

meuleuse d'établi

outils à polir

scie à froid

meuleuse à rectifier les matrices

meuleuse à disque

alésouses en ligne

perceuse à colonne magnétique

grignoteuse

scie à ruban portative

perceuse portative

fraiseuse portative pour rainures de clavette

coffret de projection abrasive

ponceuse orbitale

ponceuse vibrante à tambour

four haute température

hydraulic press
parts cleaner

presse hydraulique
bac de nettoyage

Machine-Tools

abrasive cut-off saw
boring machines
computer numerical control (CNC) machines
(drilling machines, turning centres, machining
centres (horizontal and vertical), grinding
machines)
conventional drilling machines (sensitive drill
press, multi-spindle head, radial arm drilling
machine, turret drilling machine, pedestal
drill)
conventional grinders (cylindrical, surface, tool
and cutter, centreless, pedestal)

conventional lathes (turret, engine/centre,
single and multi spindle)

conventional milling machines (vertical,
horizontal, universal)
power saws (band saw (horizontal and vertical),
power hacksaw, reciprocating saw)

tronçonneuse à meule abrasive
aléseuses
machines à commande numérique par
ordinateur (CNC) (perceuses, tours, centres
d'usinage [horizontaux et verticaux],
rectifieuses)
perceuses conventionnelles (perceuse
sensitive, perceuse à tête multibroche,
perceuse à bras radial, perceuse à tourelle,
perceuse sur socle)
rectifieuses conventionnelles (rectifieuse
cylindrique, rectifieuse plane, machine à
affûter les outils et les fraises, rectifieuse
sans centre, rectifieuse sur socle)
tours conventionnels (tour à tourelle, tour
parallèle, tour à une broche, tour à broches
multiples)
fraiseuses conventionnelles (verticales,
horizontales, universelles)
scies mécaniques conventionnelles (scie à
ruban [horizontale et verticale], scie
mécanique alternative, scie alternative)

Cutting Tools / Outils de coupe

abrasive cut off wheels
boring bars
broaches
carbides (cemented, inserts, solid, coated)

counterbores (with or without changeable pilots)

dies
drills
grinding wheels (aluminum oxide, silicon
carbide, boron carbide, cubic boron nitride,
diamond)
knurling tools (straight, diamond)

lathe (left and right hand, neutral, parting and
grooving, forming and threading)

milling cutters (HSS, carbide, indexable
carbide, dovetail, woodruff, side and face,
slab, chamfer, fly, form, end mill, t-slot)

meules à tronçonner
barres d'alésage
broches
outils en carbure (en carbure métallique,
plaquettes de carbure, en carbure monobloc,
plaquettes en carbure revêtu)
fraises à chambrer (avec ou sans pilotes
amovibles)
filières
forets
meules (en oxyde d'aluminium, en carbure de
silicium, en carbure de bore, en nitrure de
bore cubique, meule diamantée)
outils à moleter (pour moletage droit, pour
moletage croisé oblique)
tour (levier à gauche, levier à droite, levier au
centre, tour à tronçonner, tour à rainurer, tour
de formage, tour à fileter)
fraises (en acier rapide, au carbure, au carbure
indexables, pour queues d'aronde, pour
rainure de clavette, 3 tailles, à surfacer, à
chanfreiner, outil-mouche, de forme, en bout,
pour rainures en T)

reamers (machine, hand, spiral flute, straight flute, expandable, rose, taper)

taps

boring heads

alésours (alésour-machine, à main, à cannelures hélicoïdales, à cannelures droites, expansibles, en bout, coniques)

tarauds

têtes d'alésage

Layout Equipment / Instruments de traçage

combination set

dividers and trammels

etchers

layout fluid

layout table

punches (centre, prick, transfer)

scribers

squares (adjustable, solid, master)

surface gauge

surface plates

transfer screws

height gauges

équerre combinée

compas à pointes sèches et compas à ellipse

graveurs

liquide de traçage

table de traçage

poinçons (pointeau centreur, pointeau de traçage, poinçon de transfert)

