The National Institute for Metalworking Skills, Inc.

Duties and Standards For Machining Skills-Level I

NIMS/ANSI 101-2001

Developed By:

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Duties and Standards

for

Level I

Machining Skills

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INTRODUCING THE METALWORKING SKILLS STANDARDS PROJECT

Machining Skills-Level I Voluntary Industry Standards

We are pleased to present the first of a series of 24 voluntary National Skill 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 I has been developed and validated to incorporate the basic requirements for the majority of skilled positions in the metalworking trades. This set of standards has been designed to allow selection of individual skills or groups of skills to be used as a foundation for perfecting skills called for in many of the more specialized metalworking disciplines. (See page 15 for an overview of the metalworking skills framework-figure 2.)

Machining Skills-Level I-II-III

In the general machining area three skill level standards 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, introductory CNC, Metric conversion, introductory Geometric Dimensioning and Tolerances, 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 more detailed CNC principles, angular measurements, and additional auxiliary equipment.

Level III

Level III in general reaches into the journeyperson 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; They are not model training programs in and of themselves. In many cases elements of all three standards will appear in metalworking training programs 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 Skill Standards initiative is performance assessment and knowledge testing that will allow workers and trainees to certify their competencies. Following procedures established for credentialing, individuals can earn industry recognition through credentials that will serve them nationwide and throughout their metalworking career.

The testing and credentialing program now underway for Level I skills is administered through the National Institute for Metalworking Skills, Inc. (NIMS) Individuals interested in this credentialing program should contact NIMS and request a copy of the Credentialing Procedures Manual.

Program certification for educational institutions, companies with formal training programs, and inter-firm arrangements for training also is available through NIMS. Contact the National Institute for Metalworking Skills, Inc. for information about program certification.

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Overview

OVERVIEW

1. Background

In late fall 1992, the U.S. Departments of Education and Labor launched an initiative to fund industry organizations and consortia to develop national occupational skill standards for their industries. Skill standards refer to the major duties, knowledge, and skills that workers must proficiency to meet performance requirements and expectations in the modern workplace. The national basis of these standards refers to the process followed in their development, namely that they be reviewed and reflect employer and employee opinions in the industry as that industry is distributed nationwide. The skill standards, once established, are intended to guide workforce development programs in the public and private sectors in building a world-class workforce in the United States.

The National Tooling and Machining Association (NTMA) was selected to work with other leading organizations in the metalworking industry to establish national skill standards for metalworking occupations. This effort is developing standards with input from workers, employers, trainers, and educators nationwide. The standards are being benchmarked to those in Germany, Japan, and other leading metalworking countries. The standards are proposed for broad application in all public and private workforce development programs that prepare youth and adults for employment in the metalworking industry. They also are intended for application in upgrading programs, retraining programs, and apprenticeships for workers already employed by metalworking companies.

NTMA has been joined by seven other trade associations and three organized labor institutions in this skill standards development effort.[1] These associations work cooperatively through the National Institute for Metalworking Skills,Inc. to guide the establishment of national standards for the industry. Major responsibilities of the Institute include:

- developing recognized occupations organized into career paths within the industry;
- writing and verifying skill standards for each recognized career path;
- providing for the assessment and credentialing of workers; and assessment, and
- certifying of training programs that train to the industry‘s skill standards.

[1]The Council of Great Lakes Governors also is participating. The Council and six of its member states pledged to pilot the metalworking skill standards in publicly administer training programs. Representatives from the Council and involved states attend meetings of the Metalworking Industry Skill Standards Board and serve on an overall project steering committee.

The National Institute for Metalworking Skills, Inc., recognizes that career paths can develop from four major occupational groups in the metalworking industry (see Figure 1). These are machining, tooling, metalforming, and industrial maintenance occupations. Within each occupational group or cluster, multiple job titles can exist and such titles as may be invoked is the prerogative of individual metalworking companies. The Institute focuses on defining skills and recommends that each occupational cluster reflect increasing levels of competency or skills. Three skill levels are suggested for each major cluster.

