

**The National Institute for Metalworking Skills, Inc.**



**Duties and Standards For  
Machining Skills-Level II**

*NIMS/ANSI 101-2001*



**Developed By:**



**Copyright July 1997-Revised September 2001**

**Distributed by: The National Institute for Metalworking Skills, Inc  
3251 Old Lee Highway  
Fairfax, VA 22030  
1-703-352-4971 Fax 1-703-352-4991  
E-Mail [www.nims@nims-skills.org](mailto:www.nims@nims-skills.org)**

Machining Skills-Level II

Duties and Standards  
for  
**Machining Skills—Level II**

## Machining Skills-Level II

The original author of this skills standards booklet was Brian Keefe. Charles E. Trott contributed to an edited the document. Keefe and Trott are with Northern Illinois University. Significant contributions including this update were made by Robert W. Sherman of Robert W. Sherman and Associates, who serves as the Project Director for the National Institute for Metalworking Skills, Inc. Other contributors are listed in the appendices. Current revisions came from recommendations of an industry standards review committee and confirmed by the NIMS Standards Committee.

The preparation of the original standards reported herein has been made possible by a grant from the U.S. Department of Labor (Grant No. F-4038-3-00-80-75) and the contributions of time and expenses from many in the metalworking industry. The reported standards and the recent revisions represent a collective development of workers, employers and trainers, and educators and do not represent any official position or endorsement of the U.S. Department of Labor.

## **Machining Skills--Level II**

### **INTRODUCING THE METALWORKING SKILLS STANDARDS PROJECT**

#### **Machining Skills--Level II Voluntary Industry Standards**

We are pleased to present the second of three voluntary National Skills Standards for the metalworking industry. The goal of this project has been to establish world-class standards reflecting industry skill requirements. The standards will provide a method through certification and training for individual workers to receive recognition and reward for their abilities. The standards at the same time will help employers identify training needs and evaluate job applicants fairly.

Machining Skills--Level II has been developed and validated to incorporate advanced requirements for the majority of skilled positions in the metalworking trade. This standard has been designed to allow selection of individual skills or groups of skills to be used for perfecting skills called for in many of the more specialized metalworking disciplines.

While the standard has been written to function as a stand alone document, it is recommended that it be used in combination with the Level I basics standard.

#### **Machining Skills--Level I-II-III**

In the general machining area three skill level standards that have been developed. Each has addressed similar skills with a graduated level of required precision or with newer and more complex technologies. Since the standards are entirely performance-based, individuals can advance at their own pace and be recognized for the skills they possess. The standards also provide employers with an objective assessment tool for worker performance and training needs.

#### **Level I**

Level I skills represent competencies that can reasonably be expected of an individual with one year of experience in a good shop or apprenticeship program; namely basic competency with common machine tools and accessories, basic shop math and inspection techniques, and basic ability to proceed with further, more advanced training.

#### **Level II**

At Level II, more complex machining skills are introduced, along with CNC principles, angular measurements, and additional auxiliary equipment.

## **Machining Skills-Level II**

### **Level III**

Level III, in general, reaches into the journeyman competencies. It includes proficiency with a wide range of machine tools, auxiliary equipment, compound angles, task planning, and the ability to work with minimal supervision.

### **Curriculum Guidance**

It should be emphasized that the standards are competency measures designed to drive training and they are not meant to be model training programs in and of themselves. In many cases elements of all three standards will appear in a metalworking training program depending on capabilities available in a training facility or in certain companies where the concentration of work is in machine specific operations.

### **Certification and Credentialing**

A major goal of the Metalworking Skills Standards program is performance testing. The standards will provide skilled workers with certification that will afford them industry recognition. The standard will also provide credentials that will serve throughout their metalworking career.

**The National Institute for Metalworking Skills, Inc.**  
**3251 Old Lee Highway, Suite 205**  
**Fairfax, VA 22030**

## Machining Skills-Level II

### TABLE OF CONTENTS

#### Overview

Occupational Description and Benchmarks for Machining Skills—Level II .....	10
Occupational Description.....	10
Bench Skills .....	10
Metal Cutting Skills .....	10
Inspection and Quality Assurance Skills .....	10
Other Skills and Competencies .....	11
Framework for Machining Skills—Level II .....	12

#### Machining Skills—Level II

Duty Area:	1.	Job Planning and Management .....	14
Duty:	1.1	Job Process Planning.....	14
Duty Area:	2	Job Execution.....	16
Duty:	2.1	Lay out Bolt Circles, Angles, Points of Tangency, and Profiles of a Line.....	16
Duty:	2.2	Contour Bandsawing.....	18
Duty:	2.3	Turning: Between Centers Taper Turning .....	20
Duty:	2.4	Turning: Chucking, O.D. and I.D. Tapers Using a Taper Attachment .....	22
Duty:	2.5	Vertical Mill: Precision Location of Holes .....	24
Duty:	2.6	Milling: Keyseat.....	26
Duty:	2.7	Milling: Deep Slot with a Staggetooth Cutter .....	28
Duty:	2.8	Milling: Rotary Tables.....	30
Duty:	2.9	Milling: Dividing Head Operations .....	32
Duty:	2.10	Milling: Basic Horizontal Boring Mill .....	34
Duty:	2.11	Drilling: Radial Drill.....	36
Duty:	2.12	Machine Tool Power Tapping: Taper Reaming and Pipe Tapping.....	38
Duty:	2.13	Surface Grinding: Finish Flats to +/- .0005 .....	40
Duty:	2.14	Surface Grinding: Finish Flats at Simple Angles and Grind Contour Radii.....	42
Duty:	2.15	Grinding Wheel Preparation and Balancing .....	44
Duty:	2.16	Cylindrical Grinding .....	46
Duty:	2.17	EDM: Produce an electrode and operate a Plunge EDM.....	48
Duty:	2.18	EDM: 2 Axis Wire EDM .....	50
Duty:	2.19	CNC: Simple RS274-D Programs .....	52
Duty:	2.20	CNC: Milling Machine .....	54
Duty:	2.21	CNC: Lathe.....	56

## Machining Skills-Level II

Duty Area:	3.	Quality Control and Inspection .....	58
Duty:	3.1	Inspection: Optical Comparator .....	58
Duty:	3.2	Inspection: Manual Coordinate Measuring Machine.....	60
Duty Area:	4.	Process Adjustment and Control.....	62
Duty:	4.1	Participate in Capability Studies .....	62
Duty Area:	5.	General Maintenance .....	64
Duty:	5.1	General Housekeeping and Maintenance.....	64
Duty:	5.2	Preventive Machine Maintenance.....	66
Duty:	5.3	Tooling Maintenance .....	68
Duty Area:	6.	Industrial Safety and Environmental Protection .....	70
Duty:	6.1	Machine Operations and Material Handling .....	70
Duty:	6.2	Hazardous Materials Handling and Storage .....	72
Duty Area:	7.	Career Management and Employment Relations .....	74
Duty:	7.1	Career Planning.....	74
Duty:	7.2	Job Application and Interviewing.....	74
Duty:	7.3	Teamwork and Interpersonal Relations .....	74
Duty:	7.4	Organizational Structures and Work Relations.....	75
Duty:	7.5	Employment Relations.....	75

## Knowledge, Skills, Abilities and Other Characteristics

KSAO Area:	1.	Written and Oral Communications .....	76
KSAO:	1.1	Reading .....	76
KSAO:	1.2	Writing .....	77
KSAO:	1.3	Speaking.....	78
KSAO:	1.4	Listening .....	79
KSAO Area:	2.	Mathematics.....	80
KSAO:	2.1	Geometry of Simple Angles and Profiles of a Line.....	80
KSAO:	2.2	Coordinate Axes, Cartesian and Polar .....	81
KSAO:	2.3	Trigonometry for CNC Toolpaths .....	82
KSAO:	2.4	Statistics for Capability Studies .....	83
KSAO Area:	3.	Engineering Drawings and Sketches .....	84
KSAO:	3.1	Isometric and Orthographic Sketching .....	84
KSAO:	3.2	Interpreting GDT Drawings: .....	85
KSAO:	3.3	Interpreting Engineering Drawings: Auxiliary Views.....	86

## Machining Skills-Level II

KSAO Area:	4.	Measurement.....	87
KSAO:	4.1	Manual Coordinate Measuring Machines.....	87
KSAO Area:	5.	Metalworking Theory .....	88
KSAO:	5.1	EDM: Electrode Selection and Design .....	88
KSAO:	5.2	CNC Machine Tools .....	89
KSAO:	5.3	CNC Tooling.....	90
KSAO:	5.4	Correct Coolants and /or Cutting Fluids for Various Applications .....	91
KSAO Area:	6.	Applied Materials.....	92
KSAO:	6.1	Apply the Properties of Various Metals to Cutting Problems.....	92
KSAO:	6.2	Apply the Properties of Non-metals to Cutting Problems.....	93
KSAO Area:	7.	Computers .....	94
KSAO:	7.1	Typing .....	94
KSAO:	7.2	Use of Basic Services of an Operating System.....	95
KSAO Area:	1.	Written and Oral Communications .....	97
KSAO:	1.1	Reading .....	97
KSAO:	1.2	Writing .....	98
KSAO:	1.3	Speaking.....	99
KSAO:	1.4	Listening .....	100
KSAO Area:	3.	Decision Making and Problem Solving .....	101
KSAO:	3.1	Applying Decision Rules .....	101
KSAO:	3.2	Basic Problem Solving.....	102
KSAO Area:	4.	Social Skills and Personal Qualities .....	103
KSAO:	4.1	Social Skills .....	103
KSAO:	4.2	Personal Qualities .....	104
KSAO Area:	6.	Measurement.....	105
KSAO:	6.1	Basic Measuring Instruments.....	105
KSAO Area:	7.	Metalworking Theory .....	106
KSAO:	7.1	Cutting Theory .....	106



## Machining Skills-Level II

## Machining Skills-Level II

### Occupational Description and Benchmarks for Machining Skills—Level II

#### Occupational Description

Level II machining skills are used by skilled tradespersons who have achieved proficiency in the core competencies of Machining Skills—Level I and have advanced to higher levels of technical competency or have developed new competencies. The general areas of competency remain:

- bench skills
- metal cutting skills
- inspection and quality assurance skills

Level II machining skills apply to both single-part and multiple-part production. A person who has achieved Level II machining skills competency has no direct supervision responsibilities for other operators or production workers. However, people who have achieved Level II competence will occasionally provide training for beginning machining technicians.

