

# COMPETENCY-BASED OCCUPATIONAL FRAMEWORK FOR REGISTERED APPRENTICESHIP

## CNC Set-Up Programmer

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# Competency-Based Occupational Frameworks

The Urban Institute, under contract by the U.S. Department of Labor, has worked with employers, subject matter experts, labor unions, trade associations, credentialing organizations and academics to develop Competency-Based Occupational Frameworks (CBOF) for Registered Apprenticeship programs. These frameworks defined the **purpose** of an occupation, the **job functions** that are carried out to fulfill that purpose, the **competencies** that enable the apprentice to execute those job functions well, and the **performance criteria** that define the specific knowledge, skills and personal attributes associated with high performance in the workplace. This organizational hierarchy – Job Purpose – Job Functions – Competencies – Performance Criteria – is designed to illustrate that performing work well requires more than just acquiring discrete knowledge elements or developing a series of manual skills. To perform a job well, the employee must be able to assimilate knowledge and skills learned in various settings, recall and apply that information to the present situation, and carry out work activities using sound professional judgement, demonstrating an appropriate attitude or disposition, and achieving a level of speed and accuracy necessary to meet the employer’s business need.

The table below compares the terminology of Functional Analysis with that of traditional Occupational Task Analysis to illustrate the important similarities and differences. While both identify the key technical elements of an occupation, Functional Analysis includes the identification of behaviors, attributes and characteristics of workers necessary to meet an employer’s expectations.

Framework Terminology	Traditional Task Analysis Terminology
Job Function – the work activities that are carried out to fulfill the job purpose	Job Duties – roles and responsibilities associated with an occupation
Competency – the actions an individual takes and the attitudes he/she displays to complete those activities	Task – a unit of work or set of activities needed to produce some result
Performance Criteria – the specific knowledge, skills, dispositions, attributes, speed and accuracy associated with meeting the employer’s expectations	Sub Task – the independent actions taken to perform a unit of work or a work activity

Although designed for use in competency-based apprenticeship, these Competency-Based Occupational Frameworks also support time-based apprenticeship by defining more clearly and precisely what an apprentice is expected to learn and do during the allocated time-period.

CBOFs are comprehensive to encompass the full range of jobs that may be performed by individuals in the same occupation. As employers or sponsors develop their individual apprenticeship programs, they can extract from or add to the framework to meet their unique organizational needs.

## Components of the Competency-Based Occupational Framework

**Occupational Overview:** This section of the framework provides a description of the occupation including its purpose, the setting in which the job is performed and unique features of the occupation.

**Work Process Schedule:** This section includes the job functions and competencies that would likely be included in an apprenticeship sponsor's application for registration. These frameworks provide a point of reference that has already been vetted by industry leaders so sponsors can develop new programs knowing that they will meet or exceed the consensus expectations of peers. Sponsors maintain the ability to customize their programs to meet their unique needs, but omission of a significant number of job functions or competencies should raise questions about whether or not the program has correctly identified the occupation of interest.

**Cross-cutting Competencies:** These competencies are common among all workers, and focus on the underlying knowledge, attitudes, personal attributes and interpersonal skills that are important regardless of the occupation. That said, while these competencies are important to all occupations, the relative importance of some versus others may change from one occupation to the next. These relative differences are illustrated in this part of the CBOF and can be used to design pre-apprenticeship programs or design effective screening tools when recruiting apprentices to the program.

**Detailed Job Function Analysis:** This portion of the framework includes considerable detail and is designed to support curriculum designers and trainers in developing and administering the program. There is considerable detail in this section, which may be confusing to those seeking a more succinct, higher-level view of the program. For this reason, we recommend that the Work Process Schedule be the focus of program planning activities, leaving the detailed job function analysis sections to instructional designers as they engage in their development work.

- a. **Related Technical Instruction:** Under each job function appears a list of foundational knowledge, skills, tools and technologies that would likely be taught in the classroom to enable the apprentice's on-the-job training safety and success.

- b. Performance Criteria: Under each competency, we provide recommended performance criteria that could be used to differentiate between minimally, moderately and highly competent apprentices. These performance criteria are generally skills-based rather than knowledge-based, but may also include dispositional and behavioral competencies.

## **Using the Competency-Based Occupational Framework to Develop a Registered Apprenticeship Program**

When developing a registered apprenticeship program, the Work Process Schedule included in this CBOF provides an overview of the job functions and competencies an expert peer group deemed to be important to this occupation. The Work Process Schedule in this document can be used directly, or modified and used to describe your program content and design as part of your registration application.

When designing the curriculum to support the apprenticeship program – including on the job training and related technical instruction – the more detailed information in Section 5 could be helpful. These more detailed job function documents include recommendations for the key knowledge and skill elements that might be included in the classroom instruction designed to support a given job function, and the performance criteria provided under each competency could be helpful to trainers and mentors in evaluating apprentice performance and insuring inter-rater reliability when multiple mentors are involved.