2. Description of Typical Level I Machining Responsibilities

An individual with Level I Machining Skills is a *skilled* machine operator or technician who has demonstrated competence in three major areas of responsibility:

1. basic bench operations
2. basic metal cutting operations
3. basic inspection and quality assurance functions.

This individual can perform these responsibilities in both single and multiple part production. No direct supervision or training responsibilities of other operators or other production workers is assumed at level I.

Level I Machining Responsibilities typically include the ability to: **(Note: These are not the standards)**

Bench Operations:

- Select and use hand tools.
- Perform basic, routine layout.
- Read and comprehend information on orthographic prints and job process sheets for routine manufacturing operations.
- Deburr.
- Perform hand fitting and minor assembly.
- Perform bench cutting tasks such as sawing, reaming, and tapping.
- Perform basic, routine preventive maintenance.
- Perform basic housekeeping responsibilities.

Metal cutting operations:

- Identify basic metallic and non-metallic materials.
- Identify and use most accessories and tooling for machining operations.
- Choose an appropriate speed and feed for a given operation.
- Perform basic process planning, setup, and operation of common classes of machine tools such as turning, milling, drilling, or surface grinding machines.
- Select and use coolants appropriately.
- Make suggestions for improving basic machining operations within a structured improvement process.
- Be competent in all safety procedures for all machining operations and material handling and disposal within their responsibility.

Inspection and quality assurance responsibilities:

- Use basic precision measurement tools.
- Follow an inspection process plan.
- Perform basic quality assurance responsibilities for both single and multiple part production including statistical process control.

Other competency areas:

- Follow standardized work procedures in a limited range of standardized work contexts under direct supervision.
- Be competent in all basic aspects of seeking and maintaining employment in the metalworking industry.

3. Education and Training

Most trainees can acquire the core Level I Machining Skills in six months to one year of education and training, depending on prior manufacturing experience, basic academic skills, mechanical aptitudes, and the availability of laboratory-based training. This training could be given in a high school or community college vocational/technical education program, apprenticeship program, formal company training program, or structured on-the-job training. Existing workers may be able to demonstrate their competence against the standards in shorter time periods and access necessary education and training through community colleges, private programs training centers, retraining or upgrading.

4. Related Occupations in the United States

Related Standard Occupational Classification (SOC) and Dictionary of Occupational Titles (DOT) occupations that can include Level I Machining Skills are:

- Lathe and turning machine operators (SOC 7512)
- Milling and planing machine operators (SOC 7313, 7513)
- Grinding, abrading, buffing, and polishing machine operators (SOC 7322, 7324, 7522)
- Miscellaneous metalworking machine operators (SOC 7329)
- Grinding machine operators (DOT 603.482-034)
- Lathe operator, production (DOT 604.685-026)
- Milling machine operator, production (DOT 605.685-030)
- Drill press operator (DOT 606.682-014)
- Vertical band-saw/cut-off-saw operators (DOT 607.682-010)

5. Program (Curriculum) Standards in the United States

Major national, state, and local curriculum standards used in the United States that have been consulted in developing standards for Level I Machining Skills include:

- Ohio's Competency Analysis Profile-Machine Trades
- California Curriculum Standards-Manufacturing Technology, Machine Tools
- Similar State Vocational Education Competencies in Great Lakes States
- Chicago Machine Trades Advisory Group-Basic and Intermediate Levels.
- National Tooling and Machining Association, Competency Profile Certificate and Metalworking Training System, Level 1.
- Tooling and Manufacturing Association-Apprenticeship Programs, first year of related theory courses.
- International Association of Machinists and Aerospace Workers, Automotive and Metal Trades Apprenticeship Training Program, first year.
- ASTD Workplace Basics.
- SCANS Skills.