pointes à tracer

équerres (réglable, monobloc, de précision)

trusquin

marbres

vis de transfert

trusquin à vernier

Measuring Tools / Instruments de mesure

angle gauge blocks

angle plate

bore gauge

combination square

coordinate measuring machine (CMM)

depth gauge

dial indicators

digital readout

dividers

drill gauge

electronic measuring devices

feeler gauge

gauge blocks

gear measuring wire

gear tooth caliper

height gauge

inside calipers

inspection gauges (fixed gauges, cylindrical plug gauges, plain ring gauges, taper plug gauges, taper ring gauges, thread ring gauges, snap gauges, drill size gauges, radius gauges, go/no-go gauges, pitch gauges)

laser

measuring rods

measuring tape

micrometer (thread, inside, outside, depth)

optical comparator

outside calipers

cale étalon d'angle

équerre de montage

calibre d'alésage

équerre combinée

machine à mesurer les coordonnées

calibre de profondeur

indicateurs à cadran

afficheur numérique

compas à pointes sèches

calibre à foret

appareils de mesure électroniques

calibre d'épaisseur

cales étalons

fil calibré pour engrenage

pied à coulisse pour dents d'engrenage

trusquin à vernier

compas d'intérieur

calibres d'inspection (calibre fixe, calibre tampon cylindrique, bague étalon lisse, calibre tampon conique, bague étalon conique, bague étalon fileté, calibre à mâchoires, calibre à foret, calibre de rayon, calibre entre-n'entre pas, calibre de pas)

laser

piges

ruban à mesurer

micromètres (micromètre pour filetage, micromètre d'intérieur, micromètre d'extérieur, micromètre de profondeur)

comparateur optique

compas d'extérieur

precision level
profilometer
protractor (universal, bevel, vernier)

radius gauge
refractometer
scale (steel, rule, hook rule)

sine bar (compound)
sine plate (compound)
small hole gauge
square (solid, adjustable, cylindrical)
surface finish comparator
surface roughness tester
surface plate
telescopic gauge
thread depth gauge
thread measuring wires
transfer caliper
transfer type instruments
caliper (dial, digital, vernier)

niveau de précision
profilomètre
rapporteur d'angles (universel, oblique, à vernier)
calibre de rayon
réfractomètre
règles graduées (règle graduée en acier, règle de mesurage, règle à butée)
barre-sinus (pour angles composés)
plaque-sinus (pour angles composés)
calibre de petits alésages
équerres (monobloc, réglable, cylindrique)
comparateur de fini de surface
rugosimètre de surface
marbre
calibre télescopique
calibre de profondeur du filetage
fil calibré pour filetage
compas de transfert
instruments de transfert
pieds à coulisse (à cadran, numérique)

Setup Accessories and Work Holding Devices / Accessoires d'installation et organes de serrage

adaptors
angle plates
arbors
centre and edge finders
centres (dead, half, rotating, spring)

chain hoists
chucks (three-jaw, four-jaw, magnetic, collet, flat back, vacuum)
clamps
collets
tombstones
dividing head
drill chuck
face plates
follower/travelling rest
grinding attachment
grinding wheel balancers
lathe dogs
machine vise
mandrels
overhead crane
parallels
quick change toolpost
rotary table
screw jacks
shim stock

adaptateurs
équerres de montage
arbres
centreurs et dispositifs de positionnement
pointes (contrepointe, pointe dégagée, pointe rotative, pointe à ressort)
palans à chaîne
mandrins (à trois mors, à quatre mors, magnétiques, à pince, à dos plat, à vide)
serre-joints
pinces de serrage
dispositifs de serrage au portant
tête-diviseur
mandrin de perçage
plateaux de montage
lunette à suivre
appareil à rectifier
équilibreuse à meule
tocs
étau de machine
arbres de montage
pont roulant
cales parallèles
support porte-outil à changement rapide
table rotative
crics à vis
feuilles de calage

slings
spacers
steady rest
taper sleeves
taper turning attachment
tapping head
tool holders
turret tool post
v-blocks
vise