#### **Bench skills:**

- Lay out hole locations on bolt circles, angular surfaces, profiles of a line, and points of tangency.
- Read and comprehend orthographic part prints using geometric dimensioning and tolerancing symbology.
- Read and comprehend part prints that have multiple auxiliary views.

#### **Metal cutting skills:**

- Use indexing devices to locate part features.
- Produce angled or tapered surfaces.
- Produce work to close tolerances ( $\pm .002$  for milling and chucking,  $\pm .001$  for boring and turning).
- Set up and operate a boring mill.
- Set up and operate a cylindrical grinder.
- Set up and operate CNC machine tools.
- Improve setups on common classes of machine tools.
- Achieve competence in all safety procedures for the tasks within the scope of Machining Skills—Level II.
- Select and use cutting fluids.

#### **Inspection and quality assurance skills:**

- Develop inspection procedures for in-process inspection.
- Inspect simple angles to required precision.
- Develop inspection process plans.
- Use optical comparator for inspection tasks.

## Machining Skills-Level II

- Use gage blocks for shop calibration of precision tools.

### **Other skills and competencies**

- Write CNC programs.
- Qualify tools for CNC use.
- Participate effectively as a member of a team.
- Maintain employment in the metalworking industry.
- Articulate a personal career development plan within the metalworking industry.
- Produce process plans that identify operations, sequence, tools, fixtures, speeds, and feeds for parts requiring several of the basic machining operations such as milling, drilling, turning, or grinding.
- Record work activities.
- Write required reports using narrative style with paragraph structure composed of complete sentences.
- Succeed in interactive verbal and written communication.

## Machining Skills-Level II

### Framework for Machining Skills--II

This chart represents the two principal sets of expectations that comprise Level II machining skills. The left-hand column is a list of duties that are expected to constitute Level II jobs. The right-hand column is a list of the abilities, skills, knowledge, or other characteristics needed to perform the duties

Occupational Duties	Knowledge, Skills, Abilities, and Other Characteristics
<b>1. Job Planning and Management</b> 1.1 Job Process Planning	<b>1. Written and Oral Communications</b> 1.1 Writing 1.2 Reading 1.3 Speaking 1.4 Listening
<b>2. Job Execution</b> 2.1 Layout Bolt Circles, Angles, Points of Tangency and Profiles of a Line. 2.2 Contour Bandsawing 2.3 Turning : Between Centers Taper Turning 2.4 Turning: Chucking O.D.and I.D.Tapers using a Taper Attachment 2.5 Vertical Mill: Precision Location of Holes 2.6 Milling: Keyseat 2.7 Milling: Deep Slots with a Staggetooth Cutter 2.8 Milling: Rotary Tables 2.9 Milling: Dividing Head Operations 2.10 Basic Horizontal Boring Mill Operations 2.11 Drilling: Radial Drill 2.12 Machine Power Tapping: Taper Reaming & Pipe Tapping 2.13 Surface Grinding: Finish Flats to +/- .0005 2.14 Surface Grinding: Finish Flats at Simple Angles and Grind Contour Radii. 2.15 Grinding Wheel Preparation and Balancing 2.16 Cylindrical Grinding 2.17 EDM: Produce an Electrode and Operate a Plunge EDM 2.18 EDM: 2 Axis Wire EDM 2.19 CNC: Simple RS274-D Programs 2.20 CNC: Operate a CNC Milling Machine 2.21 CNC: Operate a CNC Lathe	<b>2. Mathematics</b> 2.1 Geometry of Simple Angles & Profiles of a Line 2.2 Coordinate Axes, Cartesian and Polar 2.3 Trigonometry for CNC Tool paths 2.4 Statistics for Capability Studies
<b>3. Quality Control and Inspection</b> 3.1 Inspection: Optical Comparator 3.2 Inspection: Manual Coordinate Measuring Machine	<b>3. Engineering Drawings and Sketches</b> 3.1 Isometric and Orthographic Sketching 3.2 Interpreting: GDT 3.3 Interpreting: Auxiliary Views

## Machining Skills-Level II

<b>4. Process Adjustment and Control</b> 4.1 Participate in Capability Studies		<b>4. Measurement</b> 4.1 Basic Measuring Instruments 4.2 Precision Measuring Instruments 4.3 Surface Plate Instruments
<b>5. General Maintenance</b> 5.1 General Housekeeping and Maintenance 5.2 Preventive Machine Maintenance 5.3 Tooling Maintenance		<b>5. Metalworking Theory</b> 5.1 EDM: Electrode Selection and Design 5.2 CNC Machine Tools 5.3 CNC Tooling 5.4 Correct Coolants and/or Cutting Fluids for Various Applications
<b>6. Industrial Safety and Environmental Protection</b> 6.1 Machine Operations and Material Handling 6.2 Hazardous Materials Handling and Storage		<b>6. Applied Materials</b> 6.1 Metal Properties Applied to Cutting Problems 6.2 Non-metal Properties Applied to Cutting Problems
<b>7. Career Management and Employment Relations</b> 7.1 Career Planning 7.2 Job Applications and Interviewing 7.3 Teamwork and Interpersonal Relations 7.4 Organizational Structures and Work Relations 7.5 Employment Relations		<b>7. Computers</b> 7.1 Typing 7.2 Use of Basic Services of an Operating System

## Machining Skills-Level II

**Duty Area:** 1. Job Planning and Management

**Duty Title:** 1.1 Job Process Planning

***Duty:***

Write a detailed process plan that includes a quality plan for a part requiring milling, drilling, turning, or grinding. Produce an operation sheet detailing the process plan; identify all critical dimensions and required speeds and feeds. Provide sketches as needed.

***Performance Standard:***

Given a print detailing a part requiring milling, drilling, turning, and grinding, verbal instructions, and appropriate references, formulate a set of strategies to manufacture the part, and write a detailed process plan including a quality plan for that part. Provide sketches as needed. Make a presentation explaining each of the process plan steps to be taken; identify all major components and functions of the machine tools, and all major hand tools, measuring tools, tools and fixtures, and work materials, provide the rationale for the speeds and feeds selected.

***Other Evaluation Criteria:***

1. Legibility
2. Clarity of the writing
3. Appropriate speeds and feeds

***Accuracy Level:*** N/A

***Assessment Equipment and Material:***

***Workstation:*** Standard workbench

***Material:*** Part print with an appropriate part, an inventory of available tools, and necessary writing materials

***Tooling:*** N/A

***Measuring Instruments:*** N/A

***Reference:*** Machinery's Handbook

## Machining Skills-Level II

### ***KSAO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Job Process Planning Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking	X	5.1 EDM: Electrode Selection and Design
X	1.4 Listening	X	5.2 CNC Machine Tools
	<b>2. Mathematics</b>	X	5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles	X	5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

<b>Duty Area:</b>	<b>2.</b>	<b>Job Execution</b>
<b>Duty Title:</b>	<b>2.1</b>	<b>Lay out Bolt Circles, Angles, Points of Tangency, and Profiles of a Line</b>

### ***Duty:***

Set up and lay out bolt circles, locations of surfaces related by non-right angles, locations of points of tangency between arcs and lines, and profiles of a line which is non-arc based.

### ***Performance Standard:***

Given a surface plate, surface gage, layout height gage, combination set, scribe, layout ink, prick punch, ball peen hammer, process plan, and part print, lay out a block of material that includes a flange face feature with a 12-hole bolt circle, two examples of tangent radii-one a fillet, the other an external radius and a defined profile of a line with approximating arcs and their coordinates supplied.

***Accuracy Level:*** +/- .015 on all fractions, unless otherwise specified on the part print.

### ***Assessment Equipment and Material:***

***Workstation:*** Standard workbench, and a layout surface plate of at least 12" X 18"

***Material:*** Part matching the layout part print, and cold rolled steel

***Tooling:*** Scribe, layout ink, prick punch, ball peen hammer, angle plate, C-clamps, and magnifying glass

***Measuring Instruments:*** Combination set, radius gages, 6" dividers, and surface gage, or layout height gage.

***Reference:*** Machinery's Handbook



## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Lay out Bolt Circles, Angles, Points of Tangency and Profiles of a Line

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:**           2.     **Job Execution**  
**Duty Title:**        2.2    **Contour Bandsawing**

***Duty:***

Set up and perform contour sawing to a layout. Choose and mount appropriate blades; weld, break, and re-weld blades as necessary.

***Performance Standard:***

Given a part with a finished layout and access to an appropriate bandsaw and blades, finish saw the part to the layout.

***Accuracy Level:*** +/- 1/32 on all fractions, unless otherwise specified on the part print.

***Assessment Equipment and Material:***

*Workstation:* Standard workbench and appropriate bandsaw

*Material:* Part matching the bandsaw part print, and cold rolled steel

*Tooling:* Scriber, layout ink, prick punch, ball peen hammer, angle plate, C-clamps, and magnifying glass

*Measuring Instruments:* Combination set, radius gages, 6" dividers, and surface gage or layout height gage

*Reference:* Machinery's Handbook

## Machining Skills-Level II

### ***KS AO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Contour Bandsaw Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. Job Execution  
**Duty Title:** 2.3 Turning: Between Centers Taper Turning

***Duty:***

Set up and perform between centers turning for straight and tapered turning by offsetting the tailstock.