6. International Benchmarks

Major international occupational standards that have been used in benchmarking the Level I Machining Skills include:

- German Apprenticeship System, Metalcutting Mechanic, First Year Training Schedule.
- CEDEFOP (European Community), Setter/Operator of Production Machines, Metal Sector
- Japan National Association of High School Principals, certificate exams for mechanical drawing, industrial mathematics, and machinery-mechanical work.
- Japanese Ministry of Labor Trade Tests, Basic Training and Grade 1 Upgrading Training, machining, machine maintenance, machine part inspection.
- Australian Standard Framework, Metalcutting Occupations, Levels 1 and 2.
- Canadian JOBSCAN Profiles, Metalworking Machine Setters and Operators, Level 1.

7. Duty Framework for Level I Machining Skills:

Duties represent the most important responsibilities that workers are expected to perform. Each duty area may consist of a single or multiple duties. Each duty requires demonstrated competence for its execution. The duty competencies are defined as performance standards and include accuracy requirements that must be achieved within specified times. Each duty or standard also details the knowledge, academic skills, and other performance related characteristics that must be demonstrated to satisfy the standard. These duty standards are to be assessed by written and oral examinations, and performance examinations. These skill standards form the basis for awarding credentials of achievement.

The duty framework for Level I Machining is described below in Figure 2. The left-hand column lists the 7 duty areas and 25 duty titles of the level I skills. The right-hand column identifies the knowledge, academic skills, and other characteristics that undergird the duties and must be mastered to meet the performance-based duty standards. Performance on each of the job execution duties can be assessed independently. Workers and trainees can demonstrate their ability to achieve or exceed the standards for job execution one duty at a time and receive credentials accordingly. Employers may prefer to describe jobs or positions by the mix of duty skills being sought. This framework is intended to encourage workforce development programs to modularize their approaches to curriculum development and program delivery. Workers and employers can use the duty or skill standards over Levels I, II, and III to create career paths and to define learning and training opportunities and needs.

Figure 1. Framework for Level I Machining Skills

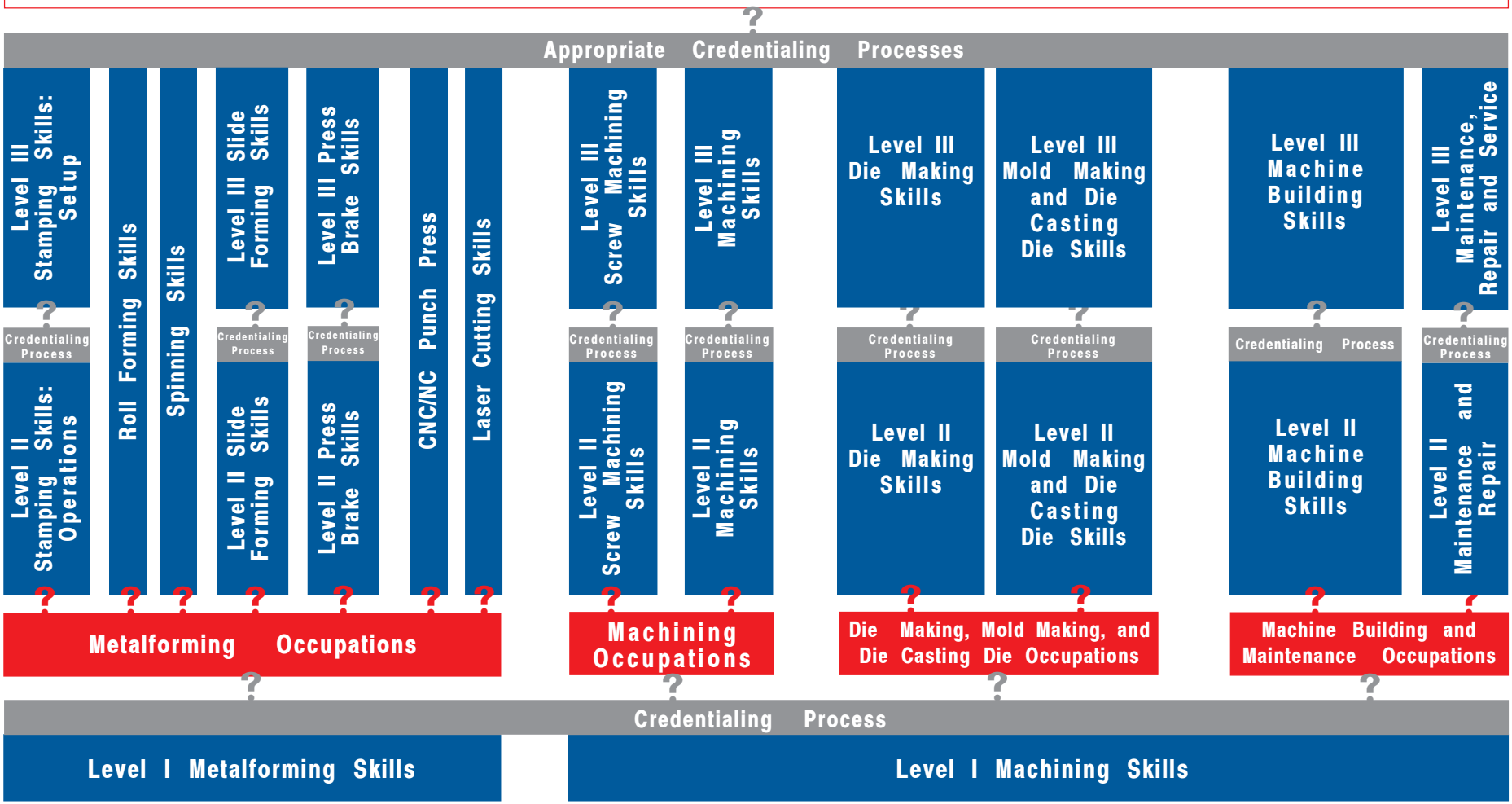
This figure represents the two principal sets of expectations that comprise Level I Machining Skills. The left-hand column is a listing of the duties that are expected to constitute Level I jobs. The right-hand column is a listing of the abilities, skills, knowledge, or other characteristics that are needed to perform the duties.

