

RED SEAL OCCUPATIONAL STANDARD

Tool and Die Maker



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TOOL AND DIE MAKER



Title: Tool and Die Maker

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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 Tool and Die Maker trade.

Background

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

Standards have the following objectives:

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

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

Trades and Apprenticeship Division
Apprenticeship and Sectoral Initiatives Directorate
Employment and Social Development Canada
140 Promenade du Portage, Phase IV, 6th Floor
Gatineau, Quebec K1A 0J9
Email: redseal-sceaurouge@hrsdc-rhdcc.gc.ca

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This standard was prepared by the Apprenticeship and Sectoral Initiatives Directorate of ESDC. The coordinating, facilitating and processing of this standard were undertaken by employees of the standards development team of the Trades and Apprenticeship Division and of 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 Tool and die maker trade: An overview of the trade's duties, work environment, job requirements, similar occupations and career progression

Trends in the Tool and die maker 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: a graph which depicts the national percentages of exam questions assigned to the major work activities

Task Matrix and Examination Weightings: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard and their respective exam weightings

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 / Outils et équipement: a non-exhaustive list of tools and equipment used in this trade

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

DESCRIPTION OF THE TOOL AND DIE MAKER TRADE

“Tool and Die Maker” is this trade’s official Red Seal occupational title approved by the CCDA. This standard covers tasks performed by tool and die makers 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
Tool and Die Maker	■	■	■	■		■	■			■			
Die Maker					■								
Mouldmaking Machinist					■								
Tool Maker					■								

Tool and die makers design, create, repair and test prototypes and production tools such as dies, cutting tools, jigs, fixtures, gauges, and specialty tools using various metals, alloys and plastics. In some jurisdictions, they also build and repair moulds. They produce tooling used to manufacture and stamp out parts and they supply tooling and dies for the automotive, aerospace, transportation, consumer goods, forestry, mining, farming, medical and electronics industries. Tool and die makers usually work indoors in tool rooms, machine shops and manufacturing environment. They lay out, set up, machine, fit and finish metal, alloys and plastic components. They design and make items to meet exacting standards in dimensions, strength and hardness.

Tool and die makers use machining tools such as lathes, mills, saws, grinders, drills, computer numerical control (CNC) machines, coordinate-measuring machines (CMM) and electrical discharge machines (EDM). They also use hand tools and measuring equipment to ensure accuracy and close tolerances. They may use 3D printers. They work from sketches, drawings, computer-aided designs/computer-aided manufacturing (CAD/CAM), specifications and their own concepts to calculate dimensions, tolerances and types of fit. They should be knowledgeable about the properties of metal and non-metallic materials such as plastic, rubber and composite materials.

Some tool and die makers may specialize in design, prototyping, automation equipment fabrication, tool and cutter making, heat treating, test equipment, gauge making, jig and fixture making, die making, mould making, assembly, inspection and programming. They may be involved in research and development for the industries mentioned above.

Safety is important at all times. There are risks of personal injury working with moving machine parts, flying chips, sharp edges and extreme heat from heated materials. Tool and die makers may be lifting and moving heavy components. Precautions are required while working with manufacturing chemicals, airborne irritants, compressed gasses, toxic lubricants and cleaners.

Some attributes for people entering this trade are: communication skills, mechanical aptitude, attention to details, hand-eye coordination, manual dexterity, ability to troubleshoot and to work independently and in teams, logical reasoning ability, advanced knowledge of mathematics and applied science, creativity, resourcefulness, above average spatial ability and ability to plan and think sequentially. The work often requires considerable physical activity and stamina as tool and die makers spend long periods of time on their feet. Tool and die makers may work with other professionals such as machinists, mould makers, industrial mechanics (millwrights), designers, programmers and engineers.

Experienced tool and die makers may become team leaders, supervisors, managers, instructors or business owners. With additional training, they may transfer their skills to design and engineering responsibilities. Their skills are also transferable to related occupations such as machinist, mould maker, pattern maker, industrial mechanic (millwright) and CNC programmer.

TRENDS IN THE TOOL AND DIE MAKER TRADE

TECHNOLOGY:

The tool and die maker trade is changing rapidly throughout the various industries in Canada and worldwide. Technology is quickly changing the basic trade. Advances in CNC, robotics, laser, exotic materials, 3D printing and composites will continue to impact the trade in future years. Knowledge and skill levels continue to increase in this trade. The tool and die maker must be adaptable to technological changes.

The advancements made on tooling are significant. Many tool and die apprentices do not use or perhaps have never seen a dividing head or rotary table in use. Although these processes are important, methods have changed. All engineering design courses can be completed through CAD courses, mostly solid modelling, as this is how tools are being designed and part drawings generated.

There is new tooling, and new and faster machinery and processes, such as white light imaging data to CNC. Currently there are companies exploring the uses of augmented reality for assessing die designs before they go to production. Rapid prototyping (3D printing) is quickly becoming a common process within the industry. Rapid prototyping is a method of prototyping with polymers or powdered metal materials which take only a few hours, compared to other prototyping processes which can take a few weeks. Nanotechnology is more often being applied in the development of new materials to make them stronger and to optimize their durability. Other high-tech processes whose use is increasing include robotics, laser cutting, laser metrology and water jet cutting.

New materials, such as composites, and advanced coatings have been introduced. There is more high speed machining of hardened material for production tool manufacturing. There are different materials that are being used on tools now.

Tools now are becoming more complicated for example, new measurement technology (scanning) and video scanning.

RESPONSIBILITIES:

Experienced tool and die makers are becoming more accountable and responsible for steps or operations that they were not involved in previously. For example, tool and die makers are often project leaders and have the responsibility and authority for the different steps that lead to the final product. Therefore, there is an increased need to develop team working skills. Due to those new responsibilities, tool and die makers are engaged in the early stages of project development involving clients, engineers, and marketing teams.

WORKPLACE:

Safety standards are becoming more rigorous and require more thorough applications of practices. Safety officers and inspectors are becoming more common in the workplace.

More and more workplaces are recycling paper products, oils, packaging materials and steels to reduce environmental impact.

The implementation of shop floor management systems (software) is becoming more common. This software facilitates the planning and scheduling process.

In some workplaces, the continued increase in the use of CNC machines and new machining processes has resulted in tool and die makers being more focussed on planning, costing, final fitting, assembly, development and proving out of tooling.

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 statements which support each subtask of the trade. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at: <http://www.red-seal.ca/>.

READING

Tool and die makers use reading skills to comprehend instructions and safety warnings on product and equipment labels. They also have to read reference material, product descriptions, work instructions on work orders and job files, policies and procedures applicable to the work they carry out and operating, safety and equipment manuals. Tool and die makers also need to read about new trends, technological developments, tooling practices and procedures in industry, and trade and safety publications.

DOCUMENT USE

Tool and die makers need critical skills to locate data in charts and tables such as material composition sheets, specification tables and conversion tables. They also locate and complete information on tracking and quality control forms. Tool and die makers take data from and interpret a variety of graphs and graphical displays, and they locate dimensions and other features on complex shop drawings to fabricate parts and assemble production tools. Tool and die makers also require document use skills to examine perspective views and assembly drawings to understand and visualize the location, orientation and function of complex components and sub-assemblies.

WRITING

Tool and die makers write comments in daily logbooks to create records and inform supervisors and co-workers. They may write e-mails and memos to clients, supervisors, engineers and technicians to provide and request information. Tool and die makers also write a variety of reports such as quality assurance and equipment repair logs. They also prepare estimating and work planning sheets.

NUMERACY

Tool and die makers need advanced numeracy skills. They require skills to establish timelines, set sequence of operations, calculate the time required to complete each sub-assembly and determine project progress against timelines. Tool and die makers use measurement and calculation skills to take a variety of measurements to ensure conformance to specifications. These skills are also required to analyze the geometry of fabricated parts, to verify dimensions, distances and angles of design features, and to calculate cutting parameters such as speeds and feeds. Several trigonometric functions and mathematical formulas are used frequently in the day-to-day work of tool and die makers. Some calculations include speeds and feeds, and tolerance stack-up on machine parts and geometric interrelationships between parts features.

Tool and die makers also use data analysis skills to compare instrument readings such as temperature, pressure and size to interpret fabrication process data and to analyze performance data for production tool sets under controlled and simulated conditions.

Numerical estimation skills are used to estimate how much stock tool and die makers require to make components for production tools, to estimate the initial machine and equipment settings for testing production tool sets and producing prototypes, and to estimate the time required to complete jobs.

ORAL COMMUNICATION

Tool and die makers need good oral communication skills to communicate with supervisors and co-workers to coordinate tasks, in order to carry out activities correctly, safely and efficiently. They offer suggestions and advice on design features, materials and tooling procedures to improve quality and production efficiency. They also discuss design modifications with engineers and request technical information from them. They may give instructions, provide directions and offer explanations to apprentices and co-workers.

THINKING

Tool and die makers need strong thinking skills. Their problem solving skills are required when they discover that specifications are incorrect or need modifications, when they encounter problems with fabrication processes and when they find that malfunctioning equipment makes further fabrication impossible. The problem solving skills are then used to work with engineers, quality control personnel and co-workers to identify failures and corrective action requirements.

Tool and die makers also use decision making skills to decide the sequence of operations such as assembly and machining of parts. The skill is also required to select the types of materials, supplies, tools, tooling paths and machines to use.

Critical thinking skills are required to evaluate the quality and acceptability of fabricated production tools, to assess the suitability of specified materials and to evaluate the feasibility and technical soundness of production tool designs from both fabrication and quality perspectives.

Tool and die makers need job task planning and organizing skills as they are responsible for setting the sequence of operations for the projects they are assigned.

WORKING WITH OTHERS

Tool and die makers work as team members with engineers, designers, quality control personnel, co-workers and clients when designing production tools, and diagnosing and resolving faults in equipment, production tools and other products. They may work with technical experts to coordinate fabrication and assembly of parts and machines.

DIGITAL TECHNOLOGY

Tool and die makers use databases to enter and retrieve information about current and past fabrication jobs. They also need computer skills when working with CAD and CAM software. These skills are also required to understand software and physical operation of CMM, CNC machine-tools and 3D printers. They may use electronic devices to communicate with others and perform Internet research.

CONTINUOUS LEARNING

Tool and die maker employers may offer training for skills development, new equipment, and health and safety training. However, much of their learning occurs day-to-day through the challenges and problems that arise during the course of each project and from discussions with experienced tool and die makers and other co-workers. They also read reference material to increase their trade knowledge, and industry publications to stay current on trends and new technologies.

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.

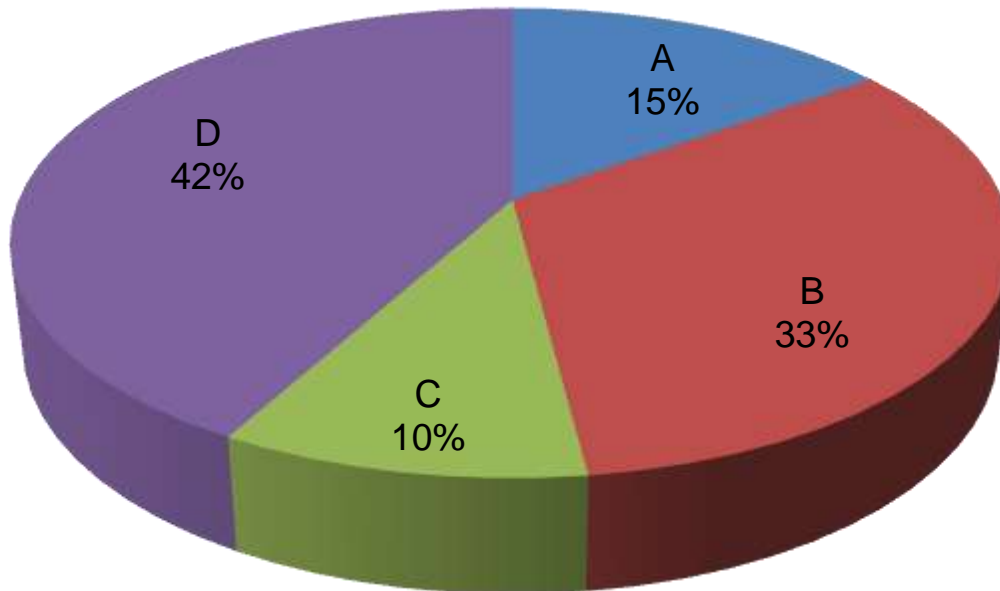
INDUSTRY EXPECTED PERFORMANCE

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 at a high quality without material waste or damage to parts, tooling or the environment. All requirements of the manufacturer, client specifications, Occupational Health and Safety (OH&S) Acts, and Workplace Hazardous Materials Information System (WHMIS) regulations must be met. At a journeyperson level of performance, all tasks must be done with minimal direction and supervision. As a journeyperson progresses in their career, there is an expectation they continue to upgrade their skills and knowledge to maintain pace with industry and promote continuous learning in their trade through mentoring of apprentices.

LANGUAGE REQUIREMENTS

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

PIE CHART OF RED SEAL EXAMINATION WEIGHTINGS



MWA A	Performs common occupational skills	15%
MWA B	Operates machine-tools	33%
MWA C	Performs heat treatment	10%
MWA D	Performs design and development of prototypes and production tools	42%

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.

TOOL AND DIE MAKER

TASK MATRIX

A – Performs common occupational skills

15%

Task A-1 Performs safety-related functions 22%	1.01 Maintains safe work environment	1.02 Uses personal protective equipment (PPE) and safety equipment	1.03 Uses hoisting, lifting, rigging and supporting equipment
Task A-2 Maintains machine-tools, accessories and cutting tools 17%	2.01 Maintains machine-tools and accessories	2.02 Maintains cutting tools	
Task A-3 Organizes work 27%	3.01 Interprets drawings, specifications and applications	3.02 Plans project activities	
Task A-4 Performs benchwork 24%	4.01 Performs layout	4.02 Finishes workpiece	4.03 Inspects workpiece
Task A-5 Uses communication and mentoring techniques 10%	5.01 Uses communication techniques		5.02 Uses mentoring techniques

B – Operates machine-tools

33%

<p>Task B-6 Operates power saws 9%</p>	<p>6.01 Sets up power saws</p>	<p>6.02 Saws straight and angle cuts</p>	<p>6.03 Cuts irregular shapes</p>
<p>Task B-7 Operates drill presses 9%</p>	<p>7.01 Sets up drill presses</p>	<p>7.02 Drills holes using drill presses</p>	<p>7.03 Cuts countersinks, counterbores, chamfers and spot faces using drill presses</p>
	<p>7.04 Performs tapping using drill presses</p>	<p>7.05 Finishes holes using drill presses</p>	
<p>Task B-8 Operates conventional lathes 19%</p>	<p>8.01 Sets up conventional lathes</p>	<p>8.02 Faces surface using conventional lathes</p>	<p>8.03 Turns internal and external surfaces using conventional lathes</p>
	<p>8.04 Creates holes using conventional lathes</p>		
<p>Task B-9 Operates conventional milling machines 20%</p>	<p>9.01 Sets up conventional milling machines</p>	<p>9.02 Mills surfaces using conventional milling machines</p>	<p>9.03 Creates holes and hole features using conventional milling machines</p>
<p>Task B-10 Operates grinding machines 21%</p>	<p>10.01 Sets up grinding machines</p>	<p>10.02 Grinds flat surfaces using a surface grinder</p>	<p>10.03 Grinds profiles</p>
	<p>10.04 Grinds internal and external cylindrical and tapered surfaces</p>	<p>10.05 Grinds tools and cutters</p>	<p>10.06 Finishes holes using a honing machine</p>

Task B-11
Operates computer numerical control (CNC) machines
14%

11.01 Performs CNC programming

11.02 Inputs program data into control memory

11.03 Establishes workpiece datum

11.04 Verifies programs

11.05 Monitors machining processes

Task B-12
Operates electrical discharge machines (EDM)
8%

12.01 Determines flushing methods

12.02 Sets cutting conditions

C – Performs heat treatment

10%

Task C-13
Heat treats materials
73%

13.01 Selects heat treatment process

13.02 Hardens materials

13.03 Tempers materials

13.04 Anneals materials

13.05 Normalizes materials

13.06 Case hardens materials

Task C-14
Tests heat treated materials
27%

14.01 Performs visual inspection

14.02 Performs hardness test

D – Performs design and development of prototypes and production tools

42%

Task D-15 Performs production tool design 15%	15.01 Identifies production tool requirements	15.02 Prepares shop sketches	15.03 Determines production tool material specifications and engineered components
	15.04 Prepares information for designing and drafting		
Task D-16 Develops prototype 11%	16.01 Selects prototyping technique and materials	16.02 Fabricates prototype components	16.03 Assembles prototype components
	16.04 Inspects prototype	16.05 Proves out prototype	
Task D-17 Fits and assembles production tools 27%	17.01 Verifies dimensions of production tool components	17.02 Performs production tool assembly	17.03 Sets production tool timing
Task D-18 Proves out production tools 24%	18.01 Sets up production tools	18.02 Verifies production part material	18.03 Develops blank/strip
	18.04 Cycles equipment with production tools	18.05 Evaluates production part	18.06 Checks production tool for damage
	18.07 Modifies production tools to enhance productivity		

Task D-19
Repairs and maintains production tools
23%

19.01 Identifies condition of production tools

19.02 Identifies repair procedures

19.03 Adjusts production tool components

19.04 Reconditions production tool components

Harmonization of Apprenticeship Training

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

1. Trade name

The official Red Seal name for this trade is Tool and Die Maker.

2. Number of Levels of Apprenticeship

The number of levels of technical training recommended for this trade is 3 (three).