***Performance Standard:***

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two straight diameters within  $\pm .001$ , an appropriate taper at each end of the part, and require a reversal of the part end for end.

***Accuracy Level:***  $\pm .015$  on all fractions, and  $\pm .005$  on all decimals unless otherwise specified on the part print. Diameters to be concentric within .001 TIR  
Surface finish 63 microinches or better.

***Assessment Equipment and Material:***

***Workstation:*** Standard workbench, a toolroom engine lathe, a three-jaw universal scroll chuck, or a four-jaw independent chuck. The lathe may have a quick-change gear box with the threads called for on the part print available from the gear box.

***Material:*** Part matching the material requirements of the turning part print

***Tooling:*** Tool post, right- and left-hand turning tools capable of turning to a square shoulder, drill chuck, centerdrill, external undercut tools,  $45^\circ$  chamfer tools, live center, dead center fitted to the spindle taper, magnetic base for a dial indicator, files, wrenches as necessary, and cutting fluids.

***Measuring Instruments:*** Required micrometers, combination set, dial indicator, 6" rule, 6" vernier, dial, or electronic caliper, surface finish comparison plates, appropriate taper ring gages and Prussian blue, or taper micrometer, or sine bar and indicator.

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### ***KS AO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Turning Between Centers Taper Turning Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths	X	6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies	X	6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

<b>Duty Area:</b>	<b>2.</b>	<b>Job Execution</b>
<b>Duty Title:</b>	<b>2.4</b>	<b>Turning: Chucking, O.D. and I.D. Tapers Using a Taper Attachment</b>

### ***Duty:***

Set up and perform tapered boring and turning using a taper attachment.

### ***Performance Standard:***

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate turning machine with a taper attachment and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two diameters within  $\pm .002$ ", one bore within  $\pm .002$ ", one external and one internal taper, and require at least two chuckings or other workholding setup.

***Accuracy Level:***  $\pm .015$  on all fractions,  $\pm .005$  on all decimals unless otherwise specified on the part print. Diameters to be concentric within .003 TIR.

### ***Assessment Equipment and Material:***

***Workstation:*** Standard workbench, toolroom engine lathe with a taper attachment, three-jaw universal scroll chuck, and four-jaw independent chuck. The lathe may have a quick-change gear box with the threads called for on the part print available from the gear box.

***Material:*** Part matching the material requirements of the turning part print

***Tooling:*** Tool post, right- and left-hand turning tools capable of turning to a square shoulder, boring bar and boring tool capable of boring to a square shoulder, drill chuck, center drill, and assorted drills necessary to rough out the bore,  $45^\circ$  chamfer tools, soft jaws, magnetic base for a dial indicator, spiders for chucks, files, and wrenches as necessary

***Measuring Instruments:*** Required micrometers, combination set, plug gages, taper ring and plug gages, and Prussian blue or other taper measuring devices, a sine bar, dial indicator, 6" rule, 6" vernier, dial, or electronic caliper, telescoping gages or inside calipers, and a surface-finish comparison plate

***Reference:*** Machinery's Handbook

## Machining Skills-Level II

### **KSAO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Turning Chucking O.D. & I.D. Tapers Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths	X	6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies	X	6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. **Job Execution**  
**Duty Title:** 2.5 **Vertical Mill: Precision Location of Holes**

***Duty:***

Set up and perform boring for location, size, and finish.

***Performance Standard:***

Produce three bores to specification. The holes will be between ¾" and 1-1/2" and their locations are to be held within +/- .001 and hold diameters within +/- .0005. One hole is to be counterbored to a decimal depth holding +/- .002" and counterbore diameter within +/- .005".

***Accuracy Level:*** +/- .015 on all fractions, and +/- .005 on all decimals unless otherwise specified on the part print. 63 microinch finish

***Assessment Equipment and Material:***

***Workstation:*** Standard workbench, a vertical mill

***Material:*** Part matching the material requirements of the part print

***Tooling:*** 6" drill vises or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vises, or suitable angle plates for the part. Assorted parallels, composition hammer, assorted Morse taper sleeves fitted to the machine spindle, drill chucks, edge finders, drills, centerdrills, and the necessary boring bars and associated cutters. Scriber, layout ink, prick punch, ball peen hammer, angle plate, 6" dividers, and surface gage

***Measuring Instruments:*** Required micrometers, combination set, 6" rule, 6" vernier, dial or electronic caliper, dial indicators, plug gages, telescoping gages, and layout height gage

***Reference:*** Machinery's Handbook.



## Machining Skills-Level II

### **KSAO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Vertical Milling: Precision Location of Holes Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. **Job Execution**  
**Duty Title:** 2.6 **Milling: Keyseats**

***Duty:***

Set up and perform milling keyseats on a shaft.

***Performance Standard:***

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified will require milling two keyseats whose characteristics match the ANSI B17.1 keys and keyseat standards.

***Accuracy Level:*** +/- .015 on all fractions, and +/- .005 on all decimals unless otherwise specified on the part print. Finished surfaces are to be 125 microinches unless otherwise specified.

***Assessment Equipment and Material:***

***Workstation:*** standard workbench, an appropriate mill. Table capacity of approximately 12"X 36".

***Material:*** Part matching the material requirements of the keyseat milling part print, and cold rolled steel

***Tooling:*** 6" milling vise or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vise or the part to the table. Assorted parallels, V-blocks, ball peen and composition hammers, assorted cutters and cutter adapters fitted to the machine spindle, files, magnetic base for indicators, soft jaws for the vise, drill chuck, and edge finder. Coolants and cutting fluids.

***Measuring Instruments:*** 0-6 micrometers, combination set, dial indicator, 6" rule, a 6" vernier, dial or electronic caliper, adjustable parallels, V-blocks, and depth micrometer

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### **KSAO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Milling Keyseats Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

**Duty Area: 2. Job Execution**

**Duty Title: 2.7 Milling: Cut a Deep Slot with a Staggertooth Cutter**

**Duty:**

Set up and perform the cutting of a deep slot using a staggertooth cutter.

**Performance Standard:**

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine and its accessories, produce 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.

**Accuracy Level:** +/- .015 on all fractions, +/- .005 on all decimals unless otherwise specified on the part print. Finished surfaces are to be 125 micro-inches unless otherwise specified.

**Assessment Equipment and Material:**

**Workstation:** A standard workbench, a mill with power feed on the X and Y axes. Table capacity of approximately 12"X 36". Forty taper spindle or greater preferred.

**Material:** A part matching the material requirements of the "deep slot" milling part print, material: cold rolled steel.

**Tooling:** A 6" milling vise or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vise or the part to the table. Assorted parallels, ball peen, and composition hammers, assorted cutters, cutter adapters, and arbors fitted to the machine spindle, files, magnetic base for indicators, soft jaws for the vise and coolants and cutting fluids.

**Measuring Instruments:** Required micrometers, combination set, dial indicator, 6" rule, 6" vernier, dial, or electronic caliper, adjustable parallels, edge finder, and surface finish comparison plates.

**Reference:** Machinery's Handbook.

## Machining Skills-Level II

### **KSAO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Deep Slot with a Staggetooth Cutter Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. Job Execution  
**Duty Title:** 2.8 Milling: Use Rotary Tables

### **Duty:**

Set up and perform the development of surfaces at a specified non-right angle using a rotary table. Set up and establish hole locations in various relationships to one another using a rotary table. The holes are in the same plane. Establish the profile of a radius with respect to two surfaces and the connecting points of tangency.

### **Performance Standard:**

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine, an appropriately sized rotary table, and their accessories, produce a part matching the process plan and the part print specifications. The part specified will require two groups of holes arrayed on bolt circles, as well as several surfaces at various angles to one another.

**Accuracy Level:** +/- .015 on all fractions, +/- .005 on all decimals unless otherwise specified on the part print.

### **Assessment Equipment and Material:**

**Workstation:** A standard workbench, a vertical mill. Table capacity of approximately 12"X36". A rotary table of about 18" diameter with protractor graduations and a protractor vernier.

**Material:** A part matching the material requirements of the rotary table milling part print, material: cold rolled steel.

**Tooling:** Screws, studs, nuts, washers, and clamps sufficient to secure the vise, or the part to the rotary table and the rotary table to the milling table. Assorted parallels, ball peen, and composition hammers, assorted cutters and cutter adapters fitted to the machine spindle, files, magnetic base for indicators, soft jaws for the vise, drill chuck, drills, combination drill and countersink or spotting drill, countersink, edge finder, and coolants and cutting fluids.

**Measuring Instruments:** 0-6 micrometers, combination set, dial indicator with magnetic base and clamp accessories, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, and depth micrometer.

**Reference:** Machinery's Handbook.

## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Milling: Rotary Table Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. Job Execution  
**Duty Title:** 2.9 Milling: Dividing Head Operations

**Duty:**

Set up and perform operations requiring a dividing head. Set up and establish hole locations in various relationships to one another using a dividing head. Establish the profile of a radius with respect to two surfaces and the connecting points of tangency.

**Performance Standard:**

Given raw material, process plan, part print, hand, precision, and cutting tools, as well as access to an appropriate milling machine, an appropriately sized dividing head, and their accessories, produce a part matching the process plan and the part print specifications. The part specified will require two groups of holes arrayed on an outer diameter, as well as several surfaces at various angles to one another.

**Accuracy Level:** +/- .015 on all fractions, +/- .005 on all decimals unless otherwise specified on the part print.

**Assessment Equipment and Material:**

**Workstation:** A standard workbench, a vertical mill. Table capacity of approximately 12"X 36". A dividing head of about 10" swing with assorted indexing plates.