Occupational Duties	Knowledge, Skills, Abilities, and Other Characteristics
1. Job Planning and Management 1.1 Job Process Planning	**1. Written and Oral Communications** 1.1 Reading 1.2 Writing 1.3 Speaking 1.4 Listening
2. Job Execution 2.1 Manual Operations Benchwork 2.2 Manual Operations Layout 2.3 Turning Operations-Between Centers Turning 2.4 Turning Operations-Chucking *2.5* Milling: Square Up a Block *2.6* Vertical Milling 2.7a Grinding Wheel Safety 2.7b Surface Grinding 2.8 Drill Press Operations 2.9 CNC Programming	**2. Mathematics** 2.1 Arithmetic 2.2 Applied Geometry 2.3 Applied Algebra 2.4 Applied Trigonometry 2.5 Applied Statistics
3. Quality Control and Inspection 3.1 Part Inspection 3.2 Process Control	**3. Decision Making and Problem Solving** 3.1 Applying Decision Rules 3.2 Basic Problem Solving
4. Process Adjustment and Control 4.1 Process Adjustment, Single Part Production 4.2 Participation in Process Improvement	**4. Group Skills and Personal Qualities** 4.1 Group Participation and Teamwork 4.2 Personal Qualities
5. General Maintenance 5.1 General Housekeeping and Maintenance 5.2 Preventive Maintenance 5.3 Tooling Maintenance	**5. Engineering Drawings and Sketches** 5.1 Standard Orthographic prints 5.2 GDT Orthographic prints 5.3 GDT Datum, Symbology and Tolerances
6. Industrial Safety and Environmental Protection 6.1 Machine Operations and Material Handling 6.2 Hazardous Materials Handling and Disposal	**6. Measurement** 6.1 Basic Measuring Instruments 6.2 Precision Measuring Instruments 6.3 Surface Plate Instruments 6.4 Metric Conversion
7. Career Management and Employment Relations 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	**7. Metalworking Theory** 7.1 Cutting Theory 7.2 Tooling 7.3 Material Properties 7.4 Machine Tools 7.5 Cutting Fluids and Coolants

A Skills and Credentialing Framework for Careers in Metalworking in the United States

Capstone Opportunity Fields

Business Owner, Journeyperson, General Management, Industrial Management, Engineering Technology, Engineering, Sales and Application Engineer



- The credentialing processes involve performance reviews and written exams on related theory and other knowledge areas to demonstrate competencies.
- Each skill set is based on the most important responsibilities that workers are expected to perform; the credentialing process is modular in design—workers or employers select the modules of skill sets that best meet their career direction or job requirements.