élingues
cales d'écartement
lunette fixe
manchons coniques
appareil à tourner conique
tête de taraudage
porte-outils
tourelle carrée
blocs en V
étau

APPENDIX C

GLOSSARY / GLOSSAIRE

blotter	a paper disk placed between grinding wheel and retaining flange, often marked with wheel type and speed rating	garniture	disque de papier placé entre la meule et les flasques, sur lequel le type de meule et la cote de vitesse sont souvent indiqués
boring	a machining process that enlarges a round hole using a single point cutting tool	alésage en utilisant une barre d'alésage	procédé d'usinage qui élargi un trou droit rond au moyen d'un outil à tranchant unique
chamfer	usually a 45 degree angle machined on the start of a bore or a shaft to allow for ease of assembly	chanfrein	angle généralement de 45 degrés usiné à l'extrémité d'un alésage ou d'un arbre pour faciliter l'assemblage
computer numerical control (CNC)	the control of a machine using coded instructions from a programmer or an operator	commande numérique par ordinateur (CNC)	commande d'une machine au moyen d'instructions codées entrées par un programmeur ou un opérateur
conventional (machines)	manually controlled machines	machine conventionnelle	machine à commande manuelle
counterbore	enlarging the end of a previously created hole, usually to accept a Socket Head Cap Screw (SHCS)	chambrage	opération visant à élargir l'extrémité d'un trou déjà percé qui accepte généralement une vis d'assemblage à six pans creux
countersink	creating a tapered hole on the end of an existing hole to accommodate a tapered head screw	fraisage	opération produisant une surface conique à l'extrémité d'un trou existant pour y placer une vis à tête conique
drill press	a machine used to produce holes in workpieces; reaming, tapping, spot facing and countersinking can also be performed on drill presses	perceuse à colonne	appareil utilisé pour percer des trous dans la pièce à usiner; l'alésage en utilisant un alésoir, le taraudage, le lamage et le fraisage peuvent aussi être effectués avec une perceuse à colonne
grinder	a machine that removes material from workpieces using abrasives	rectifieuse	appareil qui enlève du matériau de la pièce à usiner au moyen de meules
heat treatment	the heating and cooling of metals to modify their mechanical properties	traitement thermique	chauffage et refroidissement des métaux visant à modifier leurs propriétés mécaniques
knurling	using a tool to produce a pattern on the diameter of a workpiece in a lathe	moletage	utilisation d'un outil pour produire des sillons sur le diamètre de la pièce à usiner placée sur un tour
lathe	a machine that holds and rotates the workpiece; a cutting tool is moved on ways to cut cylindrical, tapered or threaded features on a workpiece	tour	machine qui retient et fait tourner la pièce à usiner et sur laquelle un outil de coupe se déplace le long d'une glissière pour tailler des formes cylindriques, coniques ou filetées sur la pièce à usiner

<i>Machinery's Handbook</i>	a reference book used by the mechanical engineering disciplines such as engineers, tool and die makers and machinists	<i>Machinery's Handbook</i>	document de référence utilisé dans plusieurs disciplines du génie mécanique, par exemple par les ingénieurs, les outilleurs-ajusteurs et les machinistes
mill	a machine that holds the workpiece while a rotating cutter with single or multiple cutting edges cut surfaces and contours	fraiseuse	appareil qui retient la pièce à usiner pendant qu'un couteau rotatif comportant un ou plusieurs bords tranchants taille les surfaces et les contours
saw	a machine used to cut material using a multi-tooth blade	scie	appareil pourvu d'une lame dentée utilisé couramment pour couper les matériaux
spot facing	a machining operation that creates a flat surface at 90° to a hole	lamage	opération d'usinage créant une surface plane à un angle de 90° d'un trou
tapping	creating internal threads using a cutting or forming tool called a tap	taroudage	opération visant à tailler des filets dans un trou au moyen d'un outil de coupe appelé taraud