**Material:** A part matching the material requirements of the part print, material: cold rolled steel.

**Tooling:** Screws, studs, nuts, washers, and clamps sufficient to secure the dividing head and footstock to the milling table. Chucks, collets, face plates, and associated hardware necessary to secure the part in the dividing head and footstock. Assorted parallels, ball peen, and composition hammers, assorted cutters and cutter adapters fitted to the machine spindle, files, magnetic base for indicators, soft jaws for the vise, drill chuck, drills, combination drill and countersink or spotting drill, countersink, and edge finder. Coolants and cutting oil.

**Measuring Instruments:** 0-6 micrometers, combination set, dial indicator with magnetic base and clamp accessories, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, and depth micrometer.

**Reference:** Machinery's Handbook.



## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Milling: Dividing Head Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. **Job Execution**  
**Duty Title:** 2.10 **Basic Horizontal Boring Mill Operations**

***Duty:***

Set up and perform boring for location, size, and finish and mill a slot for location and size.

***Performance Standard:***

Produce three bores, one with a decimal counterbore, and one slot to specification.

***Accuracy Level:*** +/- .015 on all fractions, +/- .002 on all decimals unless otherwise specified on the part print. Finished surfaces are to be 63 micro-inches unless otherwise specified.

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench, a horizontal boring mill.

***Material:*** A part matching the material requirements of the boring mill part print, material: cold rolled steel, cutting fluids.

***Tooling:*** 6" drill vises or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vises, or suitable angle plates or the part. Assorted parallels, a composition hammer, assorted Morse taper sleeves fitted to the machine spindle, drill chucks, edge finders, drills, centerdrills, and the necessary boring bars and associated cutters. A scribe, layout ink, prick punch, ball peen hammer, angle plate, 6" dividers, surface gage.

***Measuring Instruments:*** Required micrometers, combination set, 6" rule, a 6" vernier, dial, or electronic caliper, dial indicators, plug gages, telescoping gages, and layout height gage.

***Reference:*** Machinery's Handbook.

**Notes to standards readers:** At this point the part would be a piece of flat stock about 1" thick with three bores between 3.5 and 4.5 diameter. The bores will have no axes in common in their plane. One of the bores will have a counterbore and the plate will also have a slot specified.

## Machining Skills-Level II

### ***KSAO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Horizontal Boring Mill Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. Job Execution  
**Duty Title:** 2.11 Drilling: Radial Drill

***Duty:***

Set up and perform drilling operations using a radial drill.

***Performance Standard:***

Set up, centerdrill, drill, countersink, counterbore, and tap a series of hole to part print specification. Perform other operations as required by the part print.

***Accuracy Level:*** +/- .015 on all fractions, +/- .005 on all decimals unless otherwise specified on the part print. Diameter of tapped holes to be satisfied by the use of go/nogo gages.

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench, a radial drill press with capacity adequate to control and drive drills of the diameter specified on the print. The drill press must have a tapping cycle, or a reversible clutched spindle.

***Material:*** A part matching the material requirements of the drill press part print, material: cold rolled steel, cutting fluids.

***Tooling:*** A 6" drill vise or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vise, or the part. Assorted parallels, a composition hammer, assorted Morse taper sleeves fitted to the machine spindle, drill chucks, drills, reamers, countersinks, centerdrills, and the necessary taps. A scribe, layout ink, prick punch, ball peen hammer, tap wrenches, angle plate, 6" dividers, surface gage.

***Measuring Instruments:*** Required micrometers, combination set, 6" rule, a 6" vernier, dial, or electronic caliper, go/nogo gage for threads, plug gages, and telescoping gages.

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### **KSAO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Drilling: Radial Drill Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

**Duty Area: 2. Job Execution**  
**Duty Title: 2.12 Machine Tool Power Tapping: Taper Reaming and Pipe Tapping**

***Duty:***

Set up and perform taper reaming and subsequent pipe tapping.

***Performance Standard:***

Set up, drill, taper ream, and tap a series of holes to part print specification.

***Accuracy Level:*** +/- .015 on all fractions, +/- .005 on all decimals unless otherwise specified on the part print. Diameter of tapped hole +/- 1" thread on the required pipe thread plug gage.

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench, a drill press with capacity adequate to control and drive a 1-11½NPT. The drill press must have a tapping cycle, a tapping head accessory, or a reversible clutched spindle.

***Material:*** A part matching the material requirements of the drill press part print, material: cold rolled steel, cutting fluids.

***Tooling:*** A 6" drill vise or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vise, or the part. Assorted parallels, a composition hammer, assorted Morse taper sleeves fitted to the machine spindle, drill chucks, drills, reamers, countersinks, centerdrills, and the necessary pipe taps. A scribe, layout ink, prick punch, ball peen hammer, tap wrenches, angle plate, 6" dividers, surface gage.

***Measuring Instruments:*** Required micrometers, combination set, 6" rule, a 6" vernier, dial, or electronic caliper, go/nogo gage for threads, plug gages, telescoping gages, and layout height gage.

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Machine Tool Power Tapping Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

**Duty Area: 2. Job Execution**  
**Duty Title: 2.13 Surface Grinding: Finish Flats to +/- .0005**

***Duty:***

Grind a block's six faces to finished dimensions having tolerances of +/- .0005 and squareness of .0005 over 4", and 32 microinch surface finish. Dress the wheel as necessary.

***Performance Standard:***

Given a block squared up on a mill, hardened to 55 to 60 R<sub>c</sub>, a process plan, part print, hand and precision tools, and choice of a grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel, produce a part matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been squared up. Finishing the part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

***Accuracy Level:*** +/- .0005 on all decimals unless otherwise specified on the part print. Square within .0005 over 4".

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench with a precision surface plate, a surface grinder with a suitable magnetic chuck, suitable environmental controls.

***Material:*** A semi-finished part matching the material requirements of the surface grinding part print, material: Mild steel.

***Tooling:*** A magnetic chuck, assorted parallels, a suitable angle plate or precision grinding vise, and assorted clamps, composition hammer, assorted grinding wheels suitable for mounting to the spindle, files, magnetic base for indicators, surface gage of sufficient size, and diamond dresser.

***Measuring Instruments:*** Required micrometers, combination set, gage block set, dial test indicator, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, comparator stand for indicators, depth micrometer set, master square or magnetic square, surface condition comparison gages.

***Reference:*** Machinery's Handbook.



## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Surface Grinding, Finish Flats Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

**Duty Area: 2. Job Execution**  
**Duty Title: 2.14 Surface Grinding: Finish Flats at Simple Angles and Grind Contour Radii**

***Duty:***

Set up and perform the finish surface grinding of flat surfaces at simple angles with respect to one another. Dress the wheel as necessary.

***Performance Standard:***

Given a block roughed out on a mill, a process plan, part print, hand and precision tools, and choice of a grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel, grind the specified radii and angled surfaces to a finish matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been roughed out. Finishing the part will require the precision finishing of the specified surfaces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

***Accuracy Level:*** +/- .0005 on all decimals unless otherwise specified on the part print. Square within .0001 over 1". Angles to be held within +/-15'. Radii +/- .001

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench with a precision surface plate, a surface grinder with a suitable magnetic chuck.

***Material:*** A part matching the material requirements of the surface grinding part print, material: Mild steel.

***Tooling:*** A magnetic sine chuck, sine bars, assorted parallels, a suitable angle plate or precision grinding vise, and assorted clamps, composition hammer, assorted grinding wheels suitable for mounting to the spindle, files, magnetic base for indicators, surface gage of sufficient size, and diamond dresser.

***Measuring Instruments:*** Required micrometers, combination set, dial test indicator, 6" rule, a 6" vernier, bevel vernier protractor, inspection sine plates and/or sine bars, dial or electronic caliper, gage blocks, adjustable parallels, depth micrometer set, master square or magnetic square, surface condition comparison gages. radius and angle dressers, Optical Comparator.

## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Surface Grinding: Finish Flats at Simple Angles Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

**Duty Area: 2. Job Execution**

**Duty: 2.15 Grinding Wheel Preparation and Balancing**

***Duty:***

Set up and perform the preparation and balancing of a grinding wheel 14" diameter or greater. Place the wheel into service.

***Performance Standard:***

Given a wheel and appropriate equipment prepare the wheel to go into service. Mount the wheel. Produce a surface finish of 32 microinches or better on a cylinder or flat surface of CRS.

***Accuracy Level:*** N/A

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench and cylindrical grinder or large surface grinder

***Material:*** An appropriate grinding wheel. Cold rolled steel.

***Tooling:*** Wheel balancer, counterweights, wheel arbor.

***Measuring Instruments:*** Dial test indicator, indicator mounting brackets.

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### ***KSAO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Grinding Wheel Preparation Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading		4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
	3.1 Isometric and Orthographic Sketching		7.1 Typing
	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. **Job Execution**  
**Duty Title:** 2.16 **Cylindrical Grinding**

***Duty:***

Set up and perform between centers grinding for straight diameters. Dress the grinding wheel as necessary.

***Performance Standard:***

Dress the wheel. Given a part rough finished on three diameters, mount the part between centers and grind the required diameters to finish.

***Accuracy Level:*** +/- .015 on fractions, +/- .005 on decimals, +/- .0005 on ground diameters.

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench and cylindrical grinder.

***Material:*** A part matching the material requirements of the cylindrical grinding part print, material: Cold rolled steel

***Tooling:*** Centers for the headstock and tailstock, assorted grinding dogs, composition hammer, assorted grinding wheels suitable for mounting to the spindle, files, magnetic base for indicators, and diamond dresser.

***Measuring Instruments:*** Required micrometers, combination set, dial test indicator, 6" rule, gage blocks, surface condition comparison gages.