# CNC Set-Up Programmer Occupational Overview

## Occupational Purpose and Context

CNC Set-up Programmers work in the private sector in industries such as the automotive, aviation/aerospace, rail, ship and heavy truck industries. These workers operate computer-controlled machines or robots to perform several machine functions on metal or plastic work pieces. They are critical to ensuring the smooth operation of the CNC controlled manufacturing equipment of their worksite. They help to ensure through the work that they do, that industrial machinery and equipment is maintained at the highest possible level, quality of the hardware they produce, ensuring the productivity and safety of the entire production team. They also oversee Quality Assurance, verification, and inspection of equipment.

CNC Set-up Programmers represent the culmination of the receipt of several different credentials and certifications and as a result, are subject matter experts in the equipment they work with.

## Potential Job Titles

Brake Press Operator; Computer Numerical Control Lathe Operator (CNC Lathe Operator); Computer Numerical Control Machine Operator (CNC Machine Operator); Computer Numerical Control Machinist (CNC Machinist); Computer Numerical Control Mill Operator (CNC Mill Operator); Computer Numerical Control Operator (CNC Operator); Computer Numerical Control Set-Up and Operator (CNC Set-Up and Operator); Machine Operator; Machine Set-Up, Operator; Machinist

## Attitudes and Behaviors

CNC Set-up Programmers should: have well developed critical thinking skills to solve problems quickly; have strong interpersonal skills including good listening skills, cultural sensitivity, and creating a team environment; be able to understand the implications of new information and how to utilize it in problem

solving and decision making, be able to pay attention to specifics or details and record information and stay focused despite distractions; be able to combine pieces of information to form general rules or conclusions; and be able to arrange objects or actions in an order or pattern related to a specific rule or set of rules.

## Apprenticeship Prerequisites

Some apprenticeship programs may require apprentices to pass drug testing prior to commencing the apprenticeships.

## Occupational Pathways

CNC Set-up Programmers may move from production and assembly jobs to quality assurance positions, production control jobs, inventory management positions, and supervisory roles.

## Certifications, Licensure and Other Credential Requirements

<b>CREDENTIAL</b>	<b>Offered By</b>	<b>Before, During or After Apprenticeship</b>
<b>Measurement, Materials, and Safety Level I</b>	NIMS	During
<b>Job Planning, Benchwork, and Layout Level I</b>	NIMS	During
<b>Drill Press Skills Level I</b>	NIMS	During
<b>Milling Level I</b>	NIMS	During
<b>CNC Milling Level I, II, and III</b>	NIMS	During
<b>Turning Between Centers Level</b>	NIMS	During
<b>Chucking Level I</b>	NIMS	During
<b>CNC Turning Level I, II, and III</b>	NIMS	During

## Job Functions

JOB FUNCTIONS		Core or Optional
1.	Demonstrates basics of measurement, materials, and safety of products and parts	Core
2.	Conducts job planning, layout, and benchwork	Core
3.	Operates manufacturing equipment	Core
4.	Generates CNC programming and operate a milling machine	Core
5.	Demonstrates CNC turning operations and operates a CNC lathe	Core
6.	Conducts general housekeeping and maintenance	Core
7.	Engages in career management and employee relations	Optional

## Stackable Programs

This occupational framework is designed to link to the following additional framework(s) as part of a career laddering pathway. Note that these programs should be completed before becoming a CNC Set-Up Programmer which is an advanced occupational skill which takes years to achieve.

Stackable Programs		Base or Higher Level	Stacks on top of
1.	CNC Milling	Base Program	
2.	CNC Turning	Base Program	
3.	CNC Machinist	Base Program	
4.	CNC Operator	Base Program	
5.	CNC Programmer	Base Program	

# Options and Specializations

The following options and specializations have been identified for this occupation. The Work Process Schedule and individual job function outlines indicate which job functions and competencies were deemed by industry advisors to be optional. Work Process Schedules for Specializations are included at the end of this document.

Options and Specializations	Option	Specialization
Brake Press Operator		
CNC Lathe Operator		
CNC Machine Operator		
CNC Machinist		
CNC Mill Operator		
CNC Operator		
CNC Set-up and Operator		
Machine Operator		
Machine Set-Up Operator		
Machinist		

# Levels

Industry advisors have indicated that individuals in this occupation may function at different levels, based on the nature of their work, the amount of time spent in an apprenticeship, the level of skills or knowledge mastery, the degree of independence in performing the job or supervisory/management responsibilities.

Level	Distinguishing Features	Added Competencies	Added Time Requirements
1	Operator, Set-Up, Programmer, Machinist		
2	Supervisor		