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
	Benchwork	Benchwork
		Grinding Machine Operation
Safety-Related Functions 1.01 Maintains safe work environment 1.02 Uses PPE and safety equipment 1.03 Uses hoisting, lifting and rigging equipment	Safety-Related Functions 1.01 Maintains safe work environment 1.02 Uses PPE and safety equipment 1.03 Uses hoisting, lifting and rigging equipment	Safety-Related Functions 1.01 Maintains safe work environment 1.02 Uses PPE and safety equipment 1.03 Uses hoisting, lifting and rigging equipment
Machine-Tools, Accessories And Cutting Tool Maintenance 2.01 Maintains machine-tools and accessories 2.02 Maintains cutting tools	Machine-Tools, Accessories And Cutting Tool Maintenance 2.01 Maintains machine-tools and accessories 2.02 Maintains cutting tools	Machine-Tools, Accessories And Cutting Tool Maintenance 2.01 Maintains machine-tools and accessories 2.02 Maintains cutting tools

Level 1	Level 2	Level 3
<p>Organizes Work 3.01 Interprets drawings, specifications and applications 3.02 Plans project activities</p>	<p>Organizes Work 3.01 Interprets drawings, specifications and applications 3.02 Plans project activities</p>	<p>Organizes Work 3.01 Interprets drawings, specifications and applications 3.02 Plans project activities</p>
<p>Benchwork 4.01 Performs layout 4.02 Finishes workpiece 4.03 Inspects workpiece</p>		
<p>Communication 5.01 Uses communication techniques</p>	<p>Communication and Mentoring 5.01 Uses communication techniques 5.02 Uses mentoring techniques</p>	<p>Mentoring 5.02 Uses mentoring techniques</p>
<p>Power Saw Operation 6.01 Sets up power saws 6.02 Saws straight and angle cuts 6.03 Cuts irregular shapes</p>		
<p>Drill Press Operation 7.01 Sets up drill presses 7.02 Drills holes using a drill press 7.03 Cuts countersinks, counterbores, chamfers and spot faces using a drill press 7.04 Performs tapping using a drill press 7.05 Finishes holes using a drill press</p>		
<p>Conventional Lathe Operation 8.01 Sets up conventional lathes 8.02 Faces surface using a conventional lathe 8.03 Turns internal and external surfaces using conventional lathes 8.04 Creates holes using conventional lathes</p>	<p>Conventional Lathe Operation 8.01 Sets up conventional lathes 8.03 Turns internal and external surfaces using conventional lathes 8.04 Creates holes using conventional lathes</p>	
<p>Conventional Milling Machine Operation 9.01 Sets up conventional milling machines 9.02 Mills surfaces using conventional milling machines 9.03 Creates holes and hole features using conventional milling machines</p>	<p>Conventional Milling Machine Operation 9.01 Sets up conventional milling machines 9.02 Mills surfaces using conventional milling machines 9.03 Creates holes and hole features using conventional milling machines</p>	
<p>Grinding Machine Operation 10.01 Sets up grinding machines 10.02 Grinds flat surfaces using a surface grinder 10.03 Grinds profiles</p>	<p>Grinding Machine Operation 10.01 Sets up grinding machines 10.02 Grinds flat surfaces using a surface grinder 10.03 Grinds profiles 10.04 Grinds internal and external cylindrical and tapered surfaces 10.05 Grinds tools and cutters 10.06 Finishes holes using a honing machine</p>	

Level 1	Level 2	Level 3
	<p>CNC Operation</p> <p>11.01 Performs CNC programming 11.02 Inputs program data into control memory 11.03 Establishes workpiece datum 11.04 Verifies program 11.05 Monitors machining processes</p>	<p>CNC Operation</p> <p>11.01 Performs CNC programming 11.04 Verifies program</p>
		<p>EDM Operation</p> <p>12.01 Determines flushing methods 12.02 Sets cutting conditions</p>
	<p>Heat Treatment of Materials</p> <p>13.01 Selects heat treating process 13.02 Hardens materials 13.03 Tempers materials 13.04 Anneals materials 13.05 Normalizes materials 13.06 Case hardens materials</p>	<p>Heat Treatment of Materials</p> <p>13.01 Selects heat treating process 13.02 Hardens materials 13.06 Case hardens materials</p>
	<p>Heat Treatment Testing</p> <p>14.01 Performs visual inspection 14.02 Performs hardness test</p>	<p>Heat Treatment Testing</p> <p>14.01 Performs visual inspection 14.02 Performs hardness test</p>
	<p>Production Tool Design</p> <p>15.01 Identifies production tool requirements 15.02 Prepares shop sketches 15.03 Determines production tool material specifications and engineered components 15.04 Prepares information for designing or drafting</p>	<p>Production Tool Design</p> <p>15.01 Identifies production tool requirements 15.02 Prepares shop sketches 15.03 Determines production tool material specifications and engineered components 15.04 Prepares information for designing or drafting</p>
	<p>Prototype Development</p> <p>16.01 Selects prototyping technique and materials 16.02 Fabricates prototype components 16.03 Assembles prototype components 16.04 Inspects prototype 16.05 Proves out prototypes</p>	<p>Prototype Development</p> <p>16.01 Selects prototyping technique and materials 16.02 Fabricates prototype components 16.03 Assembles prototype components 16.04 Inspects prototype 16.05 Proves out prototypes</p>
	<p>Production Tools (Fit and Assembly) **</p> <p>17.01 Verifies dimensions of production tool components 17.02 Performs production tool assembly</p>	<p>Production Tools (Fit and Assembly) **</p> <p>17.01 Verifies dimensions of production tool components 17.02 Performs production tool assembly 17.03 Sets production tool timing</p>

Level 1	Level 2	Level 3
	<p>Production Tools (Proves out) **</p> <ul style="list-style-type: none"> 18.01 Sets up production tools 18.02 Verifies production part material 18.04 Cycles equipment with production tools 18.05 Evaluates production part 18.06 Checks production tool for damage 18.07 Modifies production tools to enhance productivity 	<p>Production Tools (Proves out) **</p> <ul style="list-style-type: none"> 18.01 Sets up production tools 18.02 Verifies production part material 18.03 Develops blank/strip 18.04 Cycles equipment with production tools 18.05 Evaluates production part 18.06 Checks production tool for damage 18.07 Modifies production tools to enhance productivity
	<p>Production Tools (Repair and Maintenance) **</p> <ul style="list-style-type: none"> 19.01 Identifies condition of production tools 19.02 Identifies repair procedures 19.03 Adjusts production tool components 19.04 Reconditions production tool components 	<p>Production Tools (Repair and Maintenance) **</p> <ul style="list-style-type: none"> 19.01 Identifies condition of production tools 19.02 Identifies repair procedures 19.03 Adjusts production tool components 19.04 Reconditions production tool components

*This may apply to EDM Operation and may be incorporated into EDM training.

**Level 2 is developed to focus on jigs and fixtures; Level 3 is developed to focus on stamping tools (moulds as applies in jurisdictions).

MAJOR WORK ACTIVITY A

Performs common occupational skills

TASK A-1 Performs safety-related functions

TASK DESCRIPTOR

Tool and die makers perform safety-related functions and use various tools and equipment to complete multiple tasks throughout their trade.

A-1.01 Maintains safe work environment

Essential Skills Reading, Oral Communication, Writing

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

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 jurisdictional regulations, company policies, procedures and practices, and manufacturers' specifications
A-1.01.02P	identify workplace hazards	workplace hazards are identified according to regulations and company policies, procedures and practices
A-1.01.03P	identify machine hazards	machine hazards are identified according to regulations , manufacturers' specifications and, company policies, procedures and practices
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, procedures and practices, and regulations
A-1.01.05P	follow specified safety procedures	specified safety procedures are followed according to company policies, procedures and practices, and regulations

A-1.01.06P	maintain a clean and tidy work area	clean and tidy work area is maintained according to company policies, procedures and practices, and regulations
A-1.01.07P	coordinate tasks with other workers	tasks are coordinated with other workers according to company policies, procedures and practices, and regulations
A-1.01.08P	handle hazardous materials	hazardous materials are handled according to regulations , Workplace Hazardous Materials Information System (WHMIS) procedures and company policies, procedures and practices
A-1.01.09P	participate in safety meetings and discussions	safety meetings and discussions are participated in according to occupational health and safety (OH&S) regulations, and company policies, procedures and practices
A-1.01.10P	set up barricading devices and signage	barricading devices and signage are set up to define work perimeters and contain contaminants or other hazards according to company policies, procedures and practices
A-1.01.11P	set up or identify location of safety zone components	locations of safety zone components are set up or identified according to company policies, procedures and practices, and workplace safety and health regulations
A-1.01.12P	document safety-related issues	safety-related issues are documented according to company practices and jurisdictional OH&S regulations
A-1.01.13P	obtain required certification for regulated barricading devices	required certification for regulated barricading devices is obtained according to regulations , and company policies, procedures and practices

RANGE OF VARIABLES

workplace hazards include: slippery floors, tangled air lines and power cords, hazardous fumes, electrical hazards, dust, inadequate lighting, shop/facility organization, mechanical, stored energy, ventilation/fumes, fire, environmental (discharge/spills, material and energy waste), biological hazards

regulations include: OH&S, jurisdictional, Transportation of Dangerous Goods (TDG), WHMIS

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

WHMIS procedures include: disposal, labelling, use of personal protective equipment (PPE), training

barricading devices and signage include: caution tape, fences, barriers, welding screens

safety zone components include: first aid kits, fire extinguishers, safety data sheet (SDS), eye wash stations

workplace safety and health regulations include: WHMIS, jurisdictional OH&S

safety-related issues include: faulty PPE and safety equipment, inspections, potential hazards, safety meetings, injuries, safety training, transportation, WHMIS-related

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-1.01.01L	demonstrate knowledge of safe work practices	identify workplace hazards and describe safe work practices describe procedures used to handle, store, transport and dispose of hazardous materials
A-1.01.02L	demonstrate knowledge of regulations pertaining to a safe work environment	interpret regulations pertaining to workplace hazards and safe work practices

RANGE OF VARIABLES

workplace hazards include: slippery floors, tangled air lines and power cords, hazardous fumes, electrical hazards, dust, inadequate lighting, shop/facility organization, mechanical, stored energy, ventilation/fumes, fire, environmental (discharge/spills, material and energy waste), biological hazards

regulations include: OH&S, jurisdictional, Transportation of Dangerous Goods (TDG), WHMIS

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

Essential Skills Document Use, Thinking, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.02.01P	select and wear PPE	PPE is selected and worn according to task, site, company policies, procedures and practices, and jurisdictional regulations
A-1.02.02P	ensure proper fit of PPE and safety equipment	proper fit of PPE and safety equipment is ensured according to manufacturers' specifications
A-1.02.03P	identify defective and damaged PPE and remove from service	defective and damaged PPE is identified and removed from service according to company policies, procedures and practices, and jurisdictional regulations
A-1.02.04P	locate and use safety equipment	safety equipment is located and used according to task, site and risk assessments
A-1.02.05P	clean and store PPE and safety equipment	PPE and safety equipment are cleaned and stored according to manufacturers' specifications, and company policies, procedures and practices

A-1.02.06P	inspect and replace safety harnesses, hard hats and lanyards	safety harnesses, hard hats and lanyards are inspected and replaced as required, and according to jurisdictional regulations and company policies, procedures and practices
A-1.02.07P	inspect and recommend recertification of safety equipment	safety equipment is inspected and recertification is recommended if required according to jurisdictional regulations, manufacturers' specifications, and company policies, procedures and practices

RANGE OF VARIABLES

PPE includes: hard hats, safety glasses, face shields, hearing protection, respirators, boots, gloves, safety vests, fall arrest (harnesses, lanyards)

defective and damaged PPE includes: excessively worn boots, cracked safety glasses, expired safety equipment

safety equipment includes: fire extinguishers, eye wash stations, first aid kits, spill kits, defibrillators

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-1.02.01L	demonstrate knowledge of PPE and safety equipment , their applications, maintenance and procedures for use	define terminology associated with PPE and safety equipment
		identify types of PPE and safety equipment , their applications and procedures for use
		describe the procedures used to care for, maintain and store PPE and safety equipment
		identify types of fire extinguishing equipment and describe their applications and procedures for use
A-1.02.02L	demonstrate knowledge of standards and regulations pertaining to PPE and safety equipment	identify standards and regulations pertaining to PPE and safety equipment

RANGE OF VARIABLES

PPE includes: hard hats, safety glasses, face shields, hearing protection, respirators, boots, gloves, safety vests, fall arrest (harnesses, lanyards)

safety equipment includes: fire extinguishers, eye wash stations, first aid kits, spill kits, defibrillators

A-1.03**Uses hoisting, lifting, rigging and supporting equipment****Essential Skills**

Thinking, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-1.03.01P	determine approximate weight of load	approximate weight of load is determined in order to stay within capacity of available equipment
A-1.03.02P	select hoisting, lifting, rigging and supporting equipment	hoisting, lifting, rigging and supporting equipment is selected according to lift characteristics and manufacturers' specifications
A-1.03.03P	inspect hoisting, lifting and rigging equipment	hoisting, lifting and rigging equipment is inspected according to company policies, procedures and practices, manufacturers' specifications, and jurisdictional regulations to identify defects and expiration dates
A-1.03.04P	determine load's approximate centre of gravity	centre of gravity is approximated using dimensional measurements, verifying documentation and performing a test lift
A-1.03.05P	perform rigging, lifting and hoisting operations	rigging, lifting and hoisting operations are performed by qualified personnel according to regulations, manufacturers' specifications, lift characteristics , and company policies, procedures and practices
A-1.03.06P	store equipment	equipment is stored in clean and dry locations according to manufacturers' specifications, and company policies, procedures and practices

RANGE OF VARIABLES

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

lifting equipment includes: forklifts, pallet jacks, telescopic booms, hydraulic die lift table, hydraulic die separator, chain falls

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

supporting equipment includes: horses, flip blocks

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

KNOWLEDGE

Learning Outcomes	Learning Objectives
A-1.03.01L	demonstrate knowledge of hoisting, lifting, rigging and supporting 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
	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, lifting and supporting 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
A-1.03.02L	demonstrate knowledge of regulations pertaining to hoisting, lifting and rigging equipment
	identify regulations pertaining to hoisting, lifting and rigging training and certification requirements

RANGE OF VARIABLES

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

lifting equipment includes: forklifts, pallet jacks, telescopic booms, hydraulic die lift table, hydraulic die separator, chain falls

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

supporting equipment includes: horses, flip blocks

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

TASK A-2 Maintains machine-tools, accessories and cutting tools

TASK DESCRIPTOR

Tool and die makers use and maintain machine-tools, accessories and cutting tools in order to prolong service life and to ensure a safe environment.

A-2.01 Maintains machine-tools and accessories

Essential Skills Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.01.01P	clean machine-tools and accessories	machine-tools and accessories are cleaned according to company practices
A-2.01.02P	check and apply lubricants	lubricants are checked and applied according to manufacturers' specifications and company practices
A-2.01.03P	check and maintain cutting fluids and coolants	cutting fluids and coolant levels are checked and maintained according to manufacturers' specifications and company practices
A-2.01.04P	comply with maintenance schedule	maintenance schedule is complied with according to machine specifications and company practices

RANGE OF VARIABLES

machine-tools include: lathes, mills, drills, grinders, power saws, electrical discharge machine (EDM), computer numerical control (CNC) machine

accessories include: spindles, holders, chucks, cutting tools, collets, vices

cutting fluids include: oils, water-soluble fluids, synthetic fluids

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.01.01L	demonstrate knowledge of cleaning agents, their applications, and procedures for use	identify cleaning agents used to clean machine-tools and accessories
		describe process to clean machine-tools and accessories
		describe the application of cleaning agents

A-2.01.02L	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-2.01.03L	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

RANGE OF VARIABLES

machine-tools include: lathes, mills, drills, grinders, power saws, electrical discharge machine (EDM), computer numerical control (CNC) machine

accessories include: spindles, holders, chucks, cutting tools, collets, vices

cutting fluids include: oils, water-soluble fluids, synthetic fluids

A-2.02 Maintains cutting tools

Essential Skills Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-2.02.01P	clean cutting tools	cutting tools are cleaned according to company practices
A-2.02.02P	check cutting characteristics of cutting tools	cutting characteristics of cutting tools is checked according to <i>Machinery's Handbook</i> and manufacturers' specifications
A-2.02.03P	sharpen cutting tools	cutting tools are sharpened according to tooling requirements and job specifications
A-2.02.04P	protect sharpened cutting tools	sharpened cutting tools are protected according to company practices

RANGE OF VARIABLES

cutting tools include: drill, reamer, threading tools, end mills

job specifications include: type of material, size, dimensions, tolerances

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-2.02.01L	demonstrate knowledge of maintenance procedures for cutting tools	describe process to clean cutting tools
A-2.02.02L	demonstrate knowledge of safe work practices and procedures related to sharpening tools	identify cutting characteristics identify hazards and describe safe work practices pertaining to sharpening tools

RANGE OF VARIABLES

cutting tools include: drill, reamer, threading tools, end mills

TASK A-3 Organizes work

TASK DESCRIPTOR

Tool and die makers use organizational skills to perform their tasks in a safe, efficient and effective manner.

A-3.01

Interprets drawings, specifications and their applications

Essential Skills Numeracy, Thinking, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.01.01P	determine information	information is determined according to job requirements
A-3.01.02P	check drawings for information	drawings are checked for information
A-3.01.03P	perform visual inspection and analyze finished products	finished products are visually inspected and analyzed according to drawings
A-3.01.04P	locate information in reference materials	information is located in reference materials
A-3.01.05P	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, geometric dimensioning and tolerancing (GD&T), conflicting information

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

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

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
A-3.01.01L	demonstrate knowledge of drawings and their applications	define terminology associated with drawings
		identify types of drawings and sketches and describe their purpose
A-3.01.02L	demonstrate knowledge of interpreting and extracting information from drawing features	interpret and extract information from drawing features
		explain the principles of orthographic projection
A-3.01.03L	demonstrate knowledge of reference materials and their use	identify types of reference materials and their use
A-3.01.04L	demonstrate knowledge of calculations	identify information from reference materials and determine the calculations

RANGE OF VARIABLES

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

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

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

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

A-3.02 Plans project activities

Essential Skills Thinking, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-3.02.01P	identify and confirm resources required for project	resources for project are identified and confirmed
A-3.02.02P	organize and identify workpiece materials	workpiece materials are organized and identified according to drawings and shop practices
A-3.02.03P	analyze material characteristics	material characteristics are analyzed to determine manufacturing process
A-3.02.04P	identify tasks required to manufacture production tools , prototypes and one-offs	required tasks to manufacture production tools , prototypes and one-offs are identified according to quantity required
A-3.02.05P	recognize limitations of equipment and tooling	limitations of equipment and tooling are recognized to determine which work needs to be sent to external specialists or specialized firm
A-3.02.06P	determine sequence of operation	sequence of operation is determined according to workpiece, equipment, operations to be performed and job specifications
A-3.02.07P	estimate timelines for each task and establish milestones	timelines for each task are estimated and milestones are established according to factors

RANGE OF VARIABLES

resources include: components, machinery, materials, processes

workpiece materials include: round stock, bar stock, flat stock, rolled stock, raw material

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

material characteristics include: composition, properties, application, machinability

manufacturing processes include: holding strategy, rough machining operations, finish machining operations, heat treatment processes

production tools include: dies, jigs, fixtures, cutting tools, moulds

factors include: machinery availability, machine capability, company policies and practices, client requirements

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-3.02.01L	demonstrate knowledge of 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
		identify procedures used to determine sequence of operations

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-4 Performs benchwork

TASK DESCRIPTOR

The benchwork that tool and die makers perform is multifunctional; it takes in many various critical components of the trade from part layout to part fit-up to produce a finished component to exacting standards.