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### **KS40:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Cylindrical Grinding Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading		4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. Job Execution

**Duty Title:** 2.17 EDM: Produce Electrode and Operate a Plunge EDM

***Duty:***

Produce an electrode and operate a plunge electric discharge machine.

***Performance Standard:***

Given a print, process plan, select proper electrode material and produce electrode. Select proper workholding devices, EDM fluids, and plunge EDM machine. Perform the EDM operation called out on the process plan.

***Accuracy Level:*** Produce part to the requirements of the part print.

***Assessment Equipment and Material:***

***Workstation:*** A standard plunge EDM and a workbench.

***Material:*** A part matching the material requirements of the part print, material: Mild steel.

***Tooling:*** An appropriate workholding device, screws, studs, nuts, washers, and clamps, to hold the part to the table. Assorted parallels, adapters fitted to the electrode holder, files, magnetic base for indicators, soft jaws for the vise and assorted hand tools.

***Measuring Instruments:*** Required micrometers, combination set, dial indicator, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, edge finder, appropriate tools for determining squareness, and surface finish comparison standards.

***Reference:*** Machinery's Handbook.



## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the EDM Produce an Electrode and Operate a Plunge EDM Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading		4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking	X	5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles	X	5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. **Job Execution**  
**Duty Title:** 2.18 **EDM: Operate a 2 Axis Wire EDM**

***Duty:***

Operate a 2 axis wire electric discharge machine.

***Performance Standard:***

Given a print, process plan, an appropriate selection of wire electrodes, workholding devices, EDM fluids, and 2 axis wire EDM machine, perform the EDM operation called out on the process plan.

***Accuracy Level:*** Match the requirements of the part print. 125 microinch finish or better

***Assessment Equipment and Material:***

***Workstation:*** A 2 axis wire EDM and a workbench.

***Material:*** A part matching the material requirements of the part print, material: mild steel.

***Tooling:*** An appropriate workholding device, screws, studs, nuts, washers, and clamps sufficient to secure the part to the table. Assorted parallels, files, magnetic base for indicators, and assorted hand tools.

***Measuring Instruments:*** Required micrometers, combination set, dial indicator, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, edge finder, appropriate tools for determining squareness, and surface finish comparison standards.

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### **KS40:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the EDM: 2 Axis Wire EDM Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking	X	5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

**Duty Area: 2. Job Execution**

**Duty Title: 2.19 CNC: Write Simple RS274-D Programs**

***Duty:***

Using a computer and editor software write simple RS274-D programs using M and G codes from the Machinery's Handbook. Simple programs are single plane, cutter centerline, linear and circular interpolation, single cutter, with no canned cycles as specified on the print.

***Performance Standard:***

Given a part print with the tool path shown, and computer with editor software, write a program, including speeds and feeds, to drive an endmill through a continuous path around three sides of a part requiring the development of a linear interpolation tool path as well as circular interpolation. Store the program on computer media.

***Accuracy Level:*** N/A.

***Assessment Equipment and Material:***

***Workstation:*** A personal computer, a text editor, and a printer.

***Material:*** A diskette and paper.

***Tooling:*** N/A.

***Measuring Instruments:*** N/A.

***Reference:*** Machinery's Handbook, ANSI/EIA Standard RS-274-D, the manual for the machine tool the program is being written for.

## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the CNC: Simple RS 274-D Program Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening	X	5.2 CNC Machine Tools
	<b>2. Mathematics</b>	X	5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles	X	5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. Job Execution  
**Duty Title:** 2.20 CNC: Operate a CNC Milling Machine

***Duty:***

Operate a CNC milling machine.

***Performance Standard:***

Given a CNC mill create a qualified CNC program, setup and operate the mill, change tool values as necessary, replace and qualify tooling as necessary.

***Accuracy Level:*** Match the requirements of the part print. 63 microinch finish

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench, a CNC mill with continuous path capability on 2½ axes.

***Material:*** A part matching the material requirements of the part print, material: cold rolled steel.

***Tooling:*** A 6" milling vise or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vise, or the part to the table. Assorted parallels, ball peen, and composition hammers, assorted cutters and cutter adapters fitted to the machine spindle, files, magnetic base for indicators, soft jaws for the vise and assorted cutters.

***Measuring Instruments:*** Required micrometers, combination set, dial indicator, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, edge finder, appropriate tools for determining squareness, and surface finish comparison standards.

***Reference:*** Machinery's Handbook, operator's manual of the machine tool.

## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the CNC: Milling Machine Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening	X	5.2 CNC Machine Tools
	<b>2. Mathematics</b>	X	5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles	X	5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching	X	7.1 Typing
X	3.2 Interpret GDT Drawings	X	7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 2. Job Execution  
**Duty Title:** 2.21 CNC: Operate a CNC Lathe

***Duty:***

Operate a CNC lathe.

***Performance Standard:***

Given a CNC lathe create a qualified CNC Program, setup and operate the lathe, change tool values as necessary, replace and qualify tooling as necessary.

***Accuracy Level:*** Match the requirements of the part print. 63 microinch finish

***Assessment Equipment and Material:***

***Workstation:*** A standard workbench, a CNC turning center of adequate capacity, a three-jaw universal scroll chuck, and a four-jaw independent chuck.

***Material:*** A part matching the material requirements of the CNC turning part print, material: cold rolled steel.

***Tooling:*** Right- and left-hand turning tools capable of turning to a square shoulder, an external threading tool matched to the profile of the thread called out on the turning part print, a drill chuck, center drill, external undercut tools, live center, dead center fitted to the spindle taper, magnetic base for a dial indicator, files, wrenches as necessary.

***Measuring Instruments:*** Required micrometers, combination set, thread pitch gages, center gage, pitch micrometer, thread ring gages, dial indicator, 6" rule, a 6" vernier, dial, or electronic caliper, surface finish comparison standards, appropriate taper ring gages and Prussian blue, or taper micrometer, or sine bar and indicator.

***Reference:*** Machinery's Handbook, operator's manual for the machine tool.



## Machining Skills-Level II

### **KSAO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the CNC Lathe Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening	X	5.2 CNC Machine Tools
	<b>2. Mathematics</b>	X	5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles	X	5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching	X	7.1 Typing
X	3.2 Interpret GDT Drawings	X	7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 3. Quality Control and Inspection  
**Duty Title:** 3.1 Inspection: Optical Comparator

***Duty:***

Set up and perform the inspection of profiles in shadow and in reflection.

***Performance Standard:***

Given a finished part, process plan, part print, as well as access to appropriate drafting supplies and optical comparator, inspect a part's specified profiles. Produce data necessary to describe the compliance of the profiles.

***Accuracy Level:*** N/A.

***Assessment Equipment and Material:***

***Workstation:*** An optical comparator and necessary drafting supplies and equipment.

***Material:*** A finished part matching the part print, vellum or tracing paper.

***Tooling:*** Tooling appropriate to the presentation of a part on an optical comparator.

***Measuring Instruments:*** Precision tools needed to operate the comparator.

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Inspection-Optical Comparator Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 3. Quality Control and Inspection

**Duty Title:** 3.2 Inspection: Manual Coordinate Measuring Machine

***Duty:***

Set up and perform the inspection of parts.

***Performance Standard:***

Given a finished part, process plan, part print, and CMM, inspect a part's geometry. Produce data necessary to describe the compliance of the part.

***Accuracy Level:*** N/A.

***Assessment Equipment and Material:***

*Workstation:* A CMM.

*Material:* A finished part matching the part print.

*Tooling:* Tooling appropriate to the setup of a part on a CMM.

*Measuring Instruments:* Precision tools needed to establish the setup.

*Reference:* Machinery's Handbook.

## Machining Skills-Level II

### **KS AO:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Inspection: Manual Coordinate Measuring Machine Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings	X	7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area: 4. Process Adjustment and Control**

**Duty Title: 4.1 Participate in Capability Studies**

***Duty:***

Participate as a team member in a capability study. Perform the required statistical calculations to support the capability study. With the assistance of the team leader prepare the necessary shop reports for the capability study.

***Performance Standard:***

Given a needed capability study, and the data collected to satisfy the needs of the capability study, participate as a team member in support of the capability study. With the direction of the team leader, provide all the machining expertise and statistical calculation needed to satisfy the requirements of capability study.

***Accuracy Level:*** N/A.

***Assessment Equipment and Material:***

*Workstation:* A workbench.

*Material:* Statistical study data, Capability study plan.

*Tooling:* Calculator with statistical functions or computer with statistical software.

*Measuring Instruments:* N/A.

*Reference:* Machinery's Handbook, calculator manual, software manual.

## Machining Skills-Level II

### **KS40:**

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Participate in Capabilities Studies Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading	X	4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
X	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
X	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
X	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
X	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
X	3.1 Isometric and Orthographic Sketching		7.1 Typing
X	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
X	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area: 5. General Maintenance**

**Duty Title: 5.1 General Housekeeping and Maintenance**

***Duty:***

Keep the duty station clean and safe for work. Keep the tools, workbenches, and manual equipment clean, maintained, and safe for work.

***Performance Standard:***

Given maintenance, cleaning, and housekeeping check lists, as well as verbal instructions, clean, maintain, and respond appropriately to safety hazards on all benchwork tools and conventional and CNC machine tools. Maintain the cleanliness of the general work area.

***Accuracy Level:*** N/A.

***Assessment Equipment and Material:***

*Workstation:* A common workbench, and machine tool work area.

*Material:* N/A.

*Tooling:* Brooms, brushes, vacuum cleaner, waste containers.

*Measuring Instruments:* N/A.

*Reference:* OSHA guidelines.



## Machining Skills-Level II

### ***KSAO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the General Housekeeping and Maintenance Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading		4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
	3.1 Isometric and Orthographic Sketching		7.1 Typing
	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area: 5. General Maintenance**  
**Duty Title: 5.2 Preventive Maintenance: Machine Tools**

***Duty:***

Inspect and assess the general condition of an assigned machine tool. Make routine adjustments as necessary and as authorized. Report problems to supervision which are beyond the scope of authority. Carry out daily, weekly, and/ or monthly routine upkeep chores cited on checklists for a given machine tool.