# Work Process Schedule

WORK PROCESS SCHEDULE		ONET Code: 51-4012.00	
CNC Set-Up Programmer		RAPIDS Code: 1100 CB	
<b>JOB TITLE: CNC Set-Up Programmer</b>			
<b>LEVEL:</b>		<b>SPECIALIZATION:</b>	
STACKABLE PROGRAM <input type="checkbox"/> yes <input type="checkbox"/> no			
<b>BASE OCCUPATION NAME:</b>			
<b>Company Contact: Name</b>			
<b>Address:</b>		<b>Phone</b>	<b>Email</b>
<b>Apprenticeship Type:</b> <input type="checkbox"/> Competency-Based <input type="checkbox"/> Time-Based <input type="checkbox"/> Hybrid		<b>Prerequisites</b>	
<b>JOB FUNCTION 1: Demonstrates basics of measurement, materials, and safety of products and parts</b>			
Competencies	Core or Optional	RTI	OJT
A. Identifies and demonstrates use of machine safety and personal protective equipment	Core		
B. Demonstrates compliance with lock-out / tag-out procedures and OSHA requirements and guidelines	Core		
C. Handles and stores hazardous materials as assigned while adhering to safe practices in accordance with OSHA and EPA requirements and guidelines	Core		
D. Develops an inspection plan and inspects simple parts using precision tools and techniques while preparing reports on the compliance of the parts	Core		
E. Performs the inspection of parts	Core		
F. Follows a sampling plan to allow for process control	Core		
G. Analyzes the performance of a single-part production process	Core		
H. As a member of a process team, analyzes the performance of a production process	Core		

<b>JOB FUNCTION 2: Conducts job planning, layout, and benchwork</b>			
Competencies	Core or Optional	RTI	OJT
A. Lays out the location of hole centers and surfaces with accuracy	Core		
B. Using aluminum or mild steel, hand drills and hand taps holes	Core		
C. Sets up and performs sawing to a layout	Core		
D. Develops a process plan for a part requiring milling, drilling, turning, or grinding	Core		
<b>JOB FUNCTION 3: Operates manufacturing equipment</b>			
Competencies	Core or Optional	RTI	OJT
A. Sets up and operates machine tools to perform routine drilling operations	Core		
B. Sets up and performs squaring up the six surfaces of a block to within +/- .2 inch and .002 inch over 4.5 inches squareness	Core		
C. Sets up and operates vertical milling machines	Core		
<b>JOB FUNCTION 4: Generates CNC programming and operates a milling machine</b>			
Competencies	Core or Optional	RTI	OJT
A. Using the principles of Cartesian coordinates, develops a program for the manufacture of a simple part	Core		
B. Creates a qualified CNC program, sets up and operates the mill, changes tool values as necessary, and replaces and qualifies tooling as necessary	Core		
C. Sets up and operates a CNC mill or CNC milling center	Core		
D. Writes sophisticated RS-274-D programs	Core		
E. Creates programs using a manufacturing modeling software package	Core		
<b>JOB FUNCTION 5: Demonstrates CNC turning operations and operates a CNC lathe</b>			
Competencies	Core or Optional	RTI	OJT
A. Sets up and carries out, between centers and with chucks, turning operations	Core		
B. Uses the principles of Cartesian coordinates to develop a program for the manufacture of a simple part	Core		
C. Operates a CNC lathe or turning center	Core		
D. Writes sophisticated programs	Core		
E. Creates programs using a manufacturing modeling software package	Core		

<b>JOB FUNCTION 6: Conducts general housekeeping and maintenance</b>			
Competencies	Core or Optional	RTI	OJT
A. Keeps the duty station, tools, workbenches, and manual equipment clean and safe for work	Core		
B. Inspects and assesses the general condition of an assigned machine tool	Core		
C. Inspects and assesses the condition of tooling	Core		
<b>JOB FUNCTION 7: Engages in career management and employee relations</b>			
Competencies	Core or Optional	RTI	OJT
A. Develops and explains a short-term career plan and resume	Optional		
B. Completes job application form and demonstrates interviewing skills	Optional		
C. Demonstrates appropriate interpersonal skills in job performance evaluations, group communication and decision-making, and conflict resolution	Optional		
D. Identifies and explains the major departments or functions in a metalworking company and how they affect production units	Optional		
E. Understands and explains employment rights and responsibilities in metalworking companies	Optional		

# Specialization

Type of Specialization: \_\_\_\_\_

JOB FUNCTION 1:		
Competencies	RTI	OJT
JOB FUNCTION 2:		
Competencies	OJT	RTI
JOB FUNCTION 3:		
Competencies	OJT	RTI

<b>JOB FUNCTION 4:</b>		
Competencies	OJT	RTI
<b>JOB FUNCTION 5:</b>		
Competencies	OJT	RTI

# Related Technical Instruction Plan

<b>COURSE NAME</b>	Course Number
	Hours
<b>LEARNING OBJECTIVES</b>	
<b>COURSE NAME</b>	Course Number
	Hours
<b>LEARNING OBJECTIVES</b>	
<b>COURSE NAME</b>	Course Number
	Hours
<b>LEARNING OBJECTIVES</b>	
<b>COURSE NAME</b>	Course Number
	Hours
<b>LEARNING OBJECTIVES</b>	

**LEARNING OBJECTIVES**

Large empty grey rectangular area for entering learning objectives.

**COURSE NAME**

Course Number

Hours

**LEARNING OBJECTIVES**

Large empty grey rectangular area for entering learning objectives.