A-4.01 Performs layout

Essential Skills Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.01.01P	determine shape and requirement of layout	shape and requirement of layout is determined according to specifications
A-4.01.02P	select and use layout tools and instruments	layout tools and instruments are selected according to workpiece characteristics , operations to be performed and specifications

A-4.01.03P	lay out workpiece	workpiece is laid out according to specifications
A-4.01.04P	verify layout	layout is verified using measuring and inspection tools

RANGE OF VARIABLES

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

layout tools and instruments include: surface plates, prick punches, angle plates, scribes, dividers and trammels, hermaphrodite calipers, squares, rulers, combination set, universal bevel protractor, sine bar, gauge blocks, height gauges, feeler gauges, radius gauges, surface gauges

workpiece characteristics include: material, size, shape

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

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
A-4.01.01L	demonstrate knowledge of basic layout and its applications	define terminology associated with basic layout
		calculate layout dimensions and reference points or datums
		describe the procedures used to perform a basic layout
		describe the procedures used to verify a basic layout
A-4.01.02L	demonstrate knowledge of layout tools and instruments , their applications, maintenance and procedures for use	identify types of layout tools and instruments 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
		calculate angles, arcs and location from reference point
		describe the procedures used to inspect, maintain and store layout tools and instruments

RANGE OF VARIABLES

layout tools and instruments include: surface plates, prick punches, angle plates, scribes, dividers and trammels, hermaphrodite calipers, squares, rulers, combination set, universal bevel protractor, sine bar, gauge blocks, height gauges, feeler gauges, radius gauges, surface gauges

layout media/solutions include: layout dye, marker, copper sulphate

A-4.02 Finishes workpiece

Essential Skills Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.02.01P	select finishing process	finishing process is selected according to specifications
A-4.02.02P	select abrasives	abrasives are selected according to workpiece characteristics and selected finishing process
A-4.02.03P	select work holding device	work holding device is selected according to workpiece characteristics and selected finishing process
A-4.02.04P	set up workpiece in work holding device	workpiece is set up in work holding device to protect material and operator
A-4.02.05P	perform finishing technique	finishing technique is performed to achieve required finish
A-4.02.06P	clean workpiece	workpiece is cleaned to remove debris
A-4.02.07P	measure workpiece	workpiece is measured throughout the process to make finishing adjustments and to ensure that finishing process does not compromise specifications
A-4.02.08P	mark workpiece with identification markings	workpiece is marked with identification markings according to specifications and company policies, and without compromising the integrity of the workpiece
A-4.02.09P	protect finished workpiece	finished workpiece is protected using protective material

RANGE OF VARIABLES

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

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

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

workpiece characteristics include: material, size, shape, hardness

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

identification markings include: heat numbers, part numbers, composition, country of origin, trade name, material, custom identification, American Society of Mechanical Engineers (ASME) system, American National Standards Institute (ANSI) system, colour codes, number system

protective material includes: rust inhibitor, paper, crating, packing, coating

KNOWLEDGE

Learning Outcomes	Learning Objectives
A-4.02.01L	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
A-4.02.02L	demonstrate knowledge of safe work practices and procedures
	identify hazards and describe safe work practices pertaining to abrasives
A-4.02.03L	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
A-4.02.04L	demonstrate knowledge of methods used to mark workpieces
	identify methods used to mark workpieces for identification
	identify material identification markings
A-4.02.05L	demonstrate knowledge of methods used to protect workpiece
	describe the procedures used to protect workpiece
	identify types of protective material used to protect workpiece

RANGE OF VARIABLES

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

identification markings include: heat numbers, part numbers, composition, country of origin, trade name, material, custom identification, American Society of Mechanical Engineers (ASME) system, American National Standards Institute (ANSI) system, colour codes, number system

protective material includes: rust inhibitor, paper, crating, packing, coating

A-4.03 Inspects workpiece

Essential Skills

Numeracy, Document Use, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-4.03.01P	select and use <i>inspection equipment</i>	<i>inspection equipment</i> is selected and used
A-4.03.02P	verify workpiece features and dimensions	workpiece features and dimensions are verified that they meet <i>specifications</i> using <i>inspection equipment</i>
A-4.03.03P	perform visual inspection of workpiece to identify <i>defects</i>	<i>defects</i> are identified following inspection of workpiece according to <i>specifications</i>
A-4.03.04P	perform basic non-destructive inspection	non-destructive inspection is performed to ensure integrity of workpiece

RANGE OF VARIABLES

inspection equipment includes: calipers, micrometers, dial indicators, optical comparators, coordinate measuring machines (CMM), gauges, hardness testers

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

defects include: cracks, inadequate surface finish, distortions, surface deviation, damage

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-4.03.01L	demonstrate knowledge of inspections	define <i>terminology</i> associated with inspections
		identify types of <i>inspection equipment</i> and describe their applications and procedures for use
A-4.03.02L	demonstrate knowledge of <i>inspection procedures</i>	describe <i>inspection procedures</i> used to inspect workpieces
A-4.03.03L	demonstrate knowledge of non-destructive inspections	describe procedures used to conduct non-destructive inspections

RANGE OF VARIABLES

inspection equipment includes: calipers, micrometers, dial indicators, optical comparators, coordinate measuring machines (CMM), gauges, hardness testers

terminology includes: dimensions, tolerances, allowances

inspection procedures include: incoming, in process, final

TASK A-5 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-5.01 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
NV	yes	NV	yes	yes	yes	yes	ND	ND	yes	ND	ND	ND

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.01.01P	participate in safety and information meetings	meetings are attended, information is relayed to the workforce, and is understood and applied
A-5.01.02P	demonstrate communication practices with individuals or in a group	instructions and messages are understood by all parties involved in communication
A-5.01.03P	listen using active listening practices	steps of active listening are utilized
A-5.01.04P	receive and respond to feedback on work	response to feedback indicates understanding and corrective measures are taken
A-5.01.05P	explain and provide feedback	explanation and feedback is provided and task is carried out as directed
A-5.01.06P	use questioning to improve communication	questions enhance understanding, on-the-job training and goal setting

RANGE OF VARIABLES

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.01.01L	demonstrate knowledge of trade terminology	define terminology used in the trade
A-5.01.02L	demonstrate knowledge of effective communication practices	describe the importance of using effective verbal and non-verbal communication with people in the workplace

	identify sources of information to effectively communicate
	identify communication and learning styles
	describe effective listening and speaking skills
	identify personal responsibilities and attitudes that contribute to on-the-job success
	identify the value of diversity in the workplace
	identify communication that constitutes harassment and discrimination

RANGE OF VARIABLES

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

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

learning styles include: seeing it (visual), hearing it (auditory), trying it (kinesthetic)

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, gender identity or expression, marital status, family status, disability, genetic characteristics, pardoned conviction

A-5.02 Uses mentoring techniques

Essential Skills

Thinking, Oral Communication, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
A-5.02.01P	identify and communicate learning objective and point of task	apprentice or learner can explain the objective and point of the task
A-5.02.02P	link task to other tasks and the job	task sequence and unplanned learning opportunities are defined
A -5.02.03P	demonstrates performance of a skill to an apprentice or learner	steps required to demonstrate a skill are performed

A -5.02.04P	set up conditions required for an apprentice or learner to practice a skill	practice conditions are set up so that the skill can be practiced safely by the apprentice or learner
A -5.02.05P	assess apprentice or learner's ability to perform tasks with increasing independence	performance of apprentice or learner improves with practice to a point where skill can be done with limited supervision
A -5.02.06P	give supportive and constructive feedback	apprentice or learner adopts best practice after having been given supportive or constructive feedback
A -5.02.07P	support apprentice or learner in pursuing technical training opportunities	technical training is completed within timeframe prescribed by apprenticeship authority
A -5.02.08P	support racialized apprentice or learner	workplace is harassment and discrimination-free
A -5.02.09P	assess apprentice or learner suitability to the trade during probationary period	apprentice or learner is given feedback that helps them identify their own strengths and weaknesses and suitability for the trade

RANGE OF VARIABLES

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

practice conditions mean: guided, limited independence, full independence

KNOWLEDGE

	Learning Outcomes	Learning Objectives
A-5.02.01L	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
		describe the importance of different types of skills in the workplace
		describe the importance of essential skills in the workplace
		identify different learning styles
		identify different learning needs and strategies to meet learning needs
		identify strategies to assist in learning a skill
A-5.02.02L	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 task
	identify how to choose a good time to present a task
	explain the importance of linking the tasks
	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 task 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 (visual), hearing it (auditory), trying it (kinesthetic)

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

strategies to assist in learning a skill include: understanding the 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

MAJOR WORK ACTIVITY B

Operates machine-tools

TASK B-6 Operates power saws

TASK DESCRIPTOR

Horizontal and vertical power saws are used to cut material for other machining processes. Typically, workpieces are then finished using other machining operations.

B-6.01 Sets up power saws

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.01.01P	determine machining requirements	machining requirements are determined according to specifications
B-6.01.02P	determine and select power saw	power saw is determined and selected according to workpiece characteristics and operations to be performed
B-6.01.03P	determine and select saw blade	saw blade is determined and selected according to workpiece characteristics and operations to be performed
B-6.01.04P	check blade pitch and set	blade pitch and set is checked according to job requirements
B-6.01.05P	determine and select saw blade width and gauge	saw blade width and gauge are determined and selected according to cut
B-6.01.06P	verify cutting direction of blade	cutting direction of blade is verified
B-6.01.07P	install blade on drive wheel and idler wheel(s)	blade is placed on drive wheel and idler wheel(s) according to specifications
B-6.01.08P	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
B-6.01.09P	adjust blade tension	blade tension is adjusted according to specifications

B-6.01.10P	check blade tracking	blade tracking is checked to avoid damage to the blade and saw
B-6.01.11P	secure blade of power hacksaw	blade of power hacksaw is secured using locating pins
B-6.01.12P	weld and grind vertical band saw blades to saw internal contours	vertical band saw blades are welded and ground to saw internal contours
B-6.01.13P	break-in new saw blades to increase blade life	new saw blades are broken-in to increase blade life
B-6.01.14P	calculate speeds and feeds	speeds and feeds are calculated according to specifications
B-6.01.15P	select speeds and feeds	speeds and feeds are selected according to material to be cut, job requirements and specifications
B-6.01.16P	adjust speeds and feeds	speeds and feeds are adjusted according to job requirements
B-6.01.17P	adjust guide arms	guide arms are adjusted according to workpiece characteristics and specifications
B-6.01.18P	adjust blade guides	blade guides are adjusted to ensure adequate blade support according to specifications
B-6.01.19P	adjust clamping pressure	clamping pressure is adjusted according to job requirements and specifications to ensure workpiece is secure and not damaged and distorted
B-6.01.20P	adjust table angles	table angles are adjusted according to specifications when using vertical band saw
B-6.01.21P	adjust vertical band saw's fence	vertical band saw's fence is adjusted according to specifications
B-6.01.22P	adjust length stop	length stop is adjusted according to specifications
B-6.01.23P	adjust coolant	coolant is adjusted according to job requirements

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, shape, size

job requirements include: thin wall sections, I-beams, tubing, solids, material cross-sectional thickness, type of material to be cut

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.01.01L	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
		calculate speed and feed requirements
		describe the procedures used to adjust speeds and feeds
		describe the procedures used to adjust power saws
		describe the procedures used to secure workpiece on power saws
		identify types of power saw accessories
		describe the procedures used to adjust table angle
B-6.01.02L	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
B-6.01.03L	demonstrate knowledge of use of measuring devices	calculate and measure workpiece to be cut

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

accessories include: push block, clamps, guard, air blast, workpiece support, work stop

B-6.02**Saws straight and angle cuts****Essential Skills**

Thinking, Numeracy, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.02.01P	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
B-6.02.02P	adjust angle of saw	angle of saw is adjusted according to required angle of cut
B-6.02.03P	square off end of material (reference cut)	end of material (reference cut) is squared off to ensure an accurate measurement
B-6.02.04P	identify problems	problems are identified
B-6.02.05P	implement solutions	problems are eliminated
B-6.02.06P	complete cut from opposite side when blade becomes damaged	cut is completed from opposite side when blade becomes damaged
B-6.02.07P	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, coolant, lubricant

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, square, calipers, steel rule

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.02.01L	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
B-6.02.02L	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

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

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

B-6.03 Cuts irregular shapes

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-6.03.01P	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 a safe and efficient cut
B-6.03.02P	monitor profile of cut	profile of cut is monitored during cutting process
B-6.03.03P	identify problems	problems are identified
B-6.03.04P	implement solutions	problems are eliminated
B-6.03.05P	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, 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, calipers

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-6.03.01L	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
B-6.03.02L	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

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

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

power saws include: vertical, contour

TASK B-7 Operates drill presses

TASK DESCRIPTOR

Tool and die makers use drill presses to perform cutting operations such as drilling, reaming, boring and tapping holes, 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 tool and die makers. Setting up drill presses is an important task which must be done to maximize quality and efficiency.

B-7.01 Sets up drill presses

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.01.01P	read documentation	documentation is read to determine operations to be performed
B-7.01.02P	determine type of material	type of material is determined according to specifications and material test report (MTR) of material to be drilled
B-7.01.03P	determine type of drill press	type of drill press is determined according to workpiece and operations to be performed
B-7.01.04P	select cutting tool and drill press tooling	cutting tool and drill press tooling are selected according to workpiece characteristics and operations to be performed
B-7.01.05P	determine orientation of workpiece	orientation of workpiece on the table is determined according to operation to be performed
B-7.01.06P	select jigs, fixtures and work holding devices	jigs, fixtures and work holding devices are selected according to workpiece characteristics and operations to be performed
B-7.01.07P	determine sequence of operation	sequence of operation is determined according to specifications
B-7.01.08P	determine surface speed	surface speed is determined according to material type and cutting tool type
B-7.01.09P	determine spindle speed (rpm)	spindle speed (rpm) is determined according to diameter of cutter, cutting tool material, workpiece material and surface speed

B-7.01.10P	determine feed rate	feed rate is determined according to cutting tool, surface finish requirements and workpiece material
B-7.01.11P	adjust machine settings	machine settings are adjusted according to calculated settings
B-7.01.12P	mount, align and secure jigs, fixtures and work holding devices	jigs, fixtures and work holding devices are mounted, aligned and secured according to specifications
B-7.01.13P	clamp workpiece into jig or fixture	workpiece is clamped into jig or fixture according to operation to be performed and specifications
B-7.01.14P	adjust table and column height	table and column height are adjusted if required to maximize rigidity
B-7.01.15P	inspect cutting tool	cutting tool is inspected for wear
B-7.01.16P	inspect and clean tooling mounting surfaces	tooling mounting surfaces are clean and free of nicks and burrs
B-7.01.17P	install tool in spindle	tool is installed in spindle securely and true
B-7.01.18P	adjust stop to required tool depth	stop is adjusted to required tool depth according to specifications and operation to be performed
B-7.01.19P	verify drill process by performing inspection	inspection is completed and adjustments are made as necessary
B-7.01.20P	readjust machine controls	machine controls are readjusted according to cutting performance

RANGE OF VARIABLES

documentation includes: drawings, job traveller

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

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

cutting tools include: drills, reamers, taps, countersinks, counterbores, hole saws, gun drill

drill press tooling includes: drill chucks, collets, tapered sleeves, tapping heads

workpiece characteristics include: material, shape, size

work holding devices include: vices (plain, angular, compound, swivel), clamps

wear includes: chipped, damaged or worn cutting edges and margins, dullness

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-7.01.01L	demonstrate knowledge of cutting tools , drill press tooling and drill presses , their applications, maintenance and procedures for use	define terminology associated with cutting tools , drill press tooling and drill presses
		identify types of cutting tools and describe their applications
		identify types of drill press tooling and describe their applications

		identify types of drill presses and describe their components and applications
		describe the considerations to determine speed, feed and depth of cut for drill press operations
		describe the procedures used to inspect and maintain cutting tools, drill press tooling and drill presses
		describe the procedures used to install cutting tools and drill press tooling in spindle
		describe the procedures used to set up and perform drill press operations
B-7.01.02L	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

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

cutting tools include: drills, reamers, taps, countersinks, counterbores, hole saws, gun drill

drill press tooling includes: drill chucks, collets, tapered sleeves, tapping heads

work holding devices include: vices (plain, angular, compound, swivel), clamps

setup procedures include: alignment, positioning, adjustments

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

drill press operations include: drilling, counterboring, countersinking, tapping, reaming, chamfering, spot facing, boring

B-7.02**Drills holes using drill presses****Essential Skills**

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.02.01P	select centre drill	centre drill is selected for application according to specifications
B-7.02.02P	centre drill the workpiece	workpiece is centre drilled according to workpiece, hole size and operation to be performed
B-7.02.03P	select and install drill press tooling and workpiece	drill press tooling and workpiece are selected and installed securely
B-7.02.04P	drill hole in workpiece	drill is fed into workpiece to produce hole
B-7.02.05P	measure and check hole	hole is measured and checked throughout the process to make adjustments
B-7.02.06P	identify problems	problems are identified
B-7.02.07P	implement solutions	problems are eliminated
B-7.02.08P	verify feature meets specifications	feature is verified according to specifications using inspection equipment

RANGE OF VARIABLES

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

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

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

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-7.02.01L	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
		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
B-7.02.02L	demonstrate knowledge of safe work practices and procedures	identify hazards and describe safe work practices pertaining to drill presses
B-7.02.03L	demonstrate knowledge of measurements pertaining to drilling operations	identify methods of measuring workpiece
B-7.02.04L	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, compound), parallel clamps, C-clamps

B-7.03 Cuts countersinks, counterbores, chamfers and spot faces using drill presses

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.03.01P	install required cutting tool and drill press tooling	required cutting tool and drill press tooling is installed according to process and specifications
B-7.03.02P	use cutting tool to produce feature	cutting tool is fed into workpiece to produce feature
B-7.03.03P	complete operation to required dimensions	operation is completed to dimensions according to specifications
B-7.03.04P	measure and check feature of hole	feature of hole is measured and checked throughout the process to make adjustments
B-7.03.05P	verify feature meets specifications	feature is verified according to specifications using inspection equipment
B-7.03.06P	identify problems	problems are identified
B-7.03.07P	implement solutions	problems are eliminated

RANGE OF VARIABLES

cutting tools include: spot faces, countersinks, counterbores, chamfers

drill press tooling includes: drill chucks, collets, tapered sleeves

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, incorrect speed and feed, drill wandering, oversized holes

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
B-7.03.01L	demonstrate knowledge of cutting tools , drill press tooling and drill presses , their applications, maintenance and procedures for use	define terminology associated with cutting tools , drill press tooling and drill presses
		identify types of cutting tools and describe their applications
		identify types of drill press tooling and describe their applications
		identify types of drill presses and describe their components and their applications
B-7.03.02L	demonstrate knowledge of measurements pertaining to countersinks, counterbores, chamfers and spot faces	identify methods of measuring workpiece
B-7.03.03L	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

cutting tools include: spot faces, countersinks, counterbores, chamfers

drill press tooling includes: drill chucks, collets, tapered sleeves

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

B-7.04 Performs tapping using drill presses

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.04.01P	select tap	tap is selected according to specifications and workpiece characteristics
B-7.04.02P	select tap drill size	tap drill size is verified to meet specifications
B-7.04.03P	drill workpiece	workpiece is drilled using selected tap drill
B-7.04.04P	set up tap in drill press using tapping accessories	tap is set up in drill press securely
B-7.04.05P	tap hole using tapping fluid	hole is tapped and threads are produced using tapping fluid
B-7.04.06P	identify problems	problems are identified
B-7.04.07P	implement solutions	problems are eliminated
B-7.04.08P	verify feature meets specifications	feature is verified according to specifications using inspection equipment

RANGE OF VARIABLES

taps include: spiral flute, spiral point, bottoming, form

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

workpiece characteristics include: material, shape, size

tapping accessories include: centre, tapping heads, collets, chucks

problems include: damaged threads, broken taps, cross threading, insufficient or incorrect tapping fluid

inspection equipment includes: plug gauges, sample piece, pin gauges, calipers, go no-go gauge

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-7.04.01L	demonstrate knowledge of drill press tapping accessories , its applications, maintenance and procedures for use	define terminology associated with drill press tapping accessories
		identify types of drill press tapping accessories and describe their applications
		identify thread types and class of fit

RANGE OF VARIABLES

tapping accessories include: centre, tapping heads, collets, chucks

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

B-7.05 Finishes holes using drill presses

Essential Skills

Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-7.05.01P	set up hole finishing cutting tool	hole finishing cutting tool is set up according to workpiece characteristics and operation to be performed
B-7.05.02P	use hole finishing cutting tool	hole is produced according to specifications by using hole finishing cutting tool
B-7.05.03P	measure and check hole	hole is measured and checked throughout the process and adjustments are made
B-7.05.04P	identify problems	problems are identified
B-7.05.05P	implement solutions	problems are eliminated
B-7.05.06P	verify hole meets specifications	hole is verified according to specifications using inspection equipment

RANGE OF VARIABLES

hole finishing cutting tools include: drills, reamers, boring bars, laps, hones

workpiece characteristics include: materials, shape, size

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, micrometers, plug gauges

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-7.05.01L	demonstrate knowledge of hole finishing cutting tools , their applications, maintenance and procedures for use	define terminology associated with hole finishing cutting tools
		identify types of hole finishing cutting tools and describe their applications

B-7.05.02L	demonstrate knowledge of measurements pertaining to hole finishing operations	identify methods of measuring workpiece
B-7.05.03L	demonstrate knowledge of calculations pertaining to hole finishing operations	identify calculations required to verify sizing and positions

RANGE OF VARIABLES

hole finishing cutting tools include: drills, reamers, boring bars, laps, hones

TASK B-8 Operates conventional lathes

TASK DESCRIPTOR

Tool and die makers 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 tool and die makers.