***Performance Standard:***

Given the preventive maintenance procedures and schedules for a given machine tool, as well as sufficient instruction and experience to recognize maintenance problems, carry out routine maintenance, report problems which are beyond the scope of authority, fill out the history forms for tracking maintenance. Make an oral presentation explaining the condition of the machine tool and the actions taken.

***Accuracy Level:*** N/A.

***Assessment Equipment and Material:***

*Workstation:* A standard machine tool.

*Material:* Maintenance forms, oil, grease, and shop towels.

*Tooling:* Hand tools for minor adjustments of guards and tooling.

*Measuring Instruments:* 6" rule.

*Reference:* Machinery's Handbook.

## Machining Skills-Level II

### ***KS AO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Preventive Machine Maintenance Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading		4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
	3.1 Isometric and Orthographic Sketching		7.1 Typing
	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 5. General Maintenance

**Duty Title:** 5.3 Tooling Maintenance

### ***Duty:***

Inspect and assess the condition of tooling. Refurbish tooling where appropriate. Refer tooling for repair or regrind where appropriate.

### ***Performance Standard:***

Given samples of tooling in various conditions, diagnose the tooling, take the correct steps to put the tooling back in service. The sample tooling should include turning, milling, and drilling tools. These tools should be both insert tooling as well as conventional tooling. The technician must demonstrate the offhand grinding of a drill between the diameter of .125" and .500". The offhand regrinding of a turning tool and the correct rotation and replacement of inserts in an insert style milling cutter body must be demonstrated. The technician must demonstrate the ability to recognize when a cutter should be referred to a tool and cutter grinder.

### ***Other Evaluation Criteria:***

1. *The technician properly prepares the grinding wheel for grinding operations.*
2. *The drills produce holes within .005 of their nominal size.*
3. *The turning tool cuts freely and can be used to produce a finish of 125 microinches.*
4. *The technician observes the need for cleanliness when working on the cutter body.*
5. *Using an indicator, all inserts can be demonstrated to be at the same height within .001.*
6. *Placing the cutter into service, the inserts all cut as designed to do.*

***Accuracy Level:*** +/- 1/64 on all fractions, drilled diameters, +.006, -.000.

### ***Assessment Equipment and Material:***

***Workstation:*** A common workbench, a pedestal grinder.

***Material:*** N/A.

***Tooling:*** Drills, milling cutter bodies with inserts, turning tool blanks, wrenches for cutter bodies.

***Measuring Instruments:*** Required micrometers, combination set, 6" rule, a 6" vernier, dial, or electronic caliper, plug gages, telescoping gages, and layout height gage, dial indicator and base, and surface plate.

***Reference:*** Machinery's Handbook.

## Machining Skills-Level II

### ***KSAO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Tooling Maintenance Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading		4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
	3.1 Isometric and Orthographic Sketching		7.1 Typing
	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:**           6.     **Industrial Safety and Environmental Protection**  
**Duty Title:**        6.1    **Machine Operations and Material Handling**

***Duty:***

Carry out assigned responsibilities while adhering to safe practices in accordance with OSHA requirements and guidelines. Document safety activities as required.

***Performance Standard:***

Given written and verbal safety instructions and checklists based on OSHA requirements and guidelines, demonstrate safe workplace practices in material handling, machine operations, handling of tooling, handling and application of coolants, cutting fluids and lubricants. Orally explain the actions taken which directly or indirectly bear upon safe practice in the execution of duties 2.1 through 2.9.

***Accuracy Level:***       Completion of all checklist items.

***Assessment Equipment and Material:***

*Workstation:*   N/A.

*Material:*       Appropriate materials and containers.

*Tooling:*        Appropriate handling devices.

*Measuring Instruments:*   N/A.

*Reference:*      OSHA guidelines.

## Machining Skills-Level II

### ***KSAO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Machine Operations and Material Handling Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading		4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
	3.1 Isometric and Orthographic Sketching		7.1 Typing
	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:**            **6.     Industrial Safety and Environmental Protection**  
**Duty Title:**         **6.2    Hazardous Materials Handling and Storage**

***Duty:***

Handle and store hazardous materials as assigned while adhering to safe practices in accordance with OSHA and EPA requirements and guidelines. Document safety activities as required.

***Performance Standard:***

Given written and verbal safety instructions detailing the handling and storage of hazardous materials in compliance with OSHA and EPA requirements and guidelines, demonstrate safe workplace practices in the identification, handling, and storage of hazardous materials.

***Accuracy Level:***     N/A.

***Assessment Equipment and Material:***

*Workstation:* N/A.

*Material:*        A hazardous material and appropriate containers.

*Tooling:*         Appropriate handling devices.

*Measuring Instruments:*     Appropriate material identification instruments. Instruments for the measurement of concentration.

*Reference:*       Machinery's Handbook, relevant EPA and OSHA requirements and guidelines



## Machining Skills-Level II

### ***KSAO:***

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Hazardous materials Handling and Storage Duty.

	<b>1. Written and Oral Communications</b>		<b>4. Measurement</b>
X	1.1 Reading		4.1 Manual Coordinate Measuring Machine
X	1.2 Writing		<b>5. Metalworking Theory</b>
X	1.3 Speaking		5.1 EDM: Electrode Selection and Design
X	1.4 Listening		5.2 CNC Machine Tools
	<b>2. Mathematics</b>		5.3 CNC Tooling
	2.1 Geometry of Simple Angles & Line Profiles		5.4 Coolants and Cutting Fluids for Various Applications
	2.2 Coordinate Axes, Cartesian & Polar		<b>6. Applied Materials</b>
	2.3 Trigonometry for CNC Toolpaths		6.1 Apply the Properties of Various Metals to Cutting Problems
	2.4 Statistics for Capability Studies		6.2 Apply the Properties of Non-metals to Cutting Problems
	<b>3. Engineering Drawings and Sketches</b>		<b>7. Computers</b>
	3.1 Isometric and Orthographic Sketching		7.1 Typing
	3.2 Interpret GDT Drawings		7.2 Services of an Operating System
	3.3 Interpret Engineering Drawing: Auxiliary Views		

## Machining Skills-Level II

**Duty Area:** 7. Career Management and Employment Relations

**Duty Title:** 7.1 Career Planning

***Duty:***

Develop and explain a short-term career plan and resume.

***Performance Standard:***

Given written information, presentations, and informational interviews with industry representatives on career opportunities in the metalworking industry, develop a short-term career plan (1-4 years) including career objectives, training and education, and employment opportunities. Develop a resume appropriate for the metalworking industry based on the career plan. Make an oral presentation of the career plan and resume.

**Duty Area:** 7. Career Management and Employment Relations

**Duty Title:** 7.2 Job Application and Interviewing

***Duty:***

Complete job application form and demonstrate interviewing skills.

***Performance Standard:***

Given a job description and a standard application, complete the application form. Identify and demonstrate appropriate interviewing skills in a face-to-face interview with a company representative.

**Duty Area:** 7. Career Management and Employment Relations

**Duty Title:** 7.3 Teamwork and Interpersonal Relations

***Duty:***

Demonstrate appropriate interpersonal skills in job performance evaluations, group communication and decision-making, and conflict resolution.

***Performance Standard:***

Given written and oral information about a machining technician job in a work unit, demonstrate 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 with other team members, and (3) resolving conflicts with supervisors and team members.

## Machining Skills-Level II

**Duty Area:** 7. Career Management and Employment Relations

**Duty Title:** 7.4 Organizational Structures and Work Relations

***Duty:***

Identify and explain the major departments or functions in a metalworking company and how they affect production units.

***Performance Standard:***

Given written materials and a formal orientation to a metalworking company for machining technicians, explain 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 jobs. Answer five questions about how common production problems affect these other units in the company.

**Duty Area:** 7. Career Management and Employment Relations

**Duty Title:** 7.5 Employment Relations

***Duty:***

Understand and explain employment rights and responsibilities in metalworking companies.

***Performance Standard:***

Given written and verbal information on employment rights and responsibilities (similar to those contained in employee handbooks), answer questions about hiring and promotion requirements, dismissal and layoff policies, compensation schedules and amounts, and substance abuse policies.

## Machining Skills-Level II

**KSAO Area: 1. Written and Oral Communications**

**KSAO: 1.1 Writing**

***KSAO Definition:***

Communicates technical and non-technical information, messages, and ideas in writing using standard English commonly found in the metalworking industry. This writing requires the use of coherent paragraphs composed of complete sentences.

***Performance Requirement:***

Given a specific writing-related duty to perform and the necessary instructions, forms, and materials to complete the writing requirements for that duty, complete the writing requirement.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job planning	Process planning	Write detailed plans.
Process adjustment	Statistical capability study	Write up the statistical report.

## Machining Skills—Level II

**KSAO Area:** 1. Written and Oral Communication

**KSAO:** 1.2 Reading

### ***KSAO Definition:***

Locates, understands, and interprets written technical and non-technical information in documents commonly found in the metalworking industry. These documents contain short and simple sentences, paragraphs and passages, phrases, quantitative information, specialized vocabulary, graphs, charts, schedules, simple instructions, and multi-step directions. All documents are written in standard English.

### ***Performance Requirement:***

Given a specific duty to perform and the necessary written information contained on relevant documents and information sheets, locate and read the necessary information and use this information to plan, execute, and evaluate the duty and answer questions about the content or meaning of the written information.