# Cross-Cutting Competencies

		COMPETENCY**								
		0	1	2	3	4	5	6	7	8
Personal Effectiveness	Interpersonal Skills	0	1	2	3	4	5	6	7	8
	Integrity	0	1	2	3	4	5	6	7	8
	Professionalism	0	1	2	3	4	5	6	7	8
	Initiative	0	1	2	3	4	5	6	7	8
	Dependability and Reliability	0	1	2	3	4	5	6	7	8
	Adaptability and Flexibility	0	1	2	3	4	5	6	7	8
	Lifelong Learning	0	1	2	3	4	5	6	7	8
Academic	Reading	0	1	2	3	4	5	6	7	8
	Writing	0	1	2	3	4	5	6	7	8
	Mathematics	0	1	2	3	4	5	6	7	8
	Science & Technology	0	1	2	3	4	5	6	7	8
	Communication	0	1	2	3	4	5	6	7	8
	Critical and Analytical Thinking	0	1	2	3	4	5	6	7	8
	Basic Computer Skills	0	1	2	3	4	5	6	7	8
Workplace	Teamwork	0	1	2	3	4	5	6	7	8
	Customer Focus	0	1	2	3	4	5	6	7	8
	Planning and Organization	0	1	2	3	4	5	6	7	8
	Creative Thinking	0	1	2	3	4	5	6	7	8
	Problem Solving & Decision Making	0	1	2	3	4	5	6	7	8
	Working with Tools & Technology	0	1	2	3	4	5	6	7	8
	Checking, Examining & Recording	0	1	2	3	4	5	6	7	8
	Business Fundamentals	0	1	2	3	4	5	6	7	8
	Sustainable	0	1	2	3	4	5	6	7	8
	Health & Safety	0	1	2	3	4	5	6	7	8

\*\*Cross-cutting competencies are defined in the Competency Model Clearinghouse:

<https://www.careeronestop.org/CompetencyModel/competency-models/building-blocks-model.aspx>

Cross-Cutting Competencies identify transferable skills – sometimes called “soft skills” or “employability skills” – that are important for workplace success, regardless of a person’s occupation. Still, the relative importance of specific cross-cutting competencies differs from occupation to occupation. The Cross-Cutting Competencies table, above, provides information about which of these competencies is most important to be successful in a particular occupation. This information can be useful to employers or intermediaries in screening and selecting candidates for apprenticeship programs, or to pre-apprenticeship providers that seek to prepare individuals for successful entry into an apprenticeship program.

The names of the cross-cutting competencies come from the U.S. Department of Labor’s Competency Model Clearinghouse and definitions for each can be viewed at <https://www.careeronestop.org/CompetencyModel/competency-models/building-blocks-model.aspx>.

The scoring system utilized to evaluate the level of competency required in each cross cutting skill aligns with the recommendations of the Lumina Foundation’s Connecting Credentials Framework. The framework can be found at: <http://connectingcredentials.org/wp-content/uploads/2015/05/ConnectingCredentials-4-29-30.pdf>.

# Detailed Job Functions

## JOB FUNCTION 1: Demonstrates basics of measurement, materials, and safety of products and parts

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> <li>• OSHA requirements for personal and occupational safety</li> <li>• EPA requirements for storing hazardous materials</li> <li>• Methods for working safely in confined spaces</li> <li>• Principles and techniques of first-aid and emergency response</li> <li>• Principles of hazards identification and mitigation</li> <li>• Measurement principles</li> <li>• Risk assessment techniques and protocols</li> <li>• Mathematical calculations and measurements</li> </ul>	<ul style="list-style-type: none"> <li>• Lift and move materials properly</li> <li>• Perform lock-out/tag-out procedures</li> <li>• Inspection of parts, equipment, safety devices, tools and production products</li> <li>• Identify and reduce/eliminate potential hazards</li> <li>• Maintain situational awareness</li> <li>• Perform risk assessment and risk mitigation activities</li> <li>• Clear and concise thinking</li> <li>• Clear speaking</li> </ul>	<ul style="list-style-type: none"> <li>• Hearing devices and safety glasses</li> <li>• Hammer, wrenches, screw drivers, punches and pliers</li> <li>• Shoes, gloves, sleeve and pant length, jewelry items, hair length and personal cleanliness</li> </ul>

Competency A: Identifies and demonstrates use of machine safety and personal protective equipment	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Identifies areas in plant that require hearing devices and safety glasses	Core
2. Identifies proper clothing required on the job to include shoes, gloves, sleeve and pant length, jewelry items, hair length and personal cleanliness	Core
3. Demonstrates OSHA lifting techniques, proper air gun usage and identification, and safe chip handling techniques	Core
4. Identifies all pinch points on primary and supportive machine tools and the proper placements of guards	Core

5. Demonstrates both emergency and standard shutdown of all required equipment	Core
6. Demonstrates the proper use of hand tools to include hammer, wrenches, screw drivers, punches and pliers	Core
<b>Competency B: Demonstrates compliance with lock-out / tag-out procedures and OSHA requirements and guidelines</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Demonstrates safe workplace practices in material handling, machine operations, handling of tooling, and handling and application of coolants, cutting fluids and lubricants	Core
2. Orally explains the actions taken which directly or indirectly bear upon safe practice in the execution of assigned responsibilities	Core
<b>Competency C: Handles and stores hazardous materials as assigned while adhering to safe practices in accordance with OSHA and EPA requirements and guidelines</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Demonstrates safe workplace practices in the identification, handling, and storage of hazardous materials	Core
<b>Competency D: Develops an inspection plan and inspects simple parts using precision tools and techniques while preparing reports on the compliance of the parts</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Given the necessary job process sheet for a part and verbal instructions, identifies and selects the required measuring instruments and conducts the required inspection procedures	Core
2. Verifies calibrations and sizes of all measuring devices	Core
3. Takes measurements to an accuracy of 1/64 for fractions, .002 for decimals and ½ degree for angles	Core
4. Reads standard orthographic prints and understands types of lines, title block information, revision levels, abbreviations, symbols, and tolerances	Core
5. Identifies surface defects, burrs and any adverse conditions such as flat or torn threads, out of round conditions, eccentricity, etc.	Core