B-8.01 Sets up conventional lathes

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.01.01P	determine operations to be performed	operations to be performed are determined according to specifications
B-8.01.02P	determine lathe	lathe is determined according to workpiece characteristics and operations to be performed
B-8.01.03P	determine sequence of operations	sequence of operations is determined according to specifications and company policies
B-8.01.04P	select work holding device	work holding device is selected according to workpiece characteristics and operations
B-8.01.05P	select conventional lathe tools and accessories	conventional lathe tools and accessories are selected according to workpiece characteristics and operations
B-8.01.06P	clean and check spindle and work holding device	spindle and work holding device are cleaned and checked for damage and debris

B-8.01.07P	protect bedways	bedways are protected according to company policies
B-8.01.08P	mount work holding device	work holding device is mounted manually or using hoisting and rigging equipment
B-8.01.09P	secure work holding device	work holding device is secured using tools
B-8.01.10P	install and use feed stops	feed stops are installed and used when required
B-8.01.11P	check for clearance	clearance is checked to ensure safe operation
B-8.01.12P	adjust cutting tool angle	cutting tool angle is adjusted according to workpiece characteristics and operations to be performed
B-8.01.13P	adjust cutting tool to machine centre height	cutting tool is adjusted to machine centre height
B-8.01.14P	inspect and clean conventional lathe accessories	conventional lathe accessories are inspected for damage and cleaned to ensure accuracy
B-8.01.15P	adjust, position and secure conventional lathe accessories	conventional lathe accessories are adjusted, positioned and secured
B-8.01.16P	identify problems	problems are identified
B-8.01.17P	implement solutions	problems are eliminated
B-8.01.18P	place workpiece in position	workpiece is placed in position
B-8.01.19P	secure workpiece with work holding device	workpiece is secured with work holding device
B-8.01.20P	check and adjust workpiece	workpiece is checked for run-out and distortion using inspection equipment , and is adjusted accordingly
B-8.01.21P	counterbalance setup	setup is balanced if required
B-8.01.22P	identify type of material to be turned	type of material to be turned is identified according to specifications
B-8.01.23P	determine surface speed	surface speed is determined according to reference material and specifications
B-8.01.24P	calculate spindle speed (rpm)	spindle speed (rpm) is calculated according to cutting speed of material and workpiece diameters
B-8.01.25P	calculate feed rate	feed rate is calculated according to depth of cut and surface finish
B-8.01.26P	adjust machine settings	machine settings are adjusted according to calculations

RANGE OF VARIABLES

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

workpiece characteristics include: materials, size, shape

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

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

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

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

problems include: misalignment, run-out, insufficient clearance, improper adjustments, incorrect cutting tool geometry and coating

inspection equipment includes: dial indicator, micrometer, surface gauge, calipers

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

tools include: wrench, key, hook spanner, chuck wrench

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
B-8.01.01L	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
		identify the components and controls of conventional lathes and describe their purpose and operation
		identify types of cutting tool holding devices and describe their applications
B-8.01.02L	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
B-8.01.03L	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
B-8.01.04L	demonstrate knowledge of cutting tools , their maintenance and procedures for use	identify potential setup problems and describe their causes and solutions
		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
B-8.01.05L	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
B-8.01.06L	demonstrate knowledge of lathe speeds and feeds	identify calculations to determine speed, feed and depth of cut
B-8.01.07L	demonstrate knowledge of calculations required to adjust machine settings	identify calculations for speed, feed and depth of cut

RANGE OF VARIABLES

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

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

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

problems include: misalignment, run-out, insufficient clearance, improper adjustments, incorrect cutting tool geometry and coating

conventional lathes include: engine, turret, vertical turret, vertical boring mill

tools include: wrench, key, hook spanner, chuck wrench

B-8.02**Faces surface using conventional lathes****Essential Skills**

Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.02.01P	determine operations to be performed	operations to be performed are determined according to specifications
B-8.02.02P	touch off tool on workpiece	tool is touched off on workpiece
B-8.02.03P	cut and measure workpiece	workpiece is cut and measured to establish starting length
B-8.02.04P	rough face workpiece	workpiece is rough faced to remove excess material
B-8.02.05P	measure workpiece throughout the process	workpiece is measured throughout the process to make adjustments
B-8.02.06P	identify problems	problems are identified
B-8.02.07P	implement solutions	problems are eliminated
B-8.02.08P	finish face workpiece	workpiece is finish faced according to specifications
B-8.02.09P	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 wear, incorrect tool height setting, chip management

inspection equipment includes: precision square, straight edge, caliper, indicators, digital readout

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-8.02.01L	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

B-8.03 Turns internal and external surfaces using conventional lathes

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.03.01P	determine operations to be performed	operations to be performed are determined according to specifications
B-8.03.02P	confirm the centre height and alignment of tool	centre height and alignment of tool is confirmed
B-8.03.03P	touch off tool on workpiece	tool is touched off on workpiece
B-8.03.04P	perform trial cut and measure workpiece	trial cut is performed and workpiece is measured using inspection equipment to make adjustments
B-8.03.05P	rough turn and rough bore workpiece	workpiece is rough turned and rough bored to remove excess material
B-8.03.06P	measure workpiece throughout the process	workpiece is measured throughout the process to make adjustments using inspection equipment
B-8.03.07P	identify problems with each operation	problems are identified
B-8.03.08P	implement solutions with each operation	problems are eliminated
B-8.03.09P	finish turn workpiece	workpiece is finish turned according to specifications
B-8.03.10P	finish bore workpiece	workpiece is finish bored according to specifications
B-8.03.11P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

B-8.03.12P	set compound rest, taper attachment or tailstock offset for cutting tapers	compound rest, taper attachment or tailstock offset are set for cutting tapers to achieve required angle
B-8.03.13P	check angle of taper for accuracy	angle of taper is checked for accuracy using inspection equipment
B-8.03.14P	finish taper workpiece	workpiece is finish tapered according to specifications
B-8.03.15P	select knurling tool	knurling tool is selected according to specifications
B-8.03.16P	engage knurling tool to workpiece	knurling tool is engaged to workpiece
B-8.03.17P	feed tool along required length of knurl	tool is fed along required length of knurl
B-8.03.18P	finish knurl workpiece	workpiece is finish knurled according to specifications
B-8.03.19P	feed grooving and parting tool into workpiece	grooving and parting tool is fed into workpiece
B-8.03.20P	measure and check groove throughout the process	groove is measured and checked throughout the process to make adjustments according to specifications
B-8.03.21P	finish grooving and parting-off operation	grooving and parting-off operation is finished according to specifications
B-8.03.22P	set quick-change gear box for threading operations	quick-change gear box is set to required thread pitch or threads per inch (TPI)
B-8.03.23P	machine test pass for threading operations	test pass is machined to verify thread pitch or TPI
B-8.03.24P	machine workpiece for threading operations	workpiece is machined according to specifications
B-8.03.25P	measure thread	thread is measured according to industry standards
B-8.03.26P	finish and deburr threaded workpiece	threaded workpiece is finished and deburred to remove sharp edges

RANGE OF VARIABLES

operations include: turning internal and external surfaces, knurling, turning tapers, threading, grooving, parting-off

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

inspection equipment includes: micrometers (thread, inside, outside, depth), indicators, calipers, gauges (taper, go no-go, centre, thread, blocks, telescopic, ball), digital read-out, protractors, parallels and pins, sine bars, sample piece, thread wires, straight edges, precision square

problems include: external surfaces (chatter, tool deflection, taper, run-out, incorrect tool geometry); knurling (galling, flaking, incorrect form, workpiece deflection, insufficient lubrication, double cutting); grooving (chattering, galling, tool wandering, tool wear, chip management, incorrect tool geometry); threading (chatter, tool deflection, taper, tool misalignment, incorrect tool geometry); parting-off (chattering, galling, tool wandering, chip management, tool misalignment, incorrect tool height, incorrect tool geometry)

KNOWLEDGE

Learning Outcomes	Learning Objectives
B-8.03.01L 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
B-8.03.02L demonstrate knowledge of tapers, their applications and machining operations	describe cutting tool geometry
	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	
B-8.03.03L demonstrate knowledge of knurling operations	identify potential problems and describe their causes and solutions
	describe the considerations to determine speed and feed for knurling operations
	identify cutting fluids and coolants used during knurling operations
	identify hazards and describe safe work practices pertaining to knurling
B-8.03.04L demonstrate knowledge of grooving operations	identify potential problems and describe their causes and solutions
	describe the considerations to determine speed and feed for grooving operations
	identify cutting fluids and coolants used during grooving operations
	describe the procedures used to set speeds and feeds

		identify hazards and describe safe work practices pertaining to grooving
		identify potential problems and describe their causes and solutions
B-8.03.05L	demonstrate knowledge of threading operations	identify methods used to cut threads and describe their associated procedures
		describe the considerations to determine speeds and feeds for threading operations
		identify cutting fluids and coolants used during threading operations
		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
B-8.03.06L	demonstrate knowledge of boring operations	describe the considerations to determine speed, feed and depth of cut for boring operations
		identify cutting fluids and coolants used during boring operations
		describe the procedures used to set speeds and feeds
		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
B-8.03.07L	demonstrate knowledge of parting-off operations	describe the considerations to determine speeds and feeds for parting-off operations
		identify cutting fluids and coolants used during parting-off operations

	describe the procedures used to set speeds and feeds
	identify hazards and describe safe work practices pertaining to parting-off
	identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

inspection equipment includes: micrometers (thread, inside, outside, depth), indicators, calipers, gauges (taper, go no-go, centre, thread, blocks, telescopic, ball), digital read-out, protractors, parallels and pins, sine bars, sample piece, thread wires, straight edges, precision square

problems include: external surfaces (chatter, tool deflection, taper, run-out, incorrect tool geometry); knurling (galling, flaking, incorrect form, workpiece deflection, insufficient lubrication, double cutting); grooving (chattering, galling, tool wandering, tool wear, chip management, incorrect tool geometry); threading (chatter, tool deflection, taper, tool misalignment, incorrect tool geometry); parting-off (chattering, galling, tool wandering, chip management, tool misalignment, incorrect tool height, incorrect tool geometry)

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

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

B-8.04 Creates holes using conventional lathes

Essential Skills

Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-8.04.01P	determine operations to be performed	operations to be performed are determined according to specifications
B-8.04.02P	install centre drill	centre drill is installed
B-8.04.03P	centre drill the workpiece	workpiece is centre drilled
B-8.04.04P	install drill for application	drill for application is installed according to specifications
B-8.04.05P	touch off tool on workpiece	tool is touched off on workpiece
B-8.04.06P	drill workpiece	workpiece is drilled
B-8.04.07P	measure and check hole	hole is measured and checked according to specifications
B-8.04.08P	identify problems for each operation	problems are identified

B-8.04.09P	implement solutions for each operation	problems are eliminated
B-8.04.10P	verify feature meets specifications	feature is verified that it meets specifications using inspection equipment
B-8.04.11P	bore hole concentric and to size	hole is bored to correct eccentricities and to pre-reamed size
B-8.04.12P	measure workpiece	workpiece is measured to establish starting diameter
B-8.04.13P	install reamer in tail stock/turret	reamer is installed in tail stock/turret
B-8.04.14P	feed reamer into bored or drilled workpiece	reamer is fed into bored or drilled workpiece to create a finished hole
B-8.04.15P	finish hole	hole is finished according to specifications
B-8.04.16P	tap hole in part using conventional lathe	hole is tapped using conventional lathe

RANGE OF VARIABLES

operations include: drilling, boring, reaming, tapping, countersinking

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

problems include: drilling (drill wandering, oversized holes, misalignment of tail stock/turret, damage to cutting tool, chip management, incorrect drill geometry); boring (insufficient chip and tool clearance, chatter, tool deflection, taper, run-out); reaming (chatter, oversized holes, misalignment of tail stock/turret, damage to cutting tool, bell-mouth); tapping (breaking tap, insufficient coolant, incorrect tap drill size [TDS])

inspection equipment includes: gauges (pin, go no-go, telescopic, small hole, bore), digital readout, micrometers (inside, depth), indicators, calipers

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-8.04.01L	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 drilling
		identify potential problems and describe their causes and solutions
B-8.04.02L	demonstrate knowledge of boring operations using a conventional lathe	describe the considerations to determine speed, feed and depth of cut for boring operations
		identify cutting fluids and coolants used during boring operations
		describe the procedures used to set speeds and feeds
		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
B-8.04.03L	demonstrate knowledge of reaming operations	describe the procedures used for reaming operations on a conventional lathe
		describe the procedures used for installing reamers
		describe the procedures used to set speeds and feeds
		identify potential problems and describe their causes and solutions
B-8.04.04L	demonstrate knowledge of tapping operations	describe the procedures used for tapping work on a conventional lathe
		describe the procedures used for installing taps
		describe the procedures used to set speeds and feeds
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

problems include: drilling (drill wandering, oversized holes, misalignment of tail stock/turret, damage to cutting tool, chip management, incorrect drill geometry); boring (insufficient chip and tool clearance, chatter, tool deflection, taper, run-out); reaming (chatter, oversized holes, misalignment of tail stock/turret, damage to cutting tool, bell-mouth); tapping (breaking tap, insufficient coolant, incorrect tap drill size [TDS])

TASK B-9 Operates conventional milling machines

TASK DESCRIPTOR

Tool and die makers use conventional milling machines to make precision parts. Conventional milling machines are also used for repair work, prototypes and tool room work.

B-9.01 Sets up conventional milling machines

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-9.01.01P	identify machining requirements	machining requirements are identified according to specifications
B-9.01.02P	select machine type	machine type is selected according to workpiece characteristics
B-9.01.03P	identify milling operations	milling operations are identified according to specifications
B-9.01.04P	determine sequence of milling operations	sequence of milling operations is identified according to specifications
B-9.01.05P	select accessories	accessories are selected according to workpiece characteristics and operations to be performed
B-9.01.06P	clean and inspect accessories for wear	accessories are cleaned and inspected for wear to ensure accuracy
B-9.01.07P	install, align, and secure accessories	accessories are installed, aligned and secured according to industry practices
B-9.01.08P	select work holding device	work holding device is selected according to workpiece characteristics and operations to be performed
B-9.01.09P	determine tooling requirements	tooling requirements are determined according to workpiece characteristics and operations to be performed
B-9.01.10P	inspect and clean table and work holding device and correct deficiencies	table and work holding device are inspected, cleaned and corrected for deficiencies
B-9.01.11P	perform required alignments	required alignments are performed using measuring devices according to specifications
B-9.01.12P	adjust and secure work holding device	work holding device is adjusted and secured using required clamping forces

B-9.01.13P	determine type of material to be cut	type of material to be cut is determined according to specifications
B-9.01.14P	select tooling	tooling is selected according to workpiece characteristics and operations to be performed
B-9.01.15P	inspect tooling	tooling is inspected for wear and cleaned to ensure accuracy
B-9.01.16P	install and secure tooling	tooling is installed and secured by using required tool holding devices
B-9.01.17P	prepare workpiece	workpiece is prepared by eliminating burrs and debris
B-9.01.18P	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
B-9.01.19P	check alignment of workpiece	workpiece is checked for alignment using inspection equipment
B-9.01.20P	establish workpiece datum	workpiece datum is established using inspection equipment
B-9.01.21P	determine surface speed	surface speed is determined according to reference material
B-9.01.22P	calculate spindle speed (rpm)	spindle speed (rpm) is calculated according to diameter of cutter and surface speed
B-9.01.23P	calculate feed rate	feed rate is calculated using rpm, number of cutter teeth and chip load per tooth according to reference material
B-9.01.24P	adjust machine settings	machine settings are adjusted according to calculations

RANGE OF VARIABLES

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

workpiece characteristics include: material, size, shape

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

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

work holding devices include: chucks, vices, dividing head, fixtures, clamping kits

measuring devices include: indicators, squares, gauge blocks, digital readout, micrometers, calipers

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

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

inspection equipment includes: indicators, squares, gauge blocks

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

KNOWLEDGE

Learning Outcomes	Learning Objectives	
B-9.01.01L	demonstrate knowledge of conventional milling machines , parts, accessories, attachments, and applications	define terminology associated with conventional milling machines
		identify types of conventional milling machines and describe their operating principles and applications
		identify the components and controls of conventional milling machines and describe their purpose and operation
		identify types of tool holding devices and describe their applications
		identify hazards and describe safe work practices pertaining to conventional milling machines
		identify types of cutting tools and describe their applications
		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 milling operations
		describe the procedures used to perform milling operations on conventional milling machines
B-9.01.02L	demonstrate knowledge of work holding devices , their setup, and applications	describe the procedures used to align workpieces
		identify types of work holding devices
		describe the procedures used to secure and align work holding devices
		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
		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
		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
B-9.01.03L	demonstrate knowledge of milling speeds and feeds	describe the considerations used to determine speed, feed and depth of cut for milling operations
		interpret tables and charts of speeds and feeds
B-9.01.04L	demonstrate knowledge of calculations required to adjust machine settings	identify calculations for speed, feed and depth of cut

RANGE OF VARIABLES

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

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

work holding devices include: chucks, vices, dividing head, fixtures, clamping kits

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

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

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

B-9.02**Mills surfaces using conventional milling machines****Essential Skills**

Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-9.02.01P	measure workpiece	workpiece is measured to determine amount of excess material using inspection equipment
B-9.02.02P	locate reference point or datum surface	reference point or datum surface is located using inspection equipment
B-9.02.03P	touch off milling cutter to workpiece surface	workpiece surface is touched off by milling cutter to establish a reference point or datum
B-9.02.04P	remove excess material	excess material is removed to meet specifications
B-9.02.05P	identify problems with each operation	problems are identified
B-9.02.06P	implement solutions with each operation	problems are eliminated
B-9.02.07P	rough out workpiece	workpiece is roughed out to remove excess material
B-9.02.08P	measure roughed out workpiece	roughed out workpiece is measured to make finish adjustments using inspection equipment
B-9.02.09P	finish workpiece	workpiece is finished according to specifications
B-9.02.10P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment

RANGE OF VARIABLES

inspection equipment includes: digital readout, indicators, squares, gauges, calipers, micrometers, height gauges

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

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-9.02.01L	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, feed and depth of cut
		identify cutting fluids and coolants used
		describe the procedures used to set speeds, feeds and depth of cut
		identify calculations required to determine amount of excess material
		identify potential problems and describe their causes and solutions

RANGE OF VARIABLES

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

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

milling operations include: facing, straddle, gang, contouring, pocketing, plunging, keyways, t-slot, slitting, slotting, dovetail

B-9.03 Creates holes and hole features using conventional milling machines

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-9.03.01P	determine reference point or datum	reference point or datum is determined using tooling
B-9.03.02P	determine tooling	tooling is determined according to specifications, workpiece characteristics and operations to be performed
B-9.03.03P	adjust speeds and feeds	speeds and feeds are adjusted according to reference materials
B-9.03.04P	center-drill (spot-drill) workpiece	workpiece is centre-drilled (spot-drilled) according to specifications

B-9.03.05P	touch off drill to workpiece surface	workpiece surface is touched off to establish a reference point
B-9.03.06P	pre-drill workpiece if required	workpiece is pre-drilled according to size to be drilled and specifications if required
B-9.03.07P	drill workpiece if required	workpiece is drilled to size according to specifications if required
B-9.03.08P	measure hole size throughout operation	hole is measured throughout operation using inspection equipment
B-9.03.09P	perform boring operation	boring operation is performed according to specifications
B-9.03.10P	perform reaming operation	reaming operations are performed
B-9.03.11P	touch off reamer to workpiece surface	reamer is touched off to workpiece to establish a reference point
B-9.03.12P	verify existing hole size	existing hole size is verified according to reaming allowance and reference materials
B-9.03.13P	perform tapping operation	tapping operation is performed
B-9.03.14P	perform counterboring, countersinking, chamfering and spot facing operations	counterboring, countersinking, chamfering and spot facing operations are performed according to specifications
B-9.03.15P	verify workpiece meets specifications	workpiece is verified that it meets specifications using inspection equipment
B-9.03.16P	identify problems with each operation	problems are identified
B-9.03.17P	implement solutions for each operation	problems are eliminated
B-9.03.18P	complete operation	operation is completed according to specifications

RANGE OF VARIABLES

tooling includes: drilling (centre drills, spot drills, drills, edge finders); reaming (tapered reamer, rose reamer, straight reamer, expansion reamer); countersinking, counterboring, chamfering, spot facing (countersinks, counterbores, chamfering tool, spot faces, drills); tapping (centre drills, tap drills, taps, tapping heads, collets, chucks); boring (centre drills, drills, boring heads, indexable tooling, boring bar)