NIMS

National Institute for Metalworking Skills, Inc.

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Level I Machining Skills

Duty Area: 1. Job Planning and Management
Duty Title: 1.1 Job Process Planning

Duty:
Develop a process plan for a part requiring milling, drilling, turning, or grinding. Fill out an operation sheet detailing the process plan and required speeds and feeds.

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 fill out an operation sheet reflecting the chosen strategies including the required speeds and feeds.

Identify all major components and functions of the machine tools, and all major hand tools, measuring tools, tools and fixtures, work materials and provide the rationale for the speeds and feeds selected.

Note: The blueprint will require the execution of the machining operations described in duties 2.1 to 2.9.

Other Evaluation Criteria:
1. *Legibility*
2. *Appropriate speeds and feeds*

Accuracy Level: N/A.

Assessment Equipment and Material:
Workstation: Common workbench.
Material: A print with an appropriate part, an inventory of available tools.
Tooling: *N/A.*
Measuring Instruments: *N/A.*
Reference: Machinery's Handbook.

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.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GD&T Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
X	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision Rules	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation and Teamwork		
	4.2 Personal Qualities		

Duty Area: 2. Job Execution
Duty Title: 2.1 Manual Operations: Benchwork

Duty:
Using aluminum, hand drill and hand tap holes. Use hand drills, hand taps, tap wrench, files, scrapers, and coated abrasives to deburr parts. Use arbor presses to perform press fits. Use bench vises and hand tools appropriately.

Performance Standard:
Given a process plan, blueprint, access to hand tools, produce a part with two holes prepared for hand tapping, a hole prepared (reamed) for the press fit of a bushing, and a stud for one of the tapped holes. Deburr the part, hand drill and hand tap the holes, press in the bushing, and install the stud.

Other Evaluation Criteria:
1. *Free of sharp edges or burrs.*
2. *Go/NoGo gage for the threads.*
3. *Length of stud within 1/32 of basic dimension and square to surface.*

Accuracy Level: +/-1/64 on all fractions, unless otherwise specified on the blueprint.

Assessment Equipment and Material:
Workstation: Common workbench with at least a four-inch bench vise, an arbor press.
Material: A part machined to the benchwork blueprint, material: Aluminum or mild steel A stud matching the requirements of the blueprint, and a selection of sleeve bushings for the desired fit, cutting oil, and appropriate lubricants.
Tooling: Taps, tap wrenches, assorted files with handles, assorted scrapers, reamer, hacksaw frame with an assortment of blades.
Measuring Instruments: Combination set, height gage or dial indicator, depth micrometer, and a ¼-20 cap screw.
Reference: Machinery's Handbook.

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic		6.2 Precision Measurements
	2.2 Applied Geometry		6.3 Surface Plate Instruments
	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics		7.1 Cutting Theory
	3. Decision Making and Problem Solving		7.2 Tooling
X	3.1 Applying Decision Rules	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving		7.4 Machine Tools
	4. Group Skills and Personal Qualities		7.5 Cutting Fluids and Coolants
	4.1 Group Participation and Teamwork		
	4.2 Personal Qualities		

Note to Standards Readers:
The part will require the development of a 1/16 X 45^0 chamfer along a 3" edge and a 1/16 radius also along another 3"edge. The part will be no more than 1" thick. One of the holes to be tapped will be blind. Holes will be countersunk for tapping. The blueprint will specify a .001" press fit.