<b>Competency E: Performs the inspection of parts</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Identifies and selects the required measuring instruments and conducts the required inspection procedures	Core
2. Verifies calibrations and sizes of all measuring devices	Core
3. Inspects a part with specified profiles including angles and radius with an optical comparator and describes the compliance of the profiles	Core
4. Reads standard orthographic prints and understands types of lines, title block information, revision levels, abbreviations, symbols, and tolerances	Core
5. Checks the finish on a turned part, records the surface finish, and compares it to blueprint specifications to determine if it is in compliance	Core
<b>Competency F: Follows a sampling plan to allow for process control</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Inspects the parts according to the sampling plan or inspection plan, collects the data required for the process adhering to the time parameter and places the data, produces new data as needed (mean and range), graphs the data and takes Stop or Go actions as indicated by the results of producing the process control chart	Core
2. Participates as a team member in support of the capability study through an understanding of capability and determines if a calculated Cpk value is acceptable or non- acceptable, and provides all the machining expertise and statistical calculation needed to satisfy the requirements of a capability study (the apprentice is not expected to calculate Cpk values through complex formulas)	Core
<b>Competency G: Analyzes the performance of a single-part production process</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Adjusts and recalculates speeds and feeds for proper tool-life, surface finish, and cycle time optimization	Core
2. Inspects a manufactured part	Core
3. Edits changes into a CNC milling program	Core

<b>Competency H: As a member of a process team, analyzes the performance of a production process</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Analyzes the problem(s), proposes a remedy(ies), having been given authorization to carry it out	Core
2. Carries out the cause and effect analysis by participating in the development of the appropriate Q.C. methodology with the team, i.e., fishbone diagram	Core
3. Explains the Q.C. tool, the corrective actions and the reasoning connecting the root cause analysis to the remedial actions taken	Core

## JOB FUNCTION 2: Conducts job planning, layout, and benchwork

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> <li>• Methods for working safely in confined spaces</li> <li>• Measurement principles</li> <li>• Risk assessment techniques and protocols</li> <li>• Mathematical calculations and measurements</li> <li>• Locational and situational awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Selecting proper tools and procedures</li> <li>• Using proper procedures in conducting work</li> <li>• Maintaining situational awareness</li> <li>• Performing risk assessment and risk mitigation activities</li> <li>• Clear thinking and speaking</li> </ul>	<ul style="list-style-type: none"> <li>• Aluminum</li> <li>• Mild Steel</li> <li>• Hand drill</li> <li>• Hand tap</li> <li>• Press</li> <li>• Blades</li> </ul>

<b>Competency A: Lays out the location of hole centers and surfaces with accuracy</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Demonstrates knowledge and understanding of blueprint reading, and understands orthographic projections in order to perform all machining tasks	Core
2. Selects proper tools, and uses correct procedure, to lay out a part including the location of hole centers and surfaces within the accuracy of +/- .015 inch	Core
<b>Competency B: Using aluminum or mild steel, hand drills and hand taps holes</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Produces a part with two holes prepared for hand tapping, a hole prepared (reamed) for the press fit of a bushing, and a stud for one of the tapped holes	Core
2. Uses arbor presses to perform press fits	Core
3. Deburrs the part, hand drills and hand taps the holes, presses in the bushing, and installs the stud	Core
4. Uses bench vises and hand tools appropriately	Core

<b>Competency C: Sets up and performs sawing to a layout</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Chooses and mounts appropriate blades; welds, breaks, and re-welds blades as necessary	Core
2. Completes sawing parts to fit the layout	Core
<b>Competency D: Develops a process plan for a part requiring milling, drilling, turning, or grinding</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Chooses the most appropriate location for the origin on the part, and establishes a method for defining that location during set-up	Core
2. Selects appropriate work holding devices for various work pieces	Core
3. Selects appropriate tooling for various operations and materials	Core
4. Calculates speeds and feeds for proper tool- life and surface finish	Core

## JOB FUNCTION 3: Operates manufacturing equipment

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> <li>• Methods for working safely in confined spaces</li> <li>• Principles and techniques of first-aid and emergency response</li> <li>• Principles of hazards identification and mitigation</li> <li>• Measurement principles</li> <li>• Risk assessment techniques and protocols</li> <li>• Mathematical calculations and measurements</li> </ul>	<ul style="list-style-type: none"> <li>• Selecting proper tools and procedures</li> <li>• Using proper procedures in conducting work</li> <li>• Maintaining situational awareness</li> <li>• Performing risk assessment and risk mitigation activities</li> <li>• Clear thinking and speaking</li> </ul>	<ul style="list-style-type: none"> <li>• Cutting tools</li> <li>• Radial dress parts</li> <li>• Drill press</li> <li>• Raw cut block</li> <li>• Milling machine parts</li> </ul>