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

workpiece characteristics include: material, size, shape

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

inspection equipment includes: micrometers, calipers, gauges (telescopic, hole, indicators, thread, go no-go, pitch, bore), protractors, surface finish comparators, digital readout

problems include: drilling (incorrect speeds and feeds, wrong depth of cut, incorrect cutter geometry, tool wear, lack of cutting fluid, chip evacuation); reaming (incorrect speeds and feeds, incorrect cutter geometry, tool wear, insufficient cutting fluid, chip evacuation); countersinking, counterboring, chamfering, spot facing (chatter, vibration, incorrect cutter geometry, tool wear, insufficient cutting fluid, chip evacuation); tapping (incorrect speeds and feed, incorrect tap geometry, incorrect tap drill size, cross-threading, tool wear, incorrect or insufficient cutting fluid, chip evacuation); boring (incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, lack of lubrication, chip evacuation)

KNOWLEDGE

Learning Outcomes	Learning Objectives
B-9.03.01L demonstrate knowledge of drilling operations using milling machines	describe the procedures used to perform drilling operations
	describe the considerations to determine speeds and feeds
	identify cutting fluids and coolants used during drilling
	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
B-9.03.02L demonstrate knowledge of reaming operations using milling machines	describe the procedures used to perform reaming operations
	describe the considerations to determine speeds and feeds
	identify cutting fluids and coolants used during reaming
	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
B-9.03.03L demonstrate knowledge of procedures for cutting countersinks, counterbores, chamfers and spot faces using milling machines	describe the procedures used to cut countersinks, counterbores, chamfers and spot faces using milling machines
	describe the considerations to determine speeds and feeds
	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	

B-9.03.04L	demonstrate knowledge of tapping operations using milling machines	describe the procedures used to perform tapping operations
		describe the considerations to determine speeds and feeds
		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 tapping
		identify accessories used for tapping
		identify thread classifications and inspection equipment
B-9.03.05L	demonstrate knowledge of boring operations using milling machines	describe the procedures used to perform boring operations
		describe the considerations to determine speeds, feeds and depth of cut
		identify cutting fluids and coolants used
		describe the procedures used to set speeds, feeds and depth of cut
		identify problems and describe their causes and solutions
		identify tooling required to bore holes
		identify inspection equipment and procedures for use

RANGE OF VARIABLES

tooling includes: drilling (centre drills, spot drills, drills, edge finders); reaming (tapered reamer, rose reamer, straight reamer, expansion reamer); countersinking, counterboring, chamfering, spot facing (countersinks, counterbores, chamfering tool, spot faces, drills); tapping (centre drills, tap drills, taps, tapping heads, collets, chucks); boring (centre drills, drills, boring heads, indexable tooling, boring bar)

inspection equipment includes: micrometers, calipers, gauges (telescopic, hole, indicators, thread, go no-go, pitch, bore), protractors, surface finish comparators, digital readout

problems include: drilling (incorrect speeds and feeds, wrong depth of cut, incorrect cutter geometry, tool wear, lack of cutting fluid, chip evacuation); reaming (incorrect speeds and feeds, incorrect cutter geometry, tool wear, insufficient cutting fluid, chip evacuation); countersinking, counterboring, chamfering, spot facing (chatter, vibration, incorrect cutter geometry, tool wear, insufficient cutting fluid, chip evacuation); tapping (incorrect speeds and feed, incorrect tap geometry, incorrect tap drill size, cross-threading, tool wear, incorrect or insufficient cutting fluid, chip evacuation); boring (incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, lack of lubrication, chip evacuation)

accessories include: dividing heads, rotary table, angle plates, parallels, vices, tap wrenches, guide centres

milling operations include: drilling, reaming, countersinking, counterboring, chamfering, spot facing, tapping, boring

TASK B-10 Operates grinding machines

TASK DESCRIPTOR

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

B-10.01 Sets up grinding machines

Essential Skills Numeracy, Thinking, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-10.01.01P	determine machining requirements	machining requirements are determined according to workpiece characteristics and operations to be performed
B-10.01.02P	determine grinding machine required	grinding machine required is selected according to workpiece characteristics and operations to be performed
B-10.01.03P	identify grinding procedures	grinding procedures are identified according to workpiece characteristics and operations to be performed
B-10.01.04P	establish order of procedures	order of procedures is established according to workpiece characteristics and operations to be performed
B-10.01.05P	determine work holding devices	work holding devices are determined according to workpiece characteristics and operations to be performed
B-10.01.06P	determine type and dimensions of material to be ground	type and dimensions of material to be ground are determined according to specifications
B-10.01.07P	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
B-10.01.08P	determine workpiece setup procedure for surface grinder	workpiece setup procedure for surface grinder is determined according to specifications
B-10.01.09P	determine workpiece setup procedure for cylindrical grinder	workpiece setup procedure for cylindrical grinder is determined according to specifications

B-10.01.10P	determine workpiece setup procedure for tool and cutter grinder	workpiece setup procedure for tool and cutter grinder is determined according to specifications
B-10.01.11P	position work holding devices	work holding devices are positioned to accommodate workpiece and operation
B-10.01.12P	align and secure workpiece and work holding devices	workpiece and work holding devices are aligned and secured according to specifications
B-10.01.13P	inspect and ring test grinding wheel	grinding wheel is inspected and ring tested for defects
B-10.01.14P	secure wheel on adapters	wheel is secured on adapters using blotters and flanges
B-10.01.15P	balance grinding wheel	grinding wheel is balanced using wheel balancing equipment
B-10.01.16P	install balanced wheel assembly on machine	balanced wheel assembly is installed on machine according to specifications
B-10.01.17P	true and dress mounted grinding wheel	mounted grinding wheel is trued and dressed using dressing tools
B-10.01.18P	assess further balancing requirements and adjust if required	further balancing requirements are assessed and required adjustments are made
B-10.01.19P	select accessories	accessories are selected according to specifications, workpiece characteristics and operations to be performed
B-10.01.20P	inspect accessories	accessories are inspected for damage and defects
B-10.01.21P	clean and check accessories and mounting surface	accessories and mounting surface are cleaned and checked to ensure accuracy
B-10.01.22P	position, align, fasten and adjust accessories	accessories are positioned, aligned, fastened and adjusted to accommodate workpiece, machine and specifications
B-10.01.23P	prepare workpiece and mounting surfaces	workpiece and mounting surfaces are prepared by eliminating burrs and debris
B-10.01.24P	secure workpiece on surface grinder	workpiece is secured on surface grinder using surface grinder accessories
B-10.01.25P	secure workpiece on cylindrical grinder	workpiece is secured on cylindrical grinder using cylindrical grinder accessories
B-10.01.26P	secure workpiece on tool and cutter grinder	workpiece is secured on tool and cutter grinder using tool and cutter grinder accessories
B-10.01.27P	check alignment of workpiece before grinding	alignment of workpiece is checked before grinding using inspection equipment to ensure accuracy
B-10.01.28P	shim workpiece if required	workpiece is shimmed to eliminate stressing of the material if required

B-10.01.29P	identify type of material	type of material is identified according to specifications
B-10.01.30P	determine and calculate grinding machine speeds	grinding machine speeds are determined and calculated according to factors
B-10.01.31P	adjust feed control	feed control is adjusted to required rate

RANGE OF VARIABLES

workpiece characteristics include: material, size, shape

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

work holding devices include: chucks, face plate, fixtures, magnetic chucks, angle plates, precision vice, whirly jig, magnetic sub-plate, indexing fixture

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

defects include: cracks, stains, gouges, improper surface finish, burnishing, fish tails

wheel balancing equipment includes: mandrels, weights, static balancer

accessories include: angle plate, collets, steady rest, chucks, drive dogs, mandrels, sine bars, sine plates

surface grinder accessories include: magnetic chuck, vice, fixture

cylindrical grinder accessories include: magnetic chuck, chucks, centres with drive dogs

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

tool and cutter grinder accessories include: centres, universal vice, collets

inspection equipment includes: indicator, gauges, precision squares, sine bars, calipers, micrometers, digital readout

factors include: wheel size, part diameter, material

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-10.01.01L	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
		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 sequence of grinding operations
		identify potential setup problems and describe their causes and solutions

	identify types of grinding wheels and specifications for the required application
	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
	describe the procedures used to set up workpieces on grinders using accessories
	describe the procedures used to check alignment of workpieces
	describe the factors used to determine feed and depth of cut for grinding operations
	identify the calculations used to determine depth of cut and cross-feed

RANGE OF VARIABLES

work holding devices include: chucks, face plate, fixtures, magnetic chucks, angle plates, precision vice, whirly jig, magnetic sub-plate, indexing fixture

accessories include: angle plate, collets, steady rest, chucks, drive dogs, mandrels, sine bars, sine plates

grinding wheels include: shape, grade, bond, structure, abrasive, grain size

factors include: wheel size, part diameter, material

B-10.02 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
NV	yes	NV	yes	yes	yes	yes	ND	ND	yes	ND	ND	ND

SKILLS

	Performance Criteria	Evidence of Attainment
B-10.02.01P	measure workpiece	workpiece is measured using inspection equipment to determine amount of excess material
B-10.02.02P	touch off grinding wheel on workpiece surface	grinding wheel is touched off on workpiece surface to establish a reference point
B-10.02.03P	remove excess material	excess material is removed according to specifications
B-10.02.04P	identify problems	problems are identified
B-10.02.05P	implement solutions	problems are eliminated
B-10.02.06P	verify flat surface meets specifications	flat surface is verified to meet specifications using inspection equipment
B-10.02.07P	demagnetize workpiece	workpiece is demagnetized

RANGE OF VARIABLES

inspection equipment includes: micrometers, gauge blocks, dial indicators, profilometers, surface finish comparators, depth micrometers, surface plate, sine bar

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, wheel wear, incorrect wheel

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-10.02.01L	demonstrate knowledge of surface grinders and grinding wheels, their setup, maintenance and procedures for use	describe the procedures used to adjust and maintain surface grinders
		identify the considerations and requirements for selecting a grinding wheel
		describe the procedures used to perform surface grinding operations

		identify potential problems and describe their causes and solutions
B-10.02.02L	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, wheel wear, incorrect wheel

considerations and requirements for selecting a grinding wheel include: operations, abrasive, grain, grade, structure, bond, workpiece material

B-10.03 Grinds profiles

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-10.03.01P	dress grinding wheel	grinding wheel is dressed to desired profile using tools
B-10.03.02P	touch off grinding wheel on workpiece surface	grinding wheel is touched off on workpiece surface to establish a reference point
B-10.03.03P	measure workpiece	workpiece is measured to determine amount of excess material using inspection equipment
B-10.03.04P	rough out workpiece profile	workpiece profile is roughed out to remove excess material leaving a finish grinding allowance
B-10.03.05P	redress wheel	wheel is redressed to desired profile using tools
B-10.03.06P	finish grind	grind is finished according to specifications
B-10.03.07P	verify profile meets specifications	profile is verified according to specifications using inspection equipment
B-10.03.08P	demagnetize workpiece	workpiece is demagnetized

RANGE OF VARIABLES

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

inspection equipment includes: micrometers, contour and profile gauges, indicators, surface finish comparators

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

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
B-10.03.01L	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
B-10.03.02L	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, workpiece material

B-10.04**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
NV	yes	NV	yes	yes	yes	yes	ND	ND	yes	ND	ND	ND

SKILLS

	Performance Criteria	Evidence of Attainment
B-10.04.01P	dress grinding wheel	grinding wheel is dressed using tools
B-10.04.02P	adjust table	table is adjusted according to required orientation
B-10.04.03P	touch off grinding wheel on workpiece surface	grinding wheel is touched off on workpiece surface to establish a reference point
B-10.04.04P	measure workpiece	workpiece is measured using inspection equipment to determine amount of excess material
B-10.04.05P	rough out workpiece	workpiece is roughed out to remove excess material leaving a finish grinding allowance
B-10.04.06P	redress wheel	wheel is redressed using tools
B-10.04.07P	finish grind	grind is finished according to specifications
B-10.04.08P	remeasure workpiece	workpiece is remeasured using inspection equipment to confirm specifications are met
B-10.04.09P	demagnetize workpiece if required	workpiece is demagnetized if required

RANGE OF VARIABLES

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

orientation includes: taper, parallelism

inspection equipment includes: micrometers, sine bars, indicators, bore gauges, surface finish comparators, taper gauges, Prussian blue

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

KNOWLEDGE

Learning Outcomes	Learning Objectives
B-10.04.01L 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
B-10.04.02L demonstrate knowledge of safety practices and procedures related to cylindrical grinding	describe the procedures used to inspect and maintain cylindrical grinding machines
	identify hazards and describe safe work practices pertaining to cylindrical grinding
B-10.04.03L 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 <i>considerations and requirements for selecting a grinding wheel</i> 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, workpiece material

B-10.05 Grinds tools and cutters

Essential Skills Thinking, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-10.05.01P	dress grinding wheel	grinding wheel is dressed using tools
B-10.05.02P	mount cutting tools	cutting tools are mounted according to operations
B-10.05.03P	set cutting tool rest	cutting tool rest is set to establish required relief angle and clearance according to specifications
B-10.05.04P	touch off grinding wheel on workpiece surface	grinding wheel is touched off on workpiece surface to establish a reference point
B-10.05.05P	grind cutting edge of tools	cutting edge of tools are ground to establish required tool geometry
B-10.05.06P	demagnetize workpiece if required	workpiece is demagnetized if required

RANGE OF VARIABLES

tools include: radius/angle dresser, form dresser, 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
B-10.05.01L	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
B-10.05.02L	demonstrate knowledge of tool and cutter grinding wheels, their applications, maintenance and procedures for use	describe tool and cutter geometry
		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, workpiece material

B-10.06 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
NV	yes	NV	yes	yes	yes	yes	ND	ND	yes	ND	ND	ND

SKILLS

	Performance Criteria	Evidence of Attainment
B-10.06.01P	select honoring machine	honoring machine is selected according to job requirements
B-10.06.02P	identify type of material to be honed	type of material to be honed is identified according to specifications
B-10.06.03P	select honing stones and fluid	honoring stones and fluid are selected according to specifications
B-10.06.04P	monitor stone pressure	stone pressure is monitored to eliminate distortion and optimize material removal
B-10.06.05P	match stroke to rpm	stroke is matched to rpm to achieve finish according to specifications
B-10.06.06P	identify problems	problems are identified
B-10.06.07P	implement solutions	problems are eliminated
B-10.06.08P	check dimension of holes	dimension of holes is checked according to specifications using inspection equipment

RANGE OF VARIABLES

honing machines include: horizontal, vertical, CNC, drill

material includes: steel, cast iron, bronze

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

fluids include: oil, water

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
B-10.06.01L	demonstrates knowledge of honing machines , their setup, maintenance and procedures for use	identify types of honing machines , their setup and maintenance
		identify types of tooling required for honing
		identify honing techniques and describe their associated procedures
		identify potential problems and describe their causes and solutions
		identify stones and fluids used for honing
		describe procedure to check dimension of holes

RANGE OF VARIABLES

honing machines include: horizontal, vertical, CNC, drill

problems include: bell mouth, lack of cylindricity, chatter, lack of lubrication, glazing

TASK B-11 Operates computer numerical control (CNC) machines

TASK DESCRIPTOR

Tool and die makers use computer numerical control (CNC) machines to manufacture tooling that would be difficult or time-consuming to manufacture using conventional machining equipment. Programming this equipment requires knowledge of conventional machining methods as well as CNC programming skills and an understanding of machine controls.

B-11.01 Performs CNC programming

Essential Skills Digital Technology, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-11.01.01P	locate information required for CNC machining	information required for CNC machining is located
B-11.01.02P	determine types of cutting tools	types of cutting tools are determined according to job specifications and recorded on setup sheet
B-11.01.03P	generate program points	program points are generated using mathematics and coordinate systems
B-11.01.04P	generate cutter paths	cutter paths are generated using manual methods to input CNC code according to drawings
B-11.01.05P	generate cutter paths using computer-aided manufacturing (CAM) software and built-in features of the machine control	cutter paths are generated using CAM software and built-in features of the machine control
B-11.01.06P	designate offsets for measurements	offsets for measurements are designated according to part specifications
B-11.01.07P	plan entry and exit moves	entry and exit moves are planned
B-11.01.08P	establish safety blocks of code	safety blocks of code are established to ensure safe program restart point to cancel previous code and initialize machine at a start point
B-11.01.09P	optimize program through simulation	program is optimized on simulation software to ensure peak program

RANGE OF VARIABLES

information includes: part origin, orientation, location of work holding devices, part material

job specifications include: type of material, size, dimensions, tolerances

measurements include: tool nose radius, cutter radius, approach vectors, tool length compensation

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
B-11.01.01L	demonstrate knowledge of CNC machines and their programming	define terminology associated with CNC machines
		identify types of CNC machines, tooling and accessories, and describe their characteristics and applications
		identify types of programming codes and describe their applications
		differentiate between centerline programming and cutter radius compensation (CRC) programming
		identify CNC control units and describe their purpose
		interpret documentation pertaining to the machining of workpieces
		identify types of edit functions used and describe their applications

RANGE OF VARIABLES

programming codes include: G-codes, M-codes, coordinates

documentation includes: drawings, computer-aided design (CAD) files, machine manuals

edit functions include: insert, alter, delete, copy, paste, send, receive, post

B-11.02 Inputs program data into control memory

Essential Skills Document Use, Digital Technology, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-11.02.01P	select and download program	program is selected and downloaded from personal computer (PC), network or storage devices to CNC controller
B-11.02.02P	manually input program data	program data is manually inputted into CNC controller
B-11.02.03P	interpret and review codes from program	codes from program are interpreted and reviewed
B-11.02.04P	edit program	program is edited using <i>input functions</i> on the CNC controller

RANGE OF VARIABLES

input functions include: insert, alter, delete, send, receive

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-11.02.01L	demonstrate knowledge of CNC programming	identify types of data used in CNC programming
		differentiate between centerline programming and CRC programming
		describe procedures used to input data into control memory
		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

B-11.03 Establishes workpiece datum

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-11.03.01P	set up workpiece on machine-tool	workpiece is set up on machine-tool according to planning sheet
B-11.03.02P	verify location of work datum	location of work datum is verified according to setup sheet and workpiece characteristics
B-11.03.03P	manually adjust machine axes	machine axes is adjusted to locate designated datum surfaces of workpiece using tools
B-11.03.04P	load tools into tool holder	tools are loaded according to setup sheet and program requirements
B-11.03.05P	establish tool length and touch off tool on suitable reference surface	tool length is established and tool is touched off on suitable reference surface
B-11.03.06P	input datum information into specific machine offset register	datum information is input into specific machine offset register

RANGE OF VARIABLES

workpiece characteristics include: material, shape, size

tools include: probes, dial indicators, edge finders, tool/height setters

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-11.03.01L	demonstrate knowledge of workpiece datum, their setup and procedures for input	identify parameters to establish work datum
		describe the procedures used to touch off datum surfaces
		describe the procedures used to input datum information

B-11.04 Verifies programs

Essential Skills Thinking, Digital Technology, Document Use

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-11.04.01P	confirm program reference number	program reference number is confirmed
B-11.04.02P	identify and correct interferences	interferences are identified and corrected
B-11.04.03P	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
B-11.04.04P	use controller features to step through program	controller features to step through program are used to identify interferences and errors
B-11.04.05P	make program modifications	program modifications are made according to program requirements
B-11.04.06P	confirm and save program modifications	program modifications are confirmed and saved for repeatability and consistency
B-11.04.07P	update and record master file	master file is updated and recorded to maintain program and setup data

RANGE OF VARIABLES

interferences include: work holding devices, tool carousel, part features, insufficient tool clearance, hazardous tool change

controller features include: single block, optional stop, feed control, rapid control

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-11.04.01L	demonstrate knowledge of CNC programming and program verification procedures	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 controller features for stepping through program
		describe the procedures used to verify program
		describe the procedures for saving modified program into master file

RANGE OF VARIABLES

controller features include: single block, optional stop, feed control, rapid control

B-11.05 Monitors machining processes

Essential Skills Thinking, Reading, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-11.05.01P	identify and assess effects of tool wear	effects of tool wear are identified and assessed according to procedures
B-11.05.02P	identify and correct chip control problems	chip control problems are corrected
B-11.05.03P	use machine overrides	machine overrides are used to ensure workpiece quality and machine maintenance
B-11.05.04P	use required coolant or airflow	required coolant or airflow is used to ensure chip removal, surface finish, tool life and optimal temperatures
B-11.05.05P	identify and correct process problems	process problems are identified and corrected by adjusting speed and feed overrides, coolant and air flow, and setup rigidity
B-11.05.06P	restart program	program is restarted with adjustments made
B-11.05.07P	measure workpiece dimensions	workpiece dimensions are measured according to sketches and drawings
B-11.05.08P	adjust offset values	offset values are adjusted by calculating deviations according to workpiece dimensions

RANGE OF VARIABLES

effects of tool wear include: poor finish, excessive noise, overheating, vibration, chatter

procedures include: visual inspection, reading spindle and drive axis load meters, checking surface finish and workpiece sizes

machine overrides include: rapid override, speed and feed override

process problems include: chatter, vibration, tool failure, poor finish, abnormal chip formations

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-11.05.01L	demonstrate knowledge of procedures used to monitor CNC machines	describe the procedures used to operate CNC machines
		describe procedures used to monitor CNC operations
		describe the procedures used to inspect and maintain CNC machines
		describe effects of tool wear, machine overrides and process problems
		identify the hazards and describe safe work practices pertaining to CNC machines

RANGE OF VARIABLES

effects of tool wear include: poor finish, excessive noise, overheating, vibration, chatter

process problems include: chatter, vibration, tool failure, poor finish, abnormal chip formations

TASK B-12 Operates electrical discharge machines (EDM)

TASK DESCRIPTOR

Tool and die makers use electrical discharge machines (EDM) to accurately remove materials by eroding cavities, contours and profiles in hardened and soft ferrous and non-ferrous material in a precise and controlled manner with electrodes and wires with electrical discharges.