### ***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Reading KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Read part prints. Read tool crib inventory. Read the handbook.
2. Job execution	Benchwork Layout Operate machine tools.	Read part prints. Read process plans. Read the handbook.
3. Quality and inspection	Inspection Control	Read part prints. Read inspection plan. Read sampling plan. Read charting instructions.
4. Process improvement	Process adjustment Participation in improvement	Read part prints. Read process plans. Read the handbook. Read team documents.

## Machining Skills—Level II

**KSAO Area:** 1. Written and Oral Communication

**KSAO:** 1.3 Speaking

### ***KSAO Definition:***

Communicates technical and non-technical detailed information, messages, multi-step directions and ideas through oral communication using standard English and related cues and communication aids in conversations, discussions, and group meetings. Understands and responds to listener feedback and asks questions when needed in two-way and group conversations.

### ***Performance Requirement:***

Given a specific duty to perform and the necessary instructions, written documents, and communication aids and materials to complete the speaking requirements for that duty, complete the speaking requirement.

### ***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Speaking KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Verbally explain the process plan.
2. Job execution	Benchwork Layout Operate machine tools.	Explain job execution activities.
3. Quality and inspection	Inspection Control	Explain inspection procedures. Explain control charts and their role in process control.
4. Process improvement	Process adjustment Participation in improvement	Propose process remedies. Explain the selected corrective actions. Explain fishbone charts. Explain root cause reasoning.

## Machining Skills—Level II

**KSAO Area:** 1. Written and Oral Communication

**KSAO:** 1.4 Listening

### ***KSAO Definition:***

Listens for, receives, interprets, and recalls specific details, ideas, and multi-step instructions in verbal presentations, conversations, discussions, and group meetings conducted in standard English and supported by written materials and other communication cues and aids. Uses active listening skills in comprehending simple technical and non-technical verbal information.

### ***Performance Requirement:***

Given a specific duty to perform and the necessary written information contained on relevant documents and information sheets, listen for, comprehend, and incorporate oral information in the performance of the duty and answer questions about the content or meaning of the oral information.

### ***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Listening KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Listen to verbal instructions.
2. Job execution	Benchwork Layout Operate machine tools.	Listen to verbal instructions.
3. Quality and inspection	Inspection Control	Listen to verbal instructions.
4. Process improvement	Process adjustment Participation in improvement	Listen to verbal instructions.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Listen to verbal instructions.
6. Safety and environment	Operations and handling HazMat handling & storage Material storage	Listen to verbal instructions.

Machining Skills—Level II

**KSAO Area: 2. Mathematics**

**KSAO: 2.1 Geometry of Simple Angles and Profiles of a Line**

***KSAO Definition:***

Apply principles of Euclidean geometry to the production of simple angles and profiles of a line.

***Performance Requirement:***

Given a set of compasses, a set of pencils, a graduated straight edge, the necessary drawing paper, and a part print matching the requirements of duty, lay out the required profiles and angles.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	Layout, B.C., angles, tangencies, line profiles	Determine the profiles to be shown by the layout.
Job execution	Taper turning	Determine the taper.
Job execution	Grinding angles	Determine the angle to grind.
Quality	Optical comparator	Measure profiles with comparator.
Quality	Coordinate measuring machine	Measure angles and profiles with CMM.



Machining Skills—Level II

**KSAO Area: 2. Mathematics**

**KSAO: 2.2 Coordinate Axes, Cartesian and Polar**

***KSAO Definition:***

Identify points on a line, in a plane, and in 3 space using Cartesian, and polar coordinates.

***Performance Requirement:***

Given a set of requirements for the location of points in space and on a plane, calculate the identity of the points as Cartesian coordinates and as polar coordinates.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	CNC programming	Determine coordinates.
Job execution	CNC operations	Determine offsets.
Quality	Optical comparator	Establish locations.
Quality	Coordinate measuring machine	Establish locations.

Machining Skills—Level II

**KSAO Area: 2. Mathematics**

**KSAO: 2.3 Trigonometry for CNC Toolpaths**

***KSAO Definition:***

Apply trigonometry to the solution of geometric position problems for CNC Toolpaths.  
Decompose position problems to the solution of right and oblique triangles.

***Performance Requirement:***

Given a part print and a set of cutter specification calculate the coordinates for each cutter destination required by the program needed to drive the cutter through its toolpath.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	CNC programming	Determine coordinate locations.

Machining Skills—Level II

**KSAO Area: 2. Mathematics**

**KSAO: 2.4 Statistics for Capability Studies**

***KSAO Definition:***

Apply statistical tools to the development of statistical process monitoring and control tools.

***Performance Requirement:***

Write up and perform a process capability study applying and interpreting the results of the statistics produced by the study. Calculate and apply the value of standard deviation and Cpk.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Process adjustment and control	Participate in capability study.	Calculate required values.

Machining Skills—Level II

**KSAO Area: 3. Engineering Drawings and Sketches**

**KSAO: 3.1 Isometric and Orthographic Sketching**

***KSAO Definition:***

Sketch orthographic and isometric projections of parts or details to support non-verbal communication.

***Performance Requirement:***

Sketch a part or detail in support of a quality report.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job planning	Write a process plan.	Sketching

Machining Skills—Level II

**KSAO Area: 3. Engineering Drawings and Sketches**

**KSAO: 3.2 Interpreting Engineering Drawings: Geometric Dimensioning and Tolerancing**

***KSAO Definition:***

Read and interpret GDT drawings with multiple datums.

***Performance Requirement:***

Given a GDT print with multiple datums, inspect a part using GDT principles for compliance with the print.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	CNC programming	Interpret drawing.
Job planning	Process planning	Interpret drawing.
Quality	Inspect using CMM.	Interpret drawing.

Machining Skills—Level II

**KSAO Area: 3. Engineering Drawings and Sketches**

**KSAO: 3.3 Interpreting Engineering Drawings: Auxiliary Views**

***KSAO Definition:***

Read and interpret engineering drawings having multiple auxiliary views.

***Duty Performance:***

Given a print with multiple auxiliary views, inspect a part for compliance with the print.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities which require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	CNC programming	Interpret drawing.
Job planning	Process planning	Interpret drawing.
Quality	Inspect using CMM.	Interpret drawing.

Machining Skills—Level II

**KSAO Area: 4. Measurement**

**KSAO: 4.1 Manual Coordinate Measuring Machines**

***KSAO Definition:***

Apply the capacities of CMMs to inspection.

***Performance Requirement:***

Inspect a part of appropriate complexity using a CMM. Establish datums, multiple planes, multiple surfaces, hole locations, and hole sides, and angles.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Quality inspection	Use CMM for inspection.	Inspect a part.

Machining Skills—Level II

**KSAO Area: 5. Metalworking Theory**

**KSAO: 5.1 EDM: Electrode Selection and Design**

***KSAO Definition:***

Identify the critical design and material characteristics of an electrode with respect to various materials to be machined.

***Performance Requirement:***

Given various cutting scenarios, select the appropriate electrode design and electrode material type.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	Operate plunge EDM.	Select electrode.



Machining Skills—Level II

**KSAO Area: 5. Metalworking Theory**

**KSAO: 5.2 CNC Machine Tools**

***KSAO Definition:***

Use and apply the concepts of how CNC machine tools operate.

***Performance Requirement:***

Explain the role of the control, the mechanical components, and the tooling in the function and output of a CNC machine tool.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	Operate a CNC mill.	Produce parts.
Job execution	Operate a CNC lathe.	Produce parts.

Machining Skills—Level II

**KSAO Area: 5. Metalworking Theory**

**KSAO: 5.3 CNC Tooling**

***KSAO Definition:***

Use and apply the concepts of tooling with properties customized to the CNC environments of mills and lathes.

***Performance Requirement:***

Explain the characteristics, benefits, and drawbacks of qualified tooling for CNC mills and lathes.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	Operate a CNC mill.	Change tools.
Job execution	Operate a CNC lathe.	Change tools.

Machining Skills—Level II

**KSAO Area: 5. Metalworking Theory**

**KSAO: 5.4 Determine Correct Coolants and /or Cutting Fluids for Various Applications**

***KSAO Definition:***

Identify and apply the properties of coolants and/or cutting fluids with respect to the tooling, materials, material condition, and the machine tool and its delivery systems. Take the appropriate safety-related measures.

***Performance Requirement:***

Given various cutting scenarios, identify an appropriate coolant and coolant delivery system. Perform any related MSD, hazmat, or environmental protection duty related to these materials. Take the appropriate personal safety measures with respect to the materials being used.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	Turning	Apply coolants.
Job execution	Milling	Apply coolants.
Job execution	Drilling	Apply coolants.
Job execution	Radial drill	Apply coolants.
Job execution	CNC operations	Apply coolants.

Machining Skills—Level II

**KSAO Area: 6. Applied Materials**

**KSAO: 6.1 Apply the Properties of Various Metals to Cutting Problems**

***KSAO Definition:***

Determine appropriate cutting technique based partially upon metallurgical properties of a class of materials.

***Performance Requirement:***

Identify appropriate cutter geometry and speeds and feeds for various materials.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	Turning	Cut metals.
Job execution	Milling	Cut metals.
Job execution	Drilling	Cut metals.
Job execution	Radial drill	Cut metals.
Job execution	CNC operations	Cut metals.

Machining Skills—Level II

**KSAO Area: 6. Applied Materials**

**KSAO: 6.2 Apply the Properties of Various Non-metals to Cutting Problems**

***KSAO Definition:***

Determine appropriate cutting technique based partially upon cutting properties of a material.

***Performance Requirement:***

Identify appropriate cutter geometry and speeds and feeds for various materials.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	Turning	Cut materials.
Job execution	Milling	Cut materials.
Job execution	Drilling	Cut materials.
Job execution	Radial drill	Cut materials.
Job execution	CNC operations	Cut materials.

Machining Skills—Level II

**KSAO Area: 7. Computers**

**KSAO: 7.1 Typing**

***KSAO Definition:***

Type a short program.