<b>Competency A: Sets up and operates machine tools to perform routine drilling operations</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Demonstrates knowledge of safety procedures, and the identification of drill press and radial drill press parts and their function	Core
2. Selects, mounts, sets up, holds, and aligns work, using work holding devices on the drill press to perform the required drill press operations	Core
3. Calculates cutting speeds and feeds and applies these calculations while performing required machining operations on the drill press	Core
4. Performs secondary operations on the semi-finished part within the tolerances specified on the part print	Core
<b>Competency B: Sets up and performs squaring up the six surfaces of a block to within +/- .2 inch and .002 inch over 4.5 inches squareness</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Demonstrates knowledge of milling machine safety procedures, as well as the identification of milling machine parts and their function	Core
2. Performs proper cutting tool selection necessary to perform all required milling operations within the specified tolerances on a part print	Core
3. Demonstrates the proper insert and tool holder selection necessary to perform all	Core

required milling operations within the specified tolerances on a blueprint	
4. Calculates cutting speeds and feeds and applies these calculations while performing required milling operations on the milling machine	Core
5. Selects, mounts, sets up, holds, and aligns work using work holding devices on the milling machine to perform the required milling and squaring operations	Core
6. Squares up six primary surfaces of a raw cut block within the tolerance of $\pm .002$ inch maintaining parallelism and perpendicularity measurement with a TIR of 4.5 inches squareness	Core
<b>Competency C: Sets up and operates vertical milling machines</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Demonstrates knowledge of milling machine safety procedures, and the identification of milling machine parts and their function	Core
2. Performs proper cutting tool selection necessary to perform all required milling operations within the specified tolerances on a part print	Core
3. Demonstrates the proper insert and tool holder selection, necessary to perform all required milling operations within the specified tolerances on a blueprint	Core
4. Calculates cutting speeds and applies these calculations while performing required milling, drilling, and boring operations on the milling machine	Core
5. Selects, mounts, sets up, holds, and aligns work using work holding devices on the milling machine to perform the required milling and squaring operations	Core
6. Adjusts the milling machine head perpendicular to the table within $\pm .001$ inch, and indicates a vise maintaining parallelism and perpendicularity measurement of $.002$ inch over 4.5 inches	Core
7. Squares up six primary surfaces of a raw cut block within the tolerance of $\pm .002$ inch maintaining parallelism and perpendicularity measurement with a TIR of $.002$ inch over 4.5 inches	Core
8. Produces a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within $\pm .005$ inch, and have three steps controlled by tolerances of $\pm .005$ inch	Core
9. Produces three bores to specification between $\frac{3}{4}$ inch and $1\frac{1}{2}$ inches and their locations are to be held within $\pm .001$ inch and diameters within $\pm .0005$ inch. One hole is to be counter bored to a decimal depth holding within $\pm .002$ inch and counter bore diameter within $\pm .005$ inch	Core
10. Produces a part matching the process plan and the part print specifications. The part specified will require the milling of three deep-slots two parallel to one another, the third at right angles to the first two	Core

## JOB FUNCTION 4: Generates CNC programming and operates a milling machine

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> <li>• Methods for working safely in confined spaces</li> <li>• Principles and techniques of first-aid and emergency response</li> <li>• Principles of hazards identification and mitigation</li> <li>• Measurement principles</li> <li>• Risk assessment techniques and protocols</li> <li>• Mathematical calculations and measurements</li> <li>• Cartesian coordinates</li> <li>• Computer and editor software</li> <li>• G &amp; M codes</li> <li>• Software and coding</li> <li>• Geometry</li> </ul>	<ul style="list-style-type: none"> <li>• Selecting proper tools and procedures</li> <li>• Using proper procedures in conducting work</li> <li>• Maintaining situational awareness</li> <li>• Performing risk assessment and risk mitigation activities</li> <li>• Clear thinking and speaking</li> <li>• Calculating and drawing shapes</li> </ul>	<ul style="list-style-type: none"> <li>• Computers</li> <li>• Software</li> </ul>

Competency A: Using the principles of Cartesian coordinates, develops a program for the manufacture of a simple part	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Describes the functions and use of basic G and M codes	Core
2. Identifies coordinates on a blueprint with respect to a part	Core
3. Calculates and implements speeds and feeds for proper tool life and surface finish	Core
4. Implements linear interpolation into a program to cut straight lines between two points	Core
5. Implements circular interpolation into a program to cut true arcs and circles, using the I & J or R (radius value) methods	Core
6. Writes a program using the appropriate format for a particular machine control, and works from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used	Core