B-12.01 Determines flushing methods

Essential Skills Thinking, Continuous Learning, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-12.01.01P	prepare electrode flushing holes and set up flushing nozzles	electrode flushing holes are prepared and flushing nozzles are set up to ensure excess material is removed from area
B-12.01.02P	ensure optimal flushing during operation	optimal flushing is ensured to prevent arcing out and to ensure machine efficiency

KNOWLEDGE

	Learning Outcomes	Learning Objectives
B-12.01.01L	demonstrate knowledge of EDMs and accessories, their maintenance and procedures for use	define terminology associated with EDMs and tooling
		distinguish between the types of EDMs and describe their characteristics and applications
		identify types of accessories used with EDMs and describe their applications
B-12.01.02L	demonstrate knowledge of flushing methods for EDMs	describe the types of dielectric fluid and their application
		define fluid pressure pertaining to methods used to flush EDMs

RANGE OF VARIABLES

EDMs are: die sinker and wire

accessories include: spinner, work holding devices

B-12.02 Sets cutting conditions

Essential Skills Thinking, Numeracy, Digital Technology

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

SKILLS

	Performance Criteria	Evidence of Attainment
B-12.02.01P	select electrode material	electrode material is selected according to workpiece characteristics
B-12.02.02P	select electrode or wire size	electrode or wire size is selected according to workpiece characteristics
B-12.02.03P	select power setting	power setting is selected according to electrode material , surface area to be removed and surface finish
B-12.02.04P	monitor control panel	control panel is monitored for information
B-12.02.05P	maintain cutting conditions during operation	cutting conditions are maintained during operation to optimize material removal

RANGE OF VARIABLES

electrode material includes: graphite, copper (tungsten, beryllium), brass

workpiece characteristics include: materials, shape, size, dimensions, tolerances, finishes

information includes: voltage, amperage, flushing, burn rate

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
B-12.02.01L	demonstrate knowledge of EDMs and types of accessories , their maintenance and procedures for use	define terminology associated with EDMs and tooling
		distinguish between the types of EDMs and describe their characteristics and applications
		identify types of accessories used with EDMs and describe their applications
B-12.02.02L	demonstrate knowledge of cutting conditions for EDMs	identify types of electrode material
		identify sizes of electrodes, wire diameter and electrode material used in setting cutting conditions
		describe the procedures used to set cutting conditions of EDMs
		identify information monitored on control panels

RANGE OF VARIABLES

electrode material includes: graphite, copper (tungsten, beryllium), brass

information includes: voltage, amperage, flushing, burn rate

accessories include: spinner, work holding devices

EDMs are: die sinker and wire

MAJOR WORK ACTIVITY C

Performs heat treatment

TASK C-13 Heat treats materials

TASK DESCRIPTOR

Tool and die makers must have knowledge of heat treatment required to change the properties of materials. The processes are used to harden, improve machinability and reduce internal stress. Tool and die makers must be able to perform simple heat treatment operations such as torch hardening, annealing, quenching and tempering of steels and alloys.

C-13.01 Selects heat treatment process

Essential Skills Document Use, Continuous Learning, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-13.01.01P	select fire-retardant PPE and safety equipment	fire-retardant PPE and safety equipment are selected according to company policies, industry practices and jurisdictional regulations
C-13.01.02P	select heat treatment process	heat treatment process is selected based on workpiece characteristics and according to manufacturers' specifications and requirements
C-13.01.03P	select heat treating equipment and supplies	heat treating equipment and supplies are selected according to workpiece characteristics , operations to be performed and specifications
C-13.01.04P	verify suitability and availability of heat treating equipment	suitability and availability of heat treating equipment is verified to confirm feasibility of chosen procedure
C-13.01.05P	select material handling equipment	material handling equipment is selected according to workpiece characteristics , operations to be performed and specifications

C-13.01.06P	determine temperature for each heat treatment process	temperature for each heat treatment process is determined according to reference data
C-13.01.07P	select quenching medium	quenching medium is selected according to reference data

RANGE OF VARIABLES

fire-retardant PPE includes: gloves, aprons, face shields, hats, jackets, protective footwear

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

workpiece characteristics include: material, size, shape, alloying elements, carbon content

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

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

material handling equipment includes: tongs, hoists, cranes, wire

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

quenching mediums include: oil, water, air

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-13.01.01L	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
		describe the procedures used to determine properties of metals
		describe the effect of heat on properties of metals
C-13.01.02L	demonstrate knowledge of heat treatment processes	identify types of heat treatment processes and their applications
		identify types of heat treating equipment , their applications and procedures for use
		identify heating mediums and procedures for use
		identify material handling equipment and procedures for use
		identify quenching medium and procedures for use

RANGE OF VARIABLES

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

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

material handling equipment includes: tongs, hoists, cranes, wire

properties of metals include: chemical, physical, mechanical

heating mediums include: gas, electric and vacuum furnaces, gas torches

quenching mediums include: oil, water, air

C-13.02 Hardens materials

Essential Skills Document Use, Thinking, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-13.02.01P	use heat treating equipment	heat treating equipment is used according to manufacturers' specifications and part requirements
C-13.02.02P	set furnace cycle	furnace cycle is set according to material specifications
C-13.02.03P	determine torch settings	torch settings are determined according to industry practices and OH&S regulations
C-13.02.04P	prepare and clean part	part is prepared and cleaned to remove contaminants using cleaning methods
C-13.02.05P	check quenching media temperature	quenching media temperature is checked using tools to ensure it is at desired temperature according to material specifications
C-13.02.06P	move quenching media to proximity of furnace if required	quenching media is moved if required to reduce heat loss of part
C-13.02.07P	heat part to specified temperature	part is heated to specified temperature and held in the oven according to manufacturers' specifications
C-13.02.08P	submerge and agitate part in quenching media	part is submerged and agitated in quenching media to achieve hardness according to workpiece characteristics
C-13.02.09P	remove part from quenching media	part is removed from quenching media when suitable temperature is attained

RANGE OF VARIABLES

heat treating equipment includes: furnaces, torches

cleaning methods include: polishing, sandblasting, ultrasonic cleaning, descaling, degreasing

tools include: thermometers, infrared scopes

workpiece characteristics include: shape, size

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
C-13.02.01L	demonstrate knowledge of heat treatment and its applications	define terminology associated with heat treatment
		identify heat treatment processes and describe their applications
		describe the procedures used to determine properties of metal
C-13.02.02L	demonstrate knowledge of hardening materials	identify hazards and describe safe work practices pertaining to hardening metals
		identify methods used for quenching metal and describe the properties of the metal produced by each

RANGE OF VARIABLES

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

properties of metals include: chemical, physical, mechanical, colour

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

C-13.03 Tempers materials

Essential Skills

Document Use, Continuous Learning, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-13.03.01P	use heat treating equipment	heat treating equipment is used according to manufacturers' specifications and part requirements
C-13.03.02P	set furnace cycle	furnace cycle is set according to material specifications
C-13.03.03P	determine torch settings	torch settings are determined according to industry practices and OH&S regulations

C-13.03.04P	prepare and clean part	part is prepared and cleaned using cleaning methods
C-13.03.05P	heat part to set temperature	part is heated to set temperature according to tempering specifications
C-13.03.06P	confirm specified temperature is reached	specified temperature is reached using equipment
C-13.03.07P	interpret tempering colours	tempering colours are interpreted using colour chart

RANGE OF VARIABLES

cleaning methods include: polishing, sandblasting, ultrasonic cleaning, descaling

equipment includes: temperature sticks, infrared thermometer

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-13.03.01L	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
		describe heat treatment applications and their procedures
C-13.03.02L	demonstrate knowledge of tempering materials	identify hardness gradients
		identify the effects of reheating materials
		identify metallurgical guidelines

RANGE OF VARIABLES

effects include: removing stress, removing hardness, removing brittleness, distortion

C-13.04 Anneals materials

Essential Skills

Document Use, Continuous Learning, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-13.04.01P	use heat treating equipment	heat treating equipment is used according to manufacturers' specifications and part requirements
C-13.04.02P	set furnace cycle	furnace cycle is set according to material specifications
C-13.04.03P	clean part	part is cleaned to remove oil prior to heating process according to industry practices
C-13.04.04P	heat part to set temperature	part is heated to set temperature according to annealing specifications
C-13.04.05P	control cool down rate	cool down rate is controlled following the annealing procedures according to material specifications

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-13.04.01L	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
		describe heat treatment applications and their procedures
C-13.04.02L	demonstrate knowledge of annealing materials	identify methods of reheating material for softening
		identify temperature control methods for controlling the cool down rate

RANGE OF VARIABLES

temperature control methods include: using oven, using graphite powder, using sand/gravel, using vermiculite

C-13.05 Normalizes materials

Essential Skills

Document Use, Continuous Learning, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-13.05.01P	use heat treating equipment	heat treating equipment is used according to manufacturers' specifications and part requirements
C-13.05.02P	set furnace cycle	furnace cycle is set according to material specifications
C-13.05.03P	prepare and clean part	part is prepared and cleaned using cleaning methods according to industry practices
C-13.05.04P	heat part to set temperature	part is heated to set temperature according to normalizing specifications
C-13.05.05P	control cool down rate	cool down rate is controlled following normalizing according to material requirements

RANGE OF VARIABLES

cleaning methods include: polishing, sandblasting, ultrasonic cleaning, descaling

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-13.05.01L	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
		describe heat treatment applications and their procedures
C-13.05.02L	demonstrate knowledge of normalizing materials	identify stress relief effects of reheating material
		describe normalizing procedures

C-13.06 Case hardens materials

Essential Skills

Document Use, Continuous Learning, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-13.06.01P	select case hardening method	case hardening method is selected according to material and equipment
C-13.06.02P	use heat treating equipment	heat treating equipment is used according to manufacturers' specifications and part requirements
C-13.06.03P	set furnace cycle	furnace cycle is set according to material specifications
C-13.06.04P	determine torch settings	torch settings are determined according to industry practices and OH&S regulations
C-13.06.05P	heat part to set temperature	part is heated to set temperature according to case-hardening specifications
C-13.06.06P	prepare and clean part	part is prepared and cleaned using cleaning methods
C-13.06.07P	place part into carburizing material	part is placed into carburizing material to completely cover the part according to industry practices
C-13.06.08P	check quenching media temperature	quenching media temperature is checked using tools to ensure it is at required temperature
C-13.06.09P	move quenching media to proximity of furnace if required	quenching media is moved to proximity of furnace if required to reduce heat loss of part
C-13.06.10P	submerge and agitate part in quenching media	part is submerged and agitated in quenching media according to workpiece characteristics
C-13.06.11P	remove part from quenching media	part is removed from quenching media when suitable temperature and time are reached
C-13.06.12P	clean part to remove oil and scale	part is cleaned using cleaning methods to remove oil and scale

RANGE OF VARIABLES

case hardening method includes: carburizing, using gas, pack hardening, submerging, induction heating, nitriding

cleaning methods include: polishing, sandblasting, ultrasonic cleaning, descaling, degreasing

carburizing material includes: carbon powder, carbon monoxide

tools include: thermometers, infrared scopes

workpiece characteristics include: material, shape, size

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
C-13.06.01L	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
		describe heat treatment applications and their procedures
C-13.06.02L	demonstrate knowledge of case-hardening materials	identify effects of case-hardening material
		identify process for case hardening

TASK C-14 Tests heat treated materials

TASK DESCRIPTOR

Tool and die makers must be able to test heat-treated materials to determine the relative hardness. It is imperative to verify the hardness of the material to ensure that they meet design specifications.

C-14.01 Performs visual inspection

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-14.01.01P	select and use tools and equipment	tools and equipment are selected and used according to industry practices
C-14.01.02P	prepare workpiece surface to be tested	workpiece surface to be tested is prepared by cleaning and removing oxidization
C-14.01.03P	identify surface imperfections	surface imperfections are identified
C-14.01.04P	identify geometric deformations	geometric deformations are identified

RANGE OF VARIABLES

tools and equipment include: magnifiers, dye penetrant, microscopes

surface imperfections include: scratches, cracks, craters

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-14.01.01L	demonstrate knowledge of heat treatment and its applications	identify effect of heat on the properties of alloys and metals
		describe heat treatment processes and their applications
C-14.01.02L	demonstrate knowledge of visual inspections	define terminology associated with visual inspections
		identify tools and equipment used for visual inspections
		identify types of surface imperfections and geometric deformations

RANGE OF VARIABLES

tools and equipment include: magnifiers, dye penetrant, microscopes

surface imperfections include: scratches, cracks, craters

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

C-14.02 Performs hardness test

Essential Skills Numeracy, Document Use, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
C-14.02.01P	select and use tools and equipment	tools and equipment are selected and used according to material being tested
C-14.02.02P	prepare workpiece surface to be tested	workpiece surface to be tested is prepared by cleaning and removing scale and high spots
C-14.02.03P	verify hardness tester is functioning properly	functioning of hardness tester is verified by using standard calibration samples
C-14.02.04P	set up workpiece on hardness tester	workpiece is set up on hardness tester by aligning with indenting tool
C-14.02.05P	activate mechanisms to initiate hardness test	mechanisms are activated to initiate hardness test according to machine specifications
C-14.02.06P	record results of hardness test	results are recorded according to company policies and procedures, and material specifications

RANGE OF VARIABLES

tools and equipment include: hardness testers, charts, indenting tools, V-blocks, standard calibration samples

KNOWLEDGE

	Learning Outcomes	Learning Objectives
C-14.02.01L	demonstrate knowledge of heat treatment and its applications	describe the procedures used to determine properties of alloys and metals
		describe heat treatment processes and their applications

C-14.02.02L	demonstrate knowledge of hardness testing of materials	define terminology associated with hardness testing
		identify hazards and describe safe work practices pertaining to hardness testing
		identify the machines and scales used for hardness testing and describe their procedures
		identify tools and equipment used for hardness testing

RANGE OF VARIABLES

tools and equipment include: hardness testers, charts, indenting tools, V-blocks, standard calibration samples

properties of alloys and metals include: chemical, physical, mechanical

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

MAJOR WORK ACTIVITY D

Performs design and development of prototypes and production tools

TASK D-15 Performs production tool design

TASK DESCRIPTOR

Tool and die makers must be able to build production tools. Tool and die makers work in design of these production tools.

D-15.01 Identifies production tool requirements

Essential Skills Thinking, Oral Communication, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-15.01.01P	evaluate client production requirements	client's production requirements are evaluated
D-15.01.02P	determine type of tooling	type of tooling is determined according to part requirements
D-15.01.03P	determine tooling capability	tooling capability is determined according to part requirements and client production requirements

RANGE OF VARIABLES

production requirements include: volume, precision, quality, work centre capacity

tooling capability includes: rigidity, accuracy, repeatability, functionality

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-15.01.01L	demonstrate knowledge of basic production tool design	identify types of production tools and describe their applications
		identify limitations and capacity of shop equipment
		identify types and availability of materials used in production tool design
		identify material properties of the production part
		describe fool-proofing strategies in design

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

D-15.02

Prepares shop sketches

Essential Skills Thinking, Numeracy, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-15.02.01P	conceptualize design	design is conceptualized according to part requirements
D-15.02.02P	select and use sketching resources	sketching resources are selected and used according to company procedures
D-15.02.03P	apply sketching techniques	sketching techniques are applied to show all relevant features and dimensions as required for the design of the finished tool

RANGE OF VARIABLES

sketching resources include: paper and pencils, measuring tools, computers

sketching techniques include: CAD, freehand

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-15.02.01L	demonstrate knowledge of basic production tool design	identify types of production tools and describe their applications and procedures for use
		describe ergonomic principles and safe operation of production tools
		identify types and availability of materials used in production tool design
D-15.02.02L	demonstrate knowledge of sketching techniques	identify sketching techniques and their application

RANGE OF VARIABLES

sketching techniques include: CAD, freehand

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

D-15.03 Determines production tool material specifications and engineered components

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-15.03.01P	select tooling material	tooling material is selected according to functional requirements
D-15.03.02P	determine processes that will be required for finishing tooling components	processes are determined for finishing tooling components
D-15.03.03P	determine availability and feasibility of use of engineered components	availability and feasibility of use of engineered components are determined according to production schedule and cost effectiveness
D-15.03.04P	select engineered components	engineered components are selected according to tooling specifications and component availability

RANGE OF VARIABLES

processes include: machining operations, benchwork, surface treatments, heat treatment

engineered components (purchasable components) include: bushings, hinges, screws, dowels, die sets, wear plates

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-15.03.01L	demonstrate knowledge of basic production tool design	identify types of production tools and describe their applications
		identify engineered components and their applications
		describe properties, types and availability of materials used in production tools
		analyze financial considerations of design in order to maintain cost effectiveness

RANGE OF VARIABLES

engineered components (purchasable components) include: bushings, hinges, screws, dowels, die sets, wear plates

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

D-15.04

Prepares information for designing and drafting

Essential Skills Oral Communication, Working with Others, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-15.04.01P	finalize tool design criteria	tool design criteria is finalized according to part requirements
D-15.04.02P	compile list of engineered components	list of engineered components is compiled by catalogue number for purchasing requirements
D-15.04.03P	compile list of raw materials required for production tool components	list of raw materials is compiled for drawing specifications and purchasing requirements
D-15.04.04P	communicate information with design/drafting department	information is provided to design/drafting department to clarify requirements and provide context

RANGE OF VARIABLES

design criteria include: final dimensions, tolerances

engineered components (purchasable components) include: bushings, hinges, screws, dowels

production tools include: dies, jigs, fixtures, cutting tools, moulds

information includes: sketches, material lists, component lists

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-15.04.01L	demonstrate knowledge of basic production tool design	identify types of production tools and describe their applications
		identify engineered components and their applications
		describe types and availability of materials used in production tool design
D-15.04.02L	demonstrate knowledge of design/drafting process	describe design/drafting techniques
		identify information used in design/drafting

RANGE OF VARIABLES

engineered components (purchasable components) include: bushings, hinges, screws, dowels

production tools include: dies, jigs, fixtures, cutting tools, moulds

information includes: sketches, material lists, component lists

design/drafting techniques include: first and third angle projection, isometric drawing, orthographic drawings, GD&T

TASK D-16 Develops prototype

TASK DESCRIPTOR

Tool and die makers build a prototype to confirm design specifications by providing a physical model. Prototype may be a single piece or an assembly of components. The purpose of building a prototype is to demonstrate the targeted characteristics of a finished product to the client. Tool and die makers develop prototypes during part development but prior to production tooling.