***Performance Requirement:***

Given a computer and editing software, type a single screen program.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	CNC programming	Produce a program.

Machining Skills—Level II

**KSAO Area: 7. Computers**

**KSAO: 7.2 Use the Basic Services of an Operating System**

***KSAO Definition:***

Format a diskette. Create and store a data file. Retrieve a data file. Change and resave a data file.

***Performance Requirement:***

Given a computer and editing software, create, store, retrieve, change, and resave a data file.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
Job execution	CNC programming	Produce a program.

## Machining Skills—Level II

Note: The Machining Skill Standards are in three levels. They are modular in approach in order to serve the needs of the many diverse operations in the metalworking profession.

As a worker becomes a candidate for certification to higher skill levels certain basic skills must be mastered. The skills included in this appendix are the basic requirements for all levels and they will be a part of any skills evaluation. They are repeated in each standard so that each document can be a stand alone study guide.

While this information has been provided, it is recommended that the candidate for each skill level review all three levels in order to plan the candidate's future development and career path.



**KSAO Area: 1. Written and Oral Communication**  
**KSAO: 1.1 Reading**

***KSAO Definition:***

Locates, understands, and interprets written technical and non-technical information in documents commonly found in the metalworking industry. These documents contain short and simple sentences, paragraphs and passages, phrases, quantitative information, specialized vocabulary, graphs, charts, schedules, simple instructions, and multi-step directions. All documents are written in standard English.

***Performance Requirement:***

Given a specific duty to perform and the necessary written information contained on relevant documents and information sheets, locate and read the necessary information and use this information to plan, execute, and evaluate the duty and answer questions about the content or meaning of the written information.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Reading KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Read part prints. Read tool crib inventory. Read the handbook.
2. Job execution	Benchwork Layout Operate machine tools.	Read part prints. Read process plans. Read the handbook.
3. Quality and inspection	Inspection Control	Read part prints. Read inspection plan. Read sampling plan. Read charting instructions.
4. Process improvement	Process adjustment Participation in improvement	Read part prints. Read process plans. Read the handbook. Read team documents.

**KSAO Area:** 1. Written and Oral Communications  
**KSAO:** 1.2 Writing

***KSAO Definition:***

Communicates technical and non-technical information, messages, and ideas in writing using standard English commonly found in the metalworking industry. This writing requires the use of coherent paragraphs composed of complete sentences.

***Performance Requirement:***

Given a specific writing-related duty to perform and the necessary instructions, forms, and materials to complete the writing requirements for that duty, complete the writing requirement.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require this KSAO.

Duty Area	Task	Activity
Job planning	Process planning	Write detailed plans.
Process adjustment	Statistical capability study	Write up the statistical report.

**KSAO Area:** 1. Written and Oral Communication  
**KSAO:** 1.3 Speaking

***KSAO Definition:***

Communicates technical and non-technical detailed information, messages, multi-step directions and ideas through oral communication using standard English and related cues and communication aids in conversations, discussions, and group meetings. Understands and responds to listener feedback and asks questions when needed in two-way and group conversations.

***Performance Requirement:***

Given a specific duty to perform and the necessary instructions, written documents, and communication aids and materials to complete the speaking requirements for that duty, complete the speaking requirement.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Speaking KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Verbally explain the process plan.
2. Job execution	Benchwork Layout Operate machine tools.	Explain job execution activities.
3. Quality and inspection	Inspection Control	Explain inspection procedures. Explain control charts and their role in process control.
4. Process improvement	Process adjustment Participation in improvement	Propose process remedies. Explain the selected corrective actions. Explain fishbone charts. Explain root cause reasoning.

**KSAO Area:** 1. Written and Oral Communication  
**KSAO:** 1.4 Listening

***KSAO Definition:***

Listens for, receives, interprets, and recalls specific details, ideas, and multi-step instructions in verbal presentations, conversations, discussions, and group meetings conducted in standard English and supported by written materials and other communication cues and aids. Uses active listening skills in comprehending simple technical and non-technical verbal information.

***Performance Requirement:***

Given a specific duty to perform and the necessary written information contained on relevant documents and information sheets, listen for, comprehend, and incorporate oral information in the performance of the duty and answer questions about the content or meaning of the oral information.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Listening KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Listen to verbal instructions.
2. Job execution	Benchwork Layout Operate machine tools.	Listen to verbal instructions.
3. Quality and inspection	Inspection Control	Listen to verbal instructions.
4. Process improvement	Process adjustment Participation in improvement	Listen to verbal instructions.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Listen to verbal instructions.
6. Safety and environment	Operations and handling HazMat handling & storage Material storage	Listen to verbal instructions.

**KSAO Area: 3. Decision Making and Problem Solving**  
**KSAO: 3.1 Applying Decision Rules**

***KSAO Definition:***

Can follow a set of instructions laid out in a sequence. Can interpret and follow "if....then...." instructions.

***Performance Requirement:***

Given a specific duty to perform requiring a checklist of sequential instructions, carry out the duty making appropriate entries on the checklist.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Applying Decision Rules KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Sequence operations.
2. Job execution	Benchwork Layout Operate machine tools.	Follow the process plan, deviating according to decision rules where necessary.
3. Quality and inspection	Inspection Control	Follow the quality plan, deviating according to decision rules where necessary.
4. Process improvement	Process adjustment Participation in improvement	Apply checklists and decision rules to process improvement.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Apply company procedures to housekeeping, PM, and TM.
6. Safety and environment	Operations and handling HazMat handling & storage Material storage	Apply OSHA and EPA decision rules to the storage and handling of materials.

**KSAO Area: 3. Decision Making and Problem Solving**  
**KSAO: 3.2 Basic Problem Solving**

***KSAO Definition:***

Can establish new responses to unexpected problems of a simple nature. Can formulate the new responses into a sequence of instructions or a set of "if ... then ..." rules.

***Performance Requirement:***

Given a specific duty to perform and being furnished with a checklist of sequential instructions, carry out the duty according to the checklist responding appropriately to problems. Formulate those responses into "if ... then ..." rules.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Basic Problem-Solving KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Sequence operations, providing alternatives according to availability of tools and equipment.
2. Job execution	Benchwork Layout Operate machine tools.	Follow a process plan, improvising new methods where unavailability of tooling makes the plan obsolete.

**KSAO Area: 4. Social Skills and Personal Qualities**  
**KSAO: 4.1 Social Skills**

***KSAO Definition:***

Identify and demonstrate the appropriate social skills and related personal qualities in the performance of major duties requiring cooperative relations with supervisors, team leaders, and team members.

***Performance Requirement:***

Demonstrates understanding, friendliness, politeness, and empathy toward others including men and women, and with people from a variety of ethnic, social, and educational backgrounds. Works cooperatively with others and contributes to group efforts with ideas, suggestions, and positive feedback to group members. Demonstrates appropriate social and communication skills in resolving conflicts with supervisors, team leaders, and team members.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Social Skills KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Work cooperatively in developing a process plan, taking input from supervisors and co-workers.
2. Job execution	Benchwork Layout Operate machine tools.	Work cooperatively by responding to the need to share common work spaces.
3. Quality and inspection	Inspection Control	Work cooperatively by participating in cooperative SPC activities.
4. Process improvement	Process adjustment Participation in improvement	Work cooperatively in workgroups, developing process improvements.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Work cooperatively by returning common tools to their appropriate storage sites.

**KSAO Area: 4. Social Skills and Personal Qualities**  
**KSAO: 4.2 Personal Qualities**

***KSAO Definition:***

Identify and demonstrate the appropriate personal qualities in performing major job duties and maintaining positive employment relations.

***Performance Requirement:***

Recognizes and demonstrates appropriate codes of conduct and values in the workplace and demonstrates honesty and integrity in exhibiting appropriate workplace behaviors. Assumes responsibility and demonstrates strong work ethic by exerting effort and perseverance in doing work tasks according to high standards. Maintains high standards of attendance, punctuality, and involvement in all major work tasks.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Personal Qualities KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
3. Quality and inspection	Inspection Control	Demonstrate honesty and integrity in reporting the findings of inspection processes.
4. Process improvement	Process adjustment Participation in improvement	Demonstrate attendance and punctuality in attending meetings for the development of process improvement.
6. Safety and environment	Operations and handling HazMat handling & storage Material storage	Demonstrate honesty and perseverance in the handling of materials according to EPA requirements.



**KSAO Area: 6. Measurement**  
**KSAO: 6.1 Basic Measuring Instruments**

***KSAO Definition:***

Recognizes and applies basic measuring instruments such as rules, protractors, and basic transfer tools such as simple inside and outside calipers.

***Performance Requirement:***

Given a part print and a finished part from that print, as well as a selection of appropriate basic measuring instruments, determine a part's compliance on selected dimensions.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Basic Measurement Instruments KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
2. Job execution	Benchwork Layout Operate machine tools.	Set the length of layout tools using basic instruments.
3. Quality and inspection	Inspection Control	Inspect dimensions that call for the use of basic measuring tools on a finished part.

**KSAO Area:** 7. Metalworking Theory  
**KSAO:** 7.1 Cutting Theory

***KSAO Definition:***

Understands and can explain the ideas of heat, shock, friction, zone of distortion, cutting interface, machinability, cutter presentation, cutter geometry, and chip-holding capacity as they relate to machining applications.

***Performance Requirement:***

Given a part print and a part to be made, select speeds, feeds, and appropriate tooling to carry out the manufacture of the part.

***Duty Standard Cross Reference Table:***

This table identifies some of the activities that require the Cutting Theory KSAO.

<b>Duty Area</b>	<b>Task</b>	<b>Activity</b>
1. Job planning	Prepare a process plan.	Determine speeds and feeds.
2. Job execution	Benchwork Layout Operate machine tools.	Select cutters appropriate to machine operations.