<b>Competency B: Creates a qualified CNC program, sets up and operates the mill, changes tool values as necessary, and replaces and qualifies tooling as necessary</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Describes the functions and use of basic G and M codes	Core
2. Identifies coordinates on a blueprint with respect to an origin	Core
3. Calculates and implements speeds and feeds for proper tool life and surface finish	Core
4. Writes a program using the appropriate format for a particular machine control, and works from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., which will be used	Core
5. Installs and qualifies the required tooling for the program	Core
6. Mounts, locates, and sets the origin of the work piece on a CNC milling machine	Core
7. Loads a program, creates a CNC-link, or enters a program via control keyboard into a CNC milling machine control	Core
8. Safely executes a program for its first run (debugging)	Core
<b>Competency C: Sets up and operates a CNC mill or CNC milling center</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Describes the functions and use of basic G and M codes and other program commands.	Core
2. Mounts, locates and sets the part origin of the work piece on a CNC milling center	Core
3. Installs and qualifies the required tooling for the program	Core
4. Loads a program, creates a CNC-link, or enters a program via control keyboard into a CNC milling machine control	Core
<b>Competency D: Writes sophisticated RS-274-D programs</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Identifies coordinates with respect to an origin	Core
2. Calculates and implements speeds and feeds for proper tool-life and surface finish	Core
3. Gets guidance for sequences, steps, procedures, machining parameters, etc., that will be used	Core

4. Implements circular interpolation into a program to cut true arcs and circles, using the I & J (arc vector), and R (radius value) methods	Core
5. Implements automatic cutter radius compensation	Core
6. Changes and performs machining on different work planes	Core
7. Program helical interpolation	Core
8. Forms and solves triangular constructions on a blueprint to find missing coordinates	Core
<b>Competency E: Creates programs using a manufacturing modeling software package</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Identifies coordinates with respect to an origin	Core
2. Calculates and implements speeds and feeds for proper tool-life and surface finish	Core
3. Identifies and uses menus and icons used in the software package	Core
4. Draws basic geometric shapes and constructions	Core
5. Edits basic geometric shapes and constructions	Core
6. Creates tool paths for contour milling, pocketing, drilling and tapping	Core
7. Post-process tool paths into programs	Core

## JOB FUNCTION 5: Demonstrates CNC turning operations and operates a CNC lathe

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> <li>• Methods for working safely in confined spaces</li> <li>• Principles and techniques of first-aid and emergency response</li> <li>• Principles of hazards identification and mitigation</li> <li>• Measurement principles</li> <li>• Risk assessment techniques and protocols</li> <li>• Mathematical calculations and measurements</li> <li>• Cartesian coordinates</li> <li>• Computer and editor software</li> <li>• G &amp; M codes</li> <li>• Software and coding</li> <li>• Geometry</li> </ul>	<ul style="list-style-type: none"> <li>• Selecting proper tools and procedures</li> <li>• Using proper procedures in conducting work</li> <li>• Maintaining situational awareness</li> <li>• Performing risk assessment and risk mitigation activities</li> <li>• Clear thinking and speaking</li> <li>• Calculating and drawing shapes</li> </ul>	<ul style="list-style-type: none"> <li>• Computers</li> <li>• Software</li> <li>• Radial dress parts</li> <li>• Drill press</li> <li>• Raw cut block</li> <li>• Milling machine parts</li> </ul>

Competency A: Sets up and carries out, between centers and with chucks, turning operations	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Demonstrates knowledge of engine lathe safety procedures, and the identification of engine lathe parts and their function	Core
2. Performs grinding operations and produces all the required tool bits necessary to perform all required turning operations and/or boring operations within the specified tolerances on a part print	Core
3. Demonstrates the proper insert and tool holder selection necessary to perform all required turning and/or boring operations within the specified tolerances on a blueprint	Core
4. Calculates cutting speeds and feeds and applies these calculations while performing required various turning operations on the engine lathe	Core
5. Selects, mounts, sets up, holds, and aligns work using work holding devices on the engine lathe to perform the required turning operations	Core
6. Performs drilling and centers drilling operations within the tolerances specified on a part print	Core

7. Performs turning, facing, necking, boring, and grooving operations within the specified tolerances on the part print	Core
8. Performs square, angular, and filleted shouldering operations within the tolerances specified on a part print	Core
9. Sets up the machine and performs knurling operations within the tolerances specified on the part print	Core
10. Cuts an external U.N. thread within the tolerances specified on the part print	Core
11. Cuts a taper on the engine lathe using the tailstock set-over method, compound rest, and a taper attachment to within the tolerances specified on a part print	Core
<b>Competency B: Uses the principles of Cartesian coordinates to develop a program for the manufacture of a simple part</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Describes the functions and use of basic G and M codes	Core
2. Identifies coordinates on a blueprint with respect to an origin	Core
3. Implements linear interpolation into a program to cut straight lines between two points	Core
4. Implements circular interpolation into a program to cut true arcs and circles, using I & J (arc vector) and R (radius value) methods	Core
5. Writes a program using the appropriate format for a particular machine control, and works from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used	Core
<b>Competency C: Operates a CNC lathe or turning center</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Applies the functions and use of basic G and M codes	Core
2. Identifies coordinates on a blueprint with respect to an origin	Core
3. Calculates and implements speeds and feeds for proper tool life and surface finish	Core
4. Calculates and implements speeds and feeds for proper tool life and surface finish	Core
5. Writes a program using the appropriate format for a particular machine control, and works from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc. that will be used	Core
6. Installs and qualifies the required tooling for the program	Core
7. Mounts, locates, and sets the origin of the work piece on a CNC lathe	Core