D-16.01 Selects prototyping technique and materials

Essential Skills Thinking, Working with Others, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-16.01.01P	determine prototype materials	prototype materials are determined by matching prototype application with material characteristics according to resource availability
D-16.01.02P	select fabrication method	fabrication method is selected according to job specifications and resource availability
D-16.01.03P	determine fastening and joining techniques	fastening and joining techniques are determined according to workpiece characteristics

RANGE OF VARIABLES

prototype materials include: composites, woods, metals, plastics, resins

fabrication methods include: electronic modelling, hand forming, machining, rapid prototyping, 3D printing, welding

fastening and joining techniques include: adhesive bonding, soldering, welding, mechanical fastening

workpiece characteristics include: hardness, weight, mechanical properties

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-16.01.01L	demonstrate knowledge of prototypes, their techniques and materials	identify prototype materials , their workpiece characteristics and applications
		describe prototype fabrication methods
		describe fastening and joining techniques pertaining to prototypes

RANGE OF VARIABLES

prototype materials include: composites, woods, metals, plastics, resins

fabrication methods include: electronic modelling, hand forming, machining, rapid prototyping, 3D printing, welding

fastening and joining techniques include: adhesive bonding, soldering, welding, mechanical fastening

workpiece characteristics include: hardness, weight, mechanical properties

D-16.02 Fabricates prototype components

Essential Skills	Thinking, Working With Others, Continuous Learning
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NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
NV	yes	NV	yes	yes	yes	yes	ND	ND	yes	ND	ND	ND

SKILLS

	Performance Criteria	Evidence of Attainment
D-16.02.01P	apply fabrication method	fabrication method is applied according to job specifications
D-16.02.02P	draw sketches of prototype and components	sketches of prototype and components are drawn showing views of part relationships and assemblies
D-16.02.03P	prepare components for special treatment	components are prepared for special treatment according to job specifications
D-16.02.04P	prepare components for assembly	components are prepared for assembly using hand finishing techniques according to job specifications
D-16.02.05P	inspect components	components are inspected according to sketches and drawings

RANGE OF VARIABLES

fabrication methods include: electronic modelling, hand forming, machining, rapid prototyping, welding

special treatments include: heat treatment, coating

hand finishing techniques include: filing, polishing, honing

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-16.02.01L	demonstrate knowledge of fabricating prototype components	identify types of <i>fabrication methods</i> and their applications
		describe procedures used for sketching and laying out prototypes and their components
		identify types of <i>special treatments</i> for prototype components
		describe <i>hand finishing techniques</i> pertaining to prototype fabrication
D-16.02.02L	demonstrate knowledge of safe work practices pertaining to fabricating prototype components	identify safe work practices pertaining to fabricating prototype components

RANGE OF VARIABLES

fabrication methods include: electronic modelling, hand forming, machining, rapid prototyping, welding

special treatments include: heat treatment, coating

hand finishing techniques include: filing, polishing, honing

D-16.03 Assembles prototype components

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-16.03.01P	select and use <i>tools and equipment</i>	<i>tools and equipment</i> are selected and used according to job specifications
D-16.03.02P	set up components	components are set up according to prototype sketches and drawings
D-16.03.03P	develop <i>special tooling aids</i>	<i>special tooling aids</i> are developed for ease of assembly
D-16.03.04P	attach components to each other	components are attached to each other using <i>fastening techniques</i>

RANGE OF VARIABLES

tools and equipment include: clamps, indicators, hand tools, welding equipment, presses

special tooling aids include: clamps, fasteners, custom hand tools

fastening techniques include: using mechanical fasteners, welding, bonding, brazing

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-16.03.01L	demonstrate knowledge of prototype component assembly	identify tools and equipment used in prototype component assembly
		identify special tooling aids , their development and application
		describe fastening techniques used to attach prototype components to each other

RANGE OF VARIABLES

tools and equipment include: clamps, indicators, hand tools, welding equipment, presses

special tooling aids include: clamps, fasteners, custom hand tools

fastening techniques include: using mechanical fasteners, welding, bonding, brazing

D-16.04 Inspects prototype

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-16.04.01P	select and use measurement equipment	measurement equipment is selected and used according to job specifications
D-16.04.02P	perform visual inspection	visual inspection is performed to confirm appearance according to job specifications
D-16.04.03P	verify movements and interactions of components	movements and interactions of components are verified according to job specifications
D-16.04.04P	ensure completeness of prototype	completeness of prototype is ensured prior to final evaluation
D-16.04.05P	prepare quality assurance documentation	documentation is prepared to meet performance standards and traceability

RANGE OF VARIABLES

measurement equipment includes: calipers, indicators, CMM, micrometers, gauges

job specifications include: written instructions, photographs, sketches, samples, CAD

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-16.04.01L	demonstrate knowledge of prototype inspection procedures	describe prototype inspection procedures
		identify measurement equipment pertaining to prototype inspection and describe their procedures for use

RANGE OF VARIABLES

measurement equipment includes: calipers, indicators, CMM, micrometers, gauges

D-16.05 Proves out prototype

Essential Skills Document Use, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-16.05.01P	set up prototype for preparation and evaluation	prototype is set up for preparation and evaluation
D-16.05.02P	install pneumatic, hydraulic and robotic systems	pneumatic, hydraulic and robotic systems are installed according to prototype application
D-16.05.03P	test prototype functions	prototype functions are tested as per intended use
D-16.05.04P	diagnose malfunctions of prototype	malfunctions are diagnosed using evaluation methods to isolate the problem
D-16.05.05P	fix identified problems	identified problems are fixed by disassembling, modifying and repairing affected components
D-16.05.06P	confirm functionality of altered prototype	functionality of altered prototype is confirmed by repeating evaluation procedures

RANGE OF VARIABLES

evaluation methods include: visual inspection, measurement, functionality run

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
D-16.05.01L	demonstrate knowledge of prototype preparation and evaluation	identify types of physical tests
		describe evaluation methods used to evaluate prototypes
		describe procedures used to prepare a prototype to evaluate its functions

RANGE OF VARIABLES

evaluation methods include: visual inspection, measurement, functionality run

physical tests include: motion, load, fatigue

TASK D-17 Fits and assembles production tools

TASK DESCRIPTOR

Following the design of the production tools, all components must be fitted and assembled. Setting tool timing is important to achieve proper part and tool specifications.

D-17.01 Verifies dimensions of production tool components

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS		
	Performance Criteria	Evidence of Attainment
D-17.01.01P	select measuring instruments	measuring instruments are selected according to features and tolerances required
D-17.01.02P	take measurements	measurements are taken using measuring instruments
D-17.01.03P	compare measurements to drawings and sketches	measurements are compared to drawings and sketches to ensure conformity, fits and clearances

RANGE OF VARIABLES

measuring instruments include: micrometers, calipers, indicators, gauge blocks/pins, CMM, height gauge, sine bar or plate

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
D-17.01.01L	demonstrate knowledge of methods for verifying dimensions and features of production tool components	identify methods for verifying dimensions and features of production tool components
		identify measuring instruments , their applications and how to verify their accuracy

RANGE OF VARIABLES

measuring instruments include: micrometers, calipers, indicators, gauge blocks/pins, CMM, height gauge, sine bar or plate

features include: outside diameter, inside diameter, angles, depth, radius, chamfers, fillets

D-17.02 Performs production tool assembly

Essential Skills Document Use, Numeracy, Thinking

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

SKILLS		
	Performance Criteria	Evidence of Attainment
D-17.02.01P	organize production tool components and engineered components	production tool and engineered components are organized to facilitate assembly and ensure all required parts are present
D-17.02.02P	fasten production tool components temporarily	production tool components are fastened as required to permit adjustments for alignment and fit
D-17.02.03P	make necessary adjustments	adjustments are made for fit, clearance and function according to tooling specifications
D-17.02.04P	fasten or clamp production tool components temporarily	production tool components are fastened or clamped temporarily for final assembly
D-17.02.05P	drill, tap and ream locating holes	locating holes are drilled, tapped and reamed as required to permanently locate components

D-17.02.06P	fasten components permanently	components are fastened using fastening techniques
D-17.02.07P	verify final dimensions and fit	final dimensions and fit are verified according to tooling specifications

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

engineered components (purchasable components) include: bushings, hinges, screws, dowels

fastening techniques include: using mechanical fasteners, welding, bonding, brazing

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
D-17.02.01L	demonstrate knowledge of fitting and assembling production tools	identify types of production tools and describe their applications
		identify engineered components and their applications
		identify types of materials used in production tool development
		describe procedures used to fit and assemble production tools
D-17.02.02L	demonstrate knowledge of positioning production tool components	identify specifications for standard assembly fits and clearances
		identify production tool specifications
		identify types of fits
		describe clearance setting practices
D-17.02.03L	demonstrate knowledge of final assembly of production tool components	identify types of fasteners, fastening techniques, adhesives and solder used in the final assembly of production tool components

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

engineered components (purchasable components) include: bushings, hinges, screws, dowels

fastening techniques include: using mechanical fasteners, welding, bonding, brazing

production tool specifications include: cutting clearances, draft angles

fits include: interference, clearance, transition

clearance setting practices include: inserting material between working faces, using light source

fasteners include: screws, stripper bolts, set screws

adhesives include: temporary, permanent

D-17.03 Sets production tool timing

Essential Skills

Digital Technology, Numeracy, Thinking

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-17.03.01P	verify shut height	shut height is verified according to tool specifications
D-17.03.02P	verify final height of cutting punches	final height of cutting punches is verified to achieve punch penetration according to industry practices
D-17.03.03P	verify final position of forming punches	final position of forming punches is verified to achieve form of the part using lead check according to industry practices and part requirements
D-17.03.04P	verify timing of shredders and pads	timing of shredders and pads is verified according to part requirements and company policies and procedures
D-17.03.05P	verify cam engagement of stamping dies	cam engagement of stamping dies is verified to achieve required punch penetration or form according to industry practices, part requirements and tooling specifications
D-17.03.06P	verify cam engagement of moulds	cam engagement of moulds is verified to achieve required seal
D-17.03.07P	verify tooling components	tooling components are verified according to tooling specifications and company policies and procedures
D-17.03.08P	adjust tooling components	tooling components are adjusted to achieve required functioning of the tool and part specifications
D-17.03.09P	document changes to tooling	changes to tooling are documented for revision control
D-17.03.10P	set up and check die protection and sensors	die protection and sensors are set up and checked according to company policies and procedures

RANGE OF VARIABLES

tooling components include: stripper plates, ejectors, compression springs, bumper blocks, pressure pads, nitrogen cylinders

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-17.03.01L	demonstrate knowledge of fitting and assembling production tools	identify types of production tools and describe their applications identify engineered components and their applications identify tooling components
		describe procedures used to fit and assemble production tools
D-17.03.02L	demonstrate knowledge of production tool timing	describe procedures used to set production tool timing describe verification of shut height describe verification of final height of cutting punches describe verification of final position of forming punches describe verification of shedders and pads describe verification of cam engagement of stamping dies describe verification of cam engagement of moulds describe verification of tooling components

RANGE OF VARIABLES

tooling components include: stripper plates, ejectors, compression springs, bumper blocks, pressure pads, nitrogen cylinders

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

engineered components (purchasable components) include: bushings, hinges, screws, dowels, die sets, wear plates

TASK D-18 Proves out production tools

TASK DESCRIPTOR

New and reconditioned production tools must be proved out (tried out) before being put into service. Proving out means performing an initial tryout of a tool to ensure its safety, functionality and accuracy. It is particularly important to observe safety protocols in performing this task.

D-18.01 Sets up production tools

Essential Skills Thinking, Numeracy, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-18.01.01P	determine equipment for operation of production tool	equipment for operation of production tool is determined according to specifications
D-18.01.02P	install, align and secure production tool	production tool is installed, aligned and secured to equipment according to type of tool
D-18.01.03P	connect press accessory systems , mould accessory systems and fixture accessory systems	press accessory systems , mould accessory systems and fixture accessory systems are connected according to tooling specifications

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

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

press accessory systems include: stock feeders, hydraulic lines, pneumatic lines, electrical connections, parts catchers

mould accessory systems include: water lines, misters, parts catchers, conveyor systems, electrical connections

fixture accessory systems include: pneumatic lines, electrical connections

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-18.01.01L	demonstrate knowledge of proving out production tools	identify types of production tools and describe their applications describe procedures used to prove out production tools

D-18.01.02L	demonstrate knowledge of setting up production tools	describe safety considerations for operating production equipment
		identify types of dies
		identify types of jigs and fixtures
		describe intended function and operation of the production tool

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

dies include: draw dies, form dies, trim dies, progressive dies

jigs and fixtures include: checking fixtures, assembly fixtures, drill jigs, welding fixtures

D-18.02 Verifies production part material

Essential Skills Reading, Document Use, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-18.02.01P	ensure that material conforms to part requirements	material meets part requirements by interpreting material identification and specifications
D-18.02.02P	identify materials by physical properties	materials are identified by physical properties
D-18.02.03P	ensure that feed stock is free from defects	feed stock is free from defects that may impact final product quality or damage tool

RANGE OF VARIABLES

material identification includes: conformance documents, trace identification tags, markings on the material

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

physical properties include: camber, crowning, longitudinal bow, hardness, magnetism

defects include: damage, foreign matter, other contamination

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-18.02.01L	demonstrate knowledge of proving out <i>production tools</i>	identify types of <i>production tools</i> and describe their applications
		describe procedures used to prove out <i>production tools</i>
D-18.02.02L	demonstrate knowledge of production parts	identify <i>material specifications</i> pertaining to production parts
		identify <i>material classifications</i> pertaining to production parts

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

material specifications include: composition, thickness, hardness, ductility, malleability

material classifications include: ANSI, Society of Automotive Engineers (SAE), ASME, Canadian Standards Association (CSA)

D-18.03 Develops blank/strip

Essential Skills Thinking, Numeracy, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-18.03.01P	calculate amount of material for finished shape	amount of material for finished shape is calculated according to industry practices
D-18.03.02P	select press and settings	press and settings are selected according to material and tooling specifications
D-18.03.03P	perform circle grid analysis	circle grid analysis is performed according to industry practices to assess material flow
D-18.03.04P	develop draw radius and adjust clamping force on the blank/strip	draw radius is developed and clamping force is adjusted using draw beads to achieve uniform material thickness
D-18.03.05P	evaluate <i>material changes</i>	<i>material changes</i> are evaluated to maintain dimensions to specifications

D-18.03.06P	verify profile geometry	profile geometry is verified against part drawing using measuring instruments
D-18.03.07P	record final blank/strip dimensions	final blank/strip dimensions are recorded to manufacture production blanks/strips

RANGE OF VARIABLES

material changes include: thinning, thickening, folding, flow, wrinkling

measuring instruments include: micrometers, calipers, indicators, gauge blocks/pins, CMM, height gauge, sine bar or plate

KNOWLEDGE		
	Learning Outcomes	Learning Objectives
D-18.03.01L	demonstrate knowledge of proving out production tools	identify types of production tools and describe their applications
		describe procedures used to prove out production tools
D-18.03.02L	demonstrate knowledge of blank/strip development	describe blank/strip material characteristics
		describe procedures used in blank development
		describe procedures used in strip development

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

blank/strip material characteristics include: composition, thickness, hardness, ductility, malleability

D-18.04 Cycles equipment with production tools

Essential Skills

Thinking, Numeracy, Oral Communication

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-18.04.01P	verify clearances and interferences	clearances and interferences between equipment, production tool and workpiece are verified
D-18.04.02P	operate machine-tool at reduced rate	machine-tool is operated at reduced rate to verify function and minimize risk of damage to equipment and production part according to company policies and procedures
D-18.04.03P	verify and adjust timing	timing is verified and adjusted to optimize tool performance
D-18.04.04P	adjust die components	die components are adjusted according to tooling and part specifications
D-18.04.05P	adjust accessories	accessories are adjusted according to tooling and part specifications
D-18.04.06P	perform press adjustments	press adjustments are performed according to tooling and part specifications
D-18.04.07P	assess production at normal conditions	production is assessed at normal conditions to ensure that part volume and consistency are optimal and to observe trends in production

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

machine-tools include: lathes, drills, grinders, saws, milling machines

die components include: stripper plate, die springs, punches, pilots, strip levels, forms, horns

accessories include: feeders, coils, straighteners, air blower, lubrication system

press adjustments include: shut height, pressure pads, limit switches, counterbalance, temperature

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-18.04.01L	demonstrate knowledge of proving out production tools	identify types of production tools and describe their applications describe procedures used to prove out production tools

D-18.04.02L	demonstrate knowledge of cycling equipment with production tools	identify types of machine-tools
		identify types of cycling equipment

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

machine-tools include: lathes, drills, grinders, saws, milling machines

cycling equipment includes: feeders, cams, presses

D-18.05 Evaluates production part

Essential Skills Numeracy, Document Use, Writing

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-18.05.01P	examine part visually	part is examined visually for deficiencies
D-18.05.02P	measure part dimensions	part dimensions are measured to confirm that measurements conform to part specifications
D-18.05.03P	document results of evaluation	results are documented including data according to company policies and procedures

RANGE OF VARIABLES

deficiencies include: poor surface finish, burrs, part damage

data includes: critical dimensions, surface finish, tolerances, functionality, repeatability

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-18.05.01L	demonstrate knowledge of evaluating production parts	identify material specifications pertaining to production parts and describe their relationship to evaluating production parts
		identify material classifications pertaining to evaluation of production parts
		identify types of part deficiencies
		describe measuring equipment used to evaluate production parts

RANGE OF VARIABLES

deficiencies include: poor surface finish, burrs, part damage

material specifications include: composition, thickness, hardness, ductility, malleability

material classifications include: ANSI, SAE, ASME, CSA

D-18.06 Checks production tool for damage

Essential Skills Numeracy, Thinking, Continuous Learning

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

SKILLS

Performance Criteria

Evidence of Attainment

D-18.06.01P	visually inspect tools	tools are inspected visually for damage using optical aids if required
D-18.06.02P	document damage	damage is documented according to company policies and procedures

RANGE OF VARIABLES

damage includes: cracks, breaks, deformities, misalignments

optical aids include: loupe eyeglasses, magnifiers, flashlight

KNOWLEDGE

Learning Outcomes

Learning Objectives

D-18.06.01L	demonstrate knowledge of inspection techniques	identify types of tool damage
		describe procedures for detecting production tool damage

RANGE OF VARIABLES

damage includes: cracks, breaks, deformities, misalignments

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

D-18.07 Modifies production tools to enhance productivity

Essential Skills Numeracy, Thinking, Continuous Learning

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-18.07.01P	adjust mechanisms	mechanisms are adjusted
D-18.07.02P	adjust production tools	production tools are adjusted by changing tool materials and components
D-18.07.03P	recommend surface treatment coatings	surface treatment coatings are recommended to enhance productivity and wear resistance of production tools
D-18.07.04P	streamline load and unload processes	load and unload processes are streamlined to reduce cycle time

RANGE OF VARIABLES

mechanisms include: stock feeders, limit switches, air blowers, air clamps, equipment fixtures, lubrication systems

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

surface treatment coatings include: nitride, plating, anodizing, cryogenic, titanium

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-18.07.01L	demonstrate knowledge of production tool modification	identify mechanisms that could be adjusted to enhance productivity
		identify types of surface treatment coatings
		describe procedures used to modify production tools

RANGE OF VARIABLES

mechanisms include: stock feeders, limit switches, air blowers, air clamps, equipment fixtures, lubrication systems

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

surface treatment coatings include: nitride, plating, anodizing, cryogenic, titanium

TASK D-19 Repairs and maintains production tools

TASK DESCRIPTOR

Tool and die makers have to ensure that production tools maintain required accuracy. It is essential that they recognize the need for repair, identify the correct repair procedure and perform reconditioning of these tools.