Duty Area: 2. Job Execution
Duty Title: 2.2 Manual Operations: Layout

Duty:
Layout the location of hole centers and surfaces within an accuracy of +/-.015.

Performance Standard:
Given a surface plate, surface gage, layout height gage, combination set, scriber, layout ink, prick punch, ball peen hammer, process plan, and part print, layout hole locations, radii, and surfaces matching the specifications.

Other Evaluation Criteria:
1. Layout ink is applied to the surface appropriately.
2. Lines are struck once.
3. Intersections are clean and clear.
4. Punch marks are centered on intersections.

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

Assessment Equipment and Material:
Workstation: Common workbench, a layout surface plate at least 12" X 18"
Material: A part matching the layout print, material: Cold rolled mild steel.
Tooling: A scriber, layout ink or a Magic Marker, prick punch, ball peen hammer, angle plate, C-clamps, parallel-closing clamps, magnifying glass.
Measuring Instruments: Combination set, radius gages, 6" dividers, surface gage, or layout height gage.
Reference: Machinery's Handbook.

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GDT Datums, Sumbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry	*X*	6.3 Surface Plate Instruments
	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics		7.1 Cutting Theory
	3. Decision Making and Problem Solving		7.2 Tooling
X	3.1 Applying Decision		7.3 Material Properties
X	3.2 Basic Problem Solving		7.4 Machine Tools
	4. Group Skills and Personal Qualities		7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

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

Duty:
Setup and carry out between centers turning operations for straight turning.

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 three diameters within +/-.002, one UNC external thread , one UNF external thread, and require an end-for-end swap.

Other Evaluation Criteria:
1. *Finishes are at least 125 microinches.*
2. *No sharp edges.*

Accuracy Level: +/- .015 on all fractions, +/-.005 on all decimals unless otherwise specified on the part print. Diameters to be concentric within .002 T.I.R.

Assessment Equipment and Material:
Workstation: A common workbench, an engine lathe of 14"X 30" minimum capacity, a three-jaw universal scroll chuck, and a four-jaw independent chuck. The lathe may have a quick change gear box with the threads called for on the blueprint available from the gear box.

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

Tooling: Tool post, 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 blueprint, a drill chuck, combination drill and countersink, leg dog, external undercut tools, 45^{o} chamfer 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, thread ring gages, dial indicator, 6" rule, 6"vernier, dial, or electronic caliper, surface finish comparison plates.

Reference: *Machinery's Handbook.*

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
X	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Duty Area: 2. Job Execution
Duty Title: 2.4 Turning Operations: Chucking

Duty:
Setup and carry out chucking operations for turning.

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 print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within +/-.005", two bores within +/-.005", one UNC external thread, and require at least two chuckings or other workholding setup.

Other Evaluation Criteria:
1. *Finishes are at least 125 microinches.*
2. *No sharp edges.*

Accuracy Level: +/- .015 on all fractions, +/-.005 on all decimals unless otherwise specified on the blueprint. Diameters to be concentric within 002 T.I.R.

Assessment Equipment and Material:

Workstation: A common workbench, an engine lathe *of 14"X 30" minimum capacity*, a three jaw universal scroll chuck, and a four jaw independent chuck. The lathe may have a quick change gear box with the threads called for on the print available from the gear box.

Material: A part matching the material requirements of the turning blueprint, material: Mild steel.

Tooling: Tool post, 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 print, a boring bar and boring tool capable of boring to a square shoulder, a drill chuck, centerdrill, and assorted drills necessary to rough out the bore, magnetic base for a dial indicator, spiders for chucks, files, wrenches as necessary.

Measuring Instruments: Required micrometers, combination set, thread pitch gages center gage, pitch micrometer, thread ring, dial indicator, 6" rule, a 6" vernier, dial, or electronic caliper, telescoping gages or inside calipers, and surface finish comparison plates.

Reference: Machinery's Handbook.

KSAO:

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Chucking Operations for Turning Duty.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
X	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Note to Standards Readers:
Readers thus far have indicated that these operations should be chucking only. No tailstock support should be used in either chucking.