8. Loads a program, creates a CNC-link, or enters a program via control keyboard into a CNC lathe control	Core
9. Safely executes a program for its first run (debugging)	Core
<b>Competency D: Writes sophisticated programs</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Identifies coordinates with respect to an origin	Core
2. Calculates and implements speeds and feeds for proper tool-life and surface finish	Core
3. Writes a program using the appropriate format for a particular machine control, and works from a process plan to get guidance for sequences, steps, procedures, machining parameters, etc., that will be used	Core
4. Implements circular interpolation into a program to cut true arcs and circles, using the I & J (arc vector), and R (radius value) methods	Core
5. Implements automatic cutter radius compensation	Core
6. Changes and performs machining on different work planes	Core
7. Programs helical interpolation	Core
8. Forms and solves triangular constructions on a blueprint to find missing coordinates	Core
<b>Competency E: Creates programs using a manufacturing modeling software package</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Identifies coordinates with respect to an origin	Core
2. Calculates and implements speeds and feeds for proper tool-life and surface finish	Core
3. Identifies and uses menus and icons used in the software package	Core
4. Draws basic geometric shapes and constructions	Core
5. Edits basic geometric shapes and constructions	Core
6. Creates tool paths for contour milling, pocketing, drilling and tapping	Core
7. Post-process tool paths into programs	Core

## JOB FUNCTION 6: Conducts general housekeeping and maintenance

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> <li>Risk assessment techniques and protocols</li> <li>Cleanliness and housekeeping</li> </ul>	<ul style="list-style-type: none"> <li>Selecting proper tools and procedures</li> <li>Using proper procedures in conducting work</li> <li>Maintaining situational awareness</li> <li>Performing risk assessment and risk mitigation activities</li> </ul>	<ul style="list-style-type: none"> <li>CNC machine tools</li> </ul>

<b>Competency A: Keeps the duty station, tools, workbenches, and manual equipment clean and safe for work</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Cleans, maintains, and responds appropriately to safety hazards on all bench work tools and conventional and CNC machine tools	Core
2. Maintains the cleanliness of the general work area	Core
<b>Competency B: Inspects and assesses the general condition of an assigned machine tool</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Carries out routine maintenance, reports problems which are beyond the scope of authority, and fills out the history forms for tracking maintenance	Core

<b>Competency C: Inspects and assesses the condition of tooling</b>		Core or Optional
<b>PERFORMANCE CRITERIA</b>		
1. Responds appropriately to safety hazards on all bench work tools and conventional and CNC machine tools		Core
2. Locates, checks, and fills all applicable lubrication reservoirs, checks for proper oil pressure, and checks that all lubrication points are functioning properly		Core
3. Diagnoses tooling in various conditions and takes the correct steps to put the tooling back in service		Core
4. Performs cutter-sharpening operations		Core
5. Understands insert identification nomenclature and index or change inserts		Core

## JOB FUNCTION 7: Engages in career management and employee relations

Related Technical Instruction		
KNOWLEDGE	SKILLS	TOOLS & TECHNOLOGIES
<ul style="list-style-type: none"> <li>• Career planning</li> <li>• Resume development</li> <li>• Interviewing</li> <li>• Metalworking</li> <li>• Employment rights</li> </ul>	<ul style="list-style-type: none"> <li>• Clear thinking and speaking</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>

<b>Competency A: Develops and explains a short-term career plan and resume</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Develops a short-term career plan (1-4 years) including career objectives, training and education, and employment opportunities	Optional
2. Develops a resume appropriate for the metalworking industry based on the career plan	Optional
3. Makes an oral presentation of the career plan and resume	Optional
<b>Competency B: Completes job application form and demonstrates interviewing skills</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Completes the application form. Identify	Optional
2. Demonstrates appropriate interviewing skills in a face-to-face interview with a company representative	Optional
<b>Competency C: Demonstrates appropriate interpersonal skills in job performance evaluations, group communication and decision-making, and conflict resolution</b>	Core or Optional
<b>PERFORMANCE CRITERIA</b>	
1. Demonstrates appropriate interpersonal skills in three simulated cases involving a supervisor or team leader and other team members: (1) receiving feedback on job performance in a formal evaluation process, (2) actively participating in a group decision-making process involving appropriate communication and feedback skills	Optional

with other team members, and (3) resolving conflicts with supervisors and team members	
<b>Competency D: Identifies and explains the major departments or functions in a metalworking company and how they affect production units</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Explains the major responsibilities of each department or unit in the company and the effect of each unit on the job performance of machining technicians in production	Optional
2. Answers five questions about how common production problems affect these other units in the company	Optional
<b>Competency E: Understands and explains employment rights and responsibilities in metalworking companies</b>	<b>Core or Optional</b>
<b>PERFORMANCE CRITERIA</b>	
1. Answers questions about hiring and promotion requirements, dismissal and layoff policies, compensation schedules and amounts, and substance abuse policies	Optional

## STATEMENT OF INDEPENDENCE

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