D-19.01 Identifies condition of production tools

Essential Skills Thinking, Numeracy, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.01.01P	monitor and evaluate production part	production part is monitored and evaluated according to part specifications
D-19.01.02P	observe operation of production tool	operation of production tool is observed for production tool defects and need for repair, adjustment or reconditioning is evaluated
D-19.01.03P	compare condition of production tools to original specifications	condition of production tools is compared to original specifications using measuring instruments
D-19.01.04P	record production tool defects	production tool defects are recorded according to company policies and procedures

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

production tool defects include: worn components, broken clamps, worn surfaces, broken edges

measuring instruments include: micrometers, calipers, indicators, gauge blocks/pins, CMM, height gauge, sine bar or sine plate, digital measuring media

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-19.01.01L	demonstrate knowledge of production tool development and operation	identify types of production tools and describe their applications
		describe engineered components and their applications
		identify types and availability of alloys used in production tool development

D-19.01.02L	demonstrate knowledge of production tool repair and maintenance	identify measuring instruments and describe their applications and procedures for use
		identify types of production tool defects and describe their effects on part

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

production tool defects include: worn components, broken clamps, worn surfaces, broken edges

measuring instruments include: micrometers, calipers, indicators, gauge blocks/pins, CMM, height gauge, sine bar or sine plate, digital measuring media

engineered components (purchasable components) include: bushings, hinges, screws, dowels

alloys include: tool steels, low-carbon steels, medium-carbon steels, powdered-metal steel

D-19.02 Identifies repair procedures

Essential Skills Thinking, Writing, Working with Others

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.02.01P	identify production tool defects	production tool defects are identified
D-19.02.02P	determine repair procedure	repair procedure is determined according to production tool defects and tool type

RANGE OF VARIABLES

production tool defects include: chips, cracks, edge wear

repair procedure includes: disassembling, resurfacing, polishing, adjusting timing of die mechanisms, sharpening, replacing components

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-19.02.01L	demonstrate knowledge of production tool development and operation	identify types of production tools and describe their applications
		describe engineered components and their applications
		identify types and availability of alloys used in production tool development

D-19.02.02L	demonstrate knowledge of repair procedures for production tools	describe types of production tool defects
		describe repair procedures

RANGE OF VARIABLES

production tool defects include: chips, cracks, edge wear

repair procedure includes: disassembling, resurfacing, polishing, adjusting timing of die mechanisms, sharpening, replacing components

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

engineered components (purchasable components) include: bushings, hinges, screws, dowels

alloys include: tool steels, low-carbon steels, medium-carbon steels, powdered-metal steel

D-19.03 Adjusts production tool components

Essential Skills Writing, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.03.01P	perform jig and fixture adjustments	jig and fixture adjustments are performed based on observations and measurements according to company policies
D-19.03.02P	perform die adjustments	die adjustments are performed based on observations and measurements according to company policies
D-19.03.03P	perform mould adjustments	mould adjustments are performed based on observations and measurements according to company policies
D-19.03.04P	verify that production part conforms to specifications	production part meets specifications according to drawings and measurements
D-19.03.05P	record production tool adjustments	production tool adjustments are recorded according to company policies and procedures

RANGE OF VARIABLES

jig and fixture adjustments include: shimming, realigning, levelling, relocating stops

die adjustments include: shimming, peening, realigning, welding

mould adjustments include: shimming, realigning

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-19.03.01L	demonstrate knowledge of production tool development and operation	identify types of production tools and describe their applications
		describe engineered components and their applications
		identify types and availability of alloys used in production tool development
D-19.03.02L	demonstrate knowledge of production tool adjustment procedures	identify types of adjustments that can be made on production tools
		describe procedures used to adjust production tools

RANGE OF VARIABLES

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

engineered components (purchasable components) include: bushings, hinges, screws, dowels

alloys include: tool steels, low-carbon steels, medium-carbon steels, powdered-metal steel

D-19.04 Reconditions production tool components

Essential Skills Writing, Thinking, Numeracy

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

SKILLS

	Performance Criteria	Evidence of Attainment
D-19.04.01P	prepare and clean component	component is prepared and cleaned to remove contaminants using cleaning methods
D-19.04.02P	remove excess production part material	excess production part material is removed using finishing tools and equipment
D-19.04.03P	determine reconditioning method	reconditioning method is determined according to part and component condition
D-19.04.04P	repair components	components are repaired by machining or applying surface treatments
D-19.04.05P	fabricate new components for production tools	new components are fabricated when components are damaged beyond repair
D-19.04.06P	replace engineered components	engineered components are replaced according to requirements

D-19.04.07P	inspect reconditioned component	reconditioned component is inspected to confirm completeness of repair
D-19.04.08P	perform sharpening of dies and resurfacing of moulds	dies are sharpened and moulds are resurfaced according to part condition
D-19.04.09P	record production tool reconditioning	production tool reconditioning is recorded according to company policies and procedures

RANGE OF VARIABLES

cleaning methods include: polishing, sandblasting, ultrasonic cleaning, descaling, degreasing

finishing tools and equipment include: abrasive stones, polishing media, grinder, polisher

reconditioning methods include: machining, applying surface treatments, replacing components, welding, coating

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

engineered components include: bushings, hinges, screws, dowels

KNOWLEDGE

	Learning Outcomes	Learning Objectives
D-19.04.01L	demonstrate knowledge of production tool development and operation	identify types of production tools and describe their applications describe engineered components and their applications
D-19.04.02L	demonstrate knowledge of procedures used to recondition production tool components	identify machine tools and hand tools used to recondition worn and damaged components identify extent of damage to components identify and describe reconditioning methods

RANGE OF VARIABLES

reconditioning methods include: machining, applying surface treatments, replacing components, welding, coating

production tools include: forging dies, jigs, fixtures, cutting tools, moulds

engineered components include: bushings, hinges, screws, dowels

APPENDIX A

ACRONYMS

AHJ	authorities having jurisdiction
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
CSA	Canadian Standards Association
EDM	electrical discharge machine
GD&T	geometric dimensioning and tolerancing
MTR	material test report
OH&S	Occupational Health and Safety
PC	personal computer
PPE	personal protective equipment
SAE	Society of Automotive Engineers
SDS	safety data sheet
TDG	transportation of dangerous goods
TDS	tap drill size
TPI	threads per inch
WHMIS	Workplace Hazardous Materials Information System

APPENDIX B

TOOLS AND EQUIPMENT / OUTILS ET ÉQUIPEMENT

Hand Tools / Outils à main

abrasive stones	pierres abrasives
bearing extractor	extracteur de paliers
brushes	brosses
chisels	ciseaux à froid
chuck key	clé de mandrin
clamp	serre-joint
deburrers	ébarbeur
dressing stick	bâton dresseur
drill drift	chasse-foret
drill gauge	jauge de perçage
file cards	cardes à lime
file handles	manches de limes
files	limes
grease guns	pistolets graisseurs
hacksaws and blades	scies à métaux et lames
hammers/mallets	marteaux/maillots
hand reamers	alésoir à main
hex keys	clés hexagonales
honing stones	pierres à roder
	marbre de dressage
lapping plate	
loupe eyeglass	lunette-loupe
magnifying screens and glasses	écrans grossissants et loupes
metal stamps	étampes à métaux
oil cans/guns	burettes/pistolets huileurs
pliers	pincés
punches and bars	poinçons et leviers
rasps	râpes
scrapers	grattoirs
screwdrivers	tournevis
soft jaws	mordaches
spotting blue (Prussian blue)	bleu de traçage (bleu de Prusse)
tap extractors	extracteurs de tarauds

tap wrenches
temperature sticks
tin snips
torch strikers
wheel dressers (hand held)
wrenches

tourne-à-gauche
crayon thermo-sensible
cisailles de ferblantier
allumoir de bec de chalumeau
dresse-meules (à main)
clés

Power Tools / Outils mécaniques

air grinder
bench grinder
die grinder
disc grinder
drill press
pencil grinder
portable drill

rectifieuse pneumatique
meuleuse d'établi
meule à rectifier les matrices
meuleuse à disque
perceuse à colonne
meuleuse-crayon
perceuse portative

Machine Tools / Machines-outils

abrasive cut-off saw
computer numerical control (CNC) machine
milling center
CNC turning center
die spotting press
drilling machines
electrical discharge machine (EDM)
grinders (surface, cylindrical, jig, tool cutter)

jig bore
lathe
milling machines
power saws
press (hydraulic, pneumatic, mechanical)

scie de tronçonnage abrasive
centre de fraisage CNC

centre de tournage CNC
presse à présenter
perceuses
machine d'usinage par étincelage
rectifieuses (planes, cylindriques, gabarits, outils de coupe)
machine à pointer
tour
fraiseuses
scies mécaniques
presse (hydraulique, pneumatique, mécanique)

Cutting Tools / Outils de coupe

abrasive wheels
boring bars
broaches
counterbore
countersink
drill bits

disques abrasifs
barres d'alésage
broches
outils à chambrer
fraise conique
forets

EDM electrodes	électrodes pour machine d'usinage par étincelage
grinding wheels	meules
knurling tools	outils à moleter
milling cutters	fraises
parting-off tools	outils à tronçonner
reamers	alésoirs
saw blades	lames de scie
spot faces	fraises à lamer
taps and die	tarauds et matrices
turning tools	outils de tour

Personal Protective Equipment (PPE) and Safety Equipment / Équipement de protection individuelle (EPI) et équipement de sécurité

dust mask	masque antipoussières
eye wash station	douche oculaire
fall arrest equipment	équipement antichute
fire blanket	couverture ignifugée
fire extinguishers	extincteurs
fire hoses	tuyaux d'incendie
first aid station	poste de premiers soins
goggles/safety glasses/face shield/side shield	lunettes de protection / lunettes de sécurité / écran facial / écran latéral
hand protection	gants
hearing protectors	protecteurs auriculaires
protective head gear	casques protecteurs
respirators	appareils respiratoires
safety barrier tapes	ruban de barrière de sécurité
safety boots	bottes de sécurité
thermal hand protection	gants thermiques
thermal outerwear	vêtements thermiques

Layout Equipment / Équipement de traçage

combination set	jeu d'équerres
dividers and trammels	compas à pointes sèches et compas d'ellipse
etchers	outil à graver
height gauge	jauge de hauteur
hermaphrodite calipers	compas hermaphrodites
layout dye	aniline de traçage
layout table	table de traçage

punches
scribers
squares
surface gauges
surface plates / surface tables

poinçon
pointes à tracer
équerres
jauges de surface
marbres

Measuring Tools / Instruments de mesure

angle block or slip
angle plate
bore gauge
calipers
combination square
coordinate measuring machine (CMM)
deflection tester
depth gauge
destructive testing equipment
dial indicators
die maker square
electronic measuring devices
feeler gauge
gauge blocks
gauge pins
hardness tester
height micrometer
measuring rods
measuring tape
micrometers
non-destructive testing equipment
optical comparator (shadow graph)
optical flats
precision blocks
precision level
protractor
radius gauge
refractometer
sine bar (compound)
sine plate (compound)
small hole gauge

bloc d'angle ou cale étalon
équerre de montage
jauge d'alésage
pieds à coulisse
équerre combinée
machine de mesure des coordonnées (MMC)
appareil d'essai de flexion
jauge de profondeur
matériel d'essais destructifs
comparateur à cadran
équerre de matricier
appareils de mesure électroniques
jauge d'épaisseur
cales étalons
piges
duromètre
micromètre de hauteur
piges graduées
ruban à mesurer
micromètre
matériel d'essais non destructifs
projecteur de profil (comparateur optique)
plans optiques
cales étalons de précision
niveau de précision
rapporteur d'angles
jauge à rayon
réfractomètre
barre-sinus (composée)
plaque-sinus (composée)
jauge à petit diamètre

squares	équerres
steel rules	règles en acier
surface finish comparator	profilomètre
surface plate	marbres
telescopic gauge	jauge télescopique
temperature block	étalons de température
tensile strength tester	appareil d'essai de résistance à la traction
thermometer	thermomètre
thread gauge	jauge de filetage
thread measuring wires	fils de mesure de filet
tooling ball	billes d'outillage
vernier caliper	pied à coulisse
vernier height gauge	jauge de hauteur
vernier protractor	rapporteur d'angles

Heat Treating Equipment / Équipement de traitement thermique

fire brick	brique réfractaire
furnaces	fours
ladles	poches de coulée
quenching mediums	éléments de trempage
shot/sand blaster	décapeuse au jet de sable/grenailleuse
stainless steel wrap	enveloppe en acier inoxydable
tongs	pincés
torches	chalumeaux

Accessories and Work Holding Devices / Accessoires et organes de serrage

Adaptors	adaptateurs
angle plates	équerres de montage
Anvils	enclumes
arbour press	presse à mandriner
Arbours	arbres
boring heads	têtes d'alésage
centre and edge finders	instrument pour trouver le centre et les côtés
Centres	pointes
chucks	mandrins
Clamps	serre-joints
Collets	pincés de serrage
Crane	grue

degreasing tanks	réservoir de dégraissage
die light	lampe d'outilleur-ajusteur
die stands	porte-filières
dividing head	diviseur
drill chuck	mandrin de perçage
drive dogs	griffes
drive plate	plateaux d'entraînement
electronic devices and software	appareils électroniques et logiciels
faceplates	plateaux à trous
follower/travelling rest	lunette à suivre
forklift	chariot élévateur à fourche
grinding attachment	appareil à rectifier
grinding wheel balancers	équilibreuse à meule
grinding wheel dressers	dresse-meules
hoists	palans
indexing heads	têtes diviseurs
jacks	crics
lathe centres	pointes de tour
lathe dogs	tocs d'entraînement
machine vice	étau de machine
mandrels	mandrins
parallels	cales parallèles
precision stops	butées de précision
quick change toolpost	tourelle à changement rapide
rigging equipment and accessories	équipement et accessoires de gréage
rotary grinding attachments	accessoires à rectifier rotatifs
rotary table	table tournante
shim stock	échantillonnage de cales
spacers	douilles entretoises
steady rest	lunette fixe
tail stock	poupée-mobile
taper sleeves	manchons coniques
taper turning attachment	dispositif de tournage conique
tapping head	tête de taraudage
tool holders	porte-outils
trip dogs	taquets de déclenchement
turret toolpost	tourelle
v-block	bloc en V

vices

étaux

APPENDIX C

GLOSSARY / GLOSSAIRE

anneal	softening hardened steel through the heat treatment process	recuit	adoucissement de l'acier durci par traitement thermique
boring	a machining process that produces a cylindrical or conical hole using a single point tool	alésage	procédé d'usinage permettant de produire des trous cylindriques ou coniques avec un outil à tranchant unique
carburize	the process of impregnating the surface of steel with carbon	cémentation au carbone	procédé permettant d'imprégner de carbone la surface de l'acier
computer numerical control (CNC)	the control of a machine tool using coded instructions	machine à commande numérique par ordinateur (CNC)	commande d'une machine au moyen d'instructions codées
die	a device for cutting or forming material to produce a finished product	matrice	dispositif servant à couper ou à former des matériaux pour obtenir un produit fini
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	machine permettant de percer des trous dans des pièces à usiner ; il est aussi possible d'effectuer de l'alésage à l'alésair, du taraudage, du lamage et du fraisage avec une perceuse à colonne
fixture	a work holding device that holds and locates a workpiece	porte-pièce	dispositif de serrage permettant de tenir et de placer une pièce à usiner
grinder	a machine that removes material from workpieces using abrasive wheels	rectifieuse	machine servant à retirer du matériau des pièces à usiner au moyen de disques abrasifs
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
jig	a device that locates a piece in position to guide a cutting tool	gabarit	dispositif maintenant une pièce en position pour guider un outil de coupe
knurling	using a tool to produce a pattern on the diameter of a workpiece in a lathe	moletage	utilisation d'un outil pour former un motif sur le diamètre d'une pièce à usiner sur un tour
lathe	a machine-tool that holds and rotates the workpiece; a cutting tool is moved on slideways to cut cylindrical, tapered or threaded features on a workpiece	tour	machine-outil sur laquelle une pièce à usiner est maintenue et mise en rotation et sur laquelle un outil de coupe se déplace latéralement pour produire des éléments cylindriques et coniques ou tailler des filets sur la pièce à usiner
machine-tool	a stationary, usually heavy and non-portable, power-driven machine used to cut, shape, or form metals	machine-outil	machine à entraînement mécanique, stationnaire et habituellement lourde et non portative utilisée pour couper ou former des métaux

<i>Machinery's Handbook</i>	a reference book used in manufacturing by professionals such as engineers, toolmakers and machinists	<i>Machinery's Handbook</i>	document de référence en fabrication utilisé par les ingénieurs, les outilleurs et les machinistes
mill	a machine that cuts surfaces and contours by holding the workpiece against a rotating cutter with single or multiple cutting edges	fraiseuse	machine taillant des surfaces et des contours en maintenant la pièce à usiner contre un outil de coupe rotatif à arête unique ou à arêtes multiples
mould	tool used to manufacture components in large quantities	moule	outil servant à fabriquer des pièces en grandes quantités
normalize	removing internal stress from the metal	recuit de normalisation	procédé permettant d'éliminer les contraintes résiduelles des métaux
production tools	types of custom made specialty devices used in the production of quantities of components by repetitive manufacturing operations. They may perform operations such as cutting, forming or moulding of individual components; they may be tools which align and hold parts for secondary operations and assembly; or they may be measuring tools used to qualify final parts during inspection. A few examples are metal stamping dies, plastic injection moulds, assembly fixtures, drill jigs, templates and gauges	outils de production	types de dispositifs spécialisés et personnalisés utilisés pour produire beaucoup de composants à l'aide d'opérations de fabrication répétitives. Ils peuvent servir dans des opérations comme le découpage, le formage ou le moulage de composants individuels ; il peut s'agir d'outils qui alignent et tiennent des pièces pour les opérations secondaires et le montage, ou d'outils de mesure utilisés pour sélectionner les pièces finales durant l'inspection. Voici quelques exemples : les matrices d'emboutissage de métal, les moules d'injection de plastique, les dispositifs d'assemblage, les gabarits de perçage, les autres types de gabarits, tous les types de jauges
prototype	a test product manufactured to assist in the development of an end product	prototype	produit expérimental fabriqué pour aider à l'élaboration d'un produit fini
proves out	procedure to test out prototypes, jigs, fixtures and dies for function	essai	processus visant à essayer les prototypes, les gabarits, les porte-pièces et les matrices pour vérifier leur fonctionnement
quench	cooling heated material at a pre-determined rate to set the material hardness	trempe	refroidissement à une vitesse prédéterminée d'un matériau chauffé pour le durcir
saw	a machine used to cut materials using a multi-tooth blade	scie	machine servant à couper les matériaux au moyen d'une lame à plusieurs dents
spot face	a flat surface at 90° to a hole	lamage	surface plate à 90° par rapport à un trou
tapping	cutting threads within a hole using a cutting tool called a tap	tarauder	tailler des filets à l'intérieur d'un trou avec un outil de coupe appelé taraud

temper	a method of changing the hardness of steel parts by first heating to a low temperature then cooling; tempering improves toughness	revenu	procédé permettant de modifier la dureté des pièces en acier qui consiste en un réchauffage suivi d'un refroidissement ; le revenu permet d'améliorer la résistance
tooling	generally refers to the collection of production tools used within a manufacturing facility for their particular processes (see also production tools)	outillage	renvoie en général à l'ensemble des outils de production utilisés dans une usine pour leurs procédés spécifiques (voir outils de production)