Duty Area: 2. Job Execution
Duty Title 2.5 Milling: Square Up a Block

Duty:
Set up and perform squaring up the six surfaces of a block to within +/-.002 and .002 over 4.5" squareness

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 will require squaring up from its raw state.

Accuracy level: +/- .002 on all decimals unless otherwise specified on the part print. Surfaces square to within .002" over 4.5". 63 microinch finish

Assessment Equipment and Material:
Workstation A standard workbench and a milling machine.
Material: A part matching the material requirements of the part print; cold rolled steel
Tooling: A 6" milling vis or greater, screws, studs, nuts, washers, and clamps sufficient to secure the vise or the part to the table. Assorted parallels, ball peen, and composite hammers, assorted cutters and cutter adaptors 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 inch 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

KSAO:

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Squaring Up a Block Duty.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
X	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Duty Area: 2. Job Execution
Duty Title: 2.6 Vertical Milling

Duty:
Setup and operate vertical milling machines. Perform routine milling, and location of hole centers within +/-.005".

Performance Standard:
Given raw material, process plan, print, hand, precision, and cutting tools, as well as access to an appropriate vertical milling machine and its accessories, produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within +/-.005" and have three steps controlled by tolerances of +/-.005".

Other Evaluation Criteria:
1. *Finishes are at least 125 microinches.*
2. *No sharp edges.*

Accuracy Level: +/- .015 on all fractions, +/-.005 on all decimals unless otherwise specified on the blueprint. Finishes Surfaces to be square within .005 over 4". Finished surfaces are to be 125 microinches unless otherwise specified.

Assessment Equipment and Material:

Workstation: A common workbench, a vertical mill. Table capacity of approximately 12"X36".

Material: A part matching the material requirements of the vertical milling print, material: Mild 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 soft-faced hammers, assorted cutters and cutter adapters fitted to the machine spindle, files, magnetic base for indicators, soft jaws for the vise, drill chuck, drills, reamers, combination drill and countersink or spotting drill, countersink, and edge finder. Coolants and cutting oil.

Measuring Instruments: 0-3 Micrometers, combination set, dial indicator, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, and depth micrometer, and surface finish comparison plates.

Reference: Machinery's Handbook.

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
X	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Duty Area: 2. Job Execution
Duty Title: 2.7a Surface Grinding, Grinding Wheel Safety

Duty:
Ring test grinding wheels, perform visual safety inspection, mount and dress a grinding wheel in preparation for surface grinding.

Performance Standard:
Given a selection of wheels in various conditions determine which are suitable for use, mount one on the spindle, and dress it in preparations for surface grinding.

Other Evaluation Criteria:
1. N/A.

Accuracy Level: N/A

Assessment Equipment and Material:
Workstation: A common workbench with a precision surface plate, a surface grinder.
Material: N/A
Tooling: A magnetic chuck, assorted grinding wheels suitable for mounting to the spindle, soft-faced hammer, assorted wrenches, screwdrivers, specialty hand tools for the spindle, and a diamond dresser.
Measuring Instruments: N/A
Reference: Machinery's Handbook

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic		6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Duty Area: 2. Job Execution
Duty Title: 2.7b Surface Grinding, Horizontal Spindle, Reciprocating Table

Duty:
Setup and operate manual surface grinders with a 8" and smaller diameter wheel. Perform routine surface grinding, location of surfaces, and squaring of surfaces. Perform wheel dressing.

Performance Standard:
Given a block squared up 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, produce a part matching the process plan and the 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.

Other Evaluation Criteria:
1. *Finishes are at least 32 microinches or better.*
2. *Free of sharp edges.*

Accuracy Level: +/- .001 on all decimals unless otherwise specified on the print. Square within .001 over 4".

Assessment Equipment and Material:
Workstation: A common 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 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, dial test indicator, 6" rule, a 6" vernier, dial, or electronic caliper, adjustable parallels, depth micrometer set, master square or magnetic square, surface finish comparison gages.

Reference: Machinery□s Handbook

KSAO:

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Duty on using Surface Grinding, Horizontal Spindle, and a Reciprocating Table.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry	*X*	6.3 Surface Plate Instruments
X	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Duty Area: 2. Job Execution
Duty Title: 2.8 Drill Press

Duty:
Setup and operate drill presses. Perform routine drill press operations.

Performance Standard:
Given a semi-finished part, process plan, part print, hand precision, and cutting tools, as well as access to a drill press and its accessories, produce a part matching the process plan and the blueprint specifications. The part specified will be in the semi-finished state having been squared up and the outer surfaces completed with five center-drilled locations. Finishing the part will require the finishing of the five center-drilled locations. Each hole must have at least two secondary operations. The secondary operations will consist of reaming, spot facing, countersinking, counterboring, and counterdrilling. At least one hole must be a blind hole and one a through hole. At least one hole will may be power tapped.

Other Evaluation Criteria:
1. *Finishes are at least 250 microinches.*
2. *No sharp edges.*
3. *The mouths of all holes are lightly countersunk.*

Accuracy Level: +/- 1/64 on all fractions, holes square within .005 per inch, drilled diameters, +.006, -.000. Reamed diameters +.001, -.000, +/-.005 on all decimals unless otherwise specified on the blueprint.

Assessment Equipment and Material:
Workstation: A common workbench, a drill press. Morse taper #3 spindle capacity or greater preferred. The drill press must have a tapping capability or a tapping head accessory.

Material: A part matching the material requirements of the drill press blueprint, material: mild 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, spot facers, counterbores, centerdrills, and various taps. A scriber, 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, go/nogo gage for threads, plug gages, telescoping gages, layout height gage, and surface finish comparison plates.

Reference: Machinery's Handbook.

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
X	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Note to Standards Readers:
The material for the drill press standard will be between 1/2 and 1 inch thick.

Duty Area: 2. Job Execution
Duty Title: 2.9 CNC Programming

Duty:
Using the principles of cartesian coordinates develop a program for the manufacture of a simple part.

Performance Standard:
Given a computer and a basic CNC software program, and a blueprint for part comparison. Apply the principles of three-dimensional coordinate planes in the development a simple program for the production of the part on a CNC milling machine.

Other Evaluation Criteria:
1. Free of sharp edges.

Accuracy Level: +/- 1/64".

Assessment Equipment and Material:
Workstation: Computer Workstation
Material: N/A
Tooling: N/A
Measuring Instruments: N/A
Reference: Machinery's Handbook. Software Manual

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics		6.1 Basic Measurements
X	2.1 Arithmetic		6.2 Precision Measurements
	2.2 Applied Geometry		6.3 Surface Plate Instruments
	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics		7.1 Cutting Theory
	3. Decision Making and Problem Solving		7.2 Tooling
X	3.1 Applying Decision		7.3 Material Properties
X	3.2 Basic Problem Solving		7.4 Machine Tools
	4. Group Skills and Personal Qualities		7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Duty Area: 3. Quality Control and Inspection
Duty Title: 3.1 Part Inspection

Duty:
Develop an inspection plan and inspect simple parts using precision tools and techniques. Prepare reports on the compliance of the parts.

Performance Standard:
Given the necessary job process sheets for a part and verbal instructions, identify and select the required measuring instruments and conduct the required inspection procedure(s). Complete required written inspection report and make a decision to accept or reject component parts. Provide brief verbal explanation of inspection procedures, results, and decisions.

Note: Inspection procedures will include basic inspections of parts and measurement instruments defined in Duties 2.1 and 2.9.

Other Evaluation Criteria:
1. N/A

Accuracy Level: Within a 1/64th for fractions, within .001" for decimals

Assessment Equipment and Material:
Workstation: A common workbench with a small surface plate.
Material: A finished part matching the requirements of the part inspection blueprint.
Tooling: Inspection grade gage blocks, angle plates, and clamps.
Measuring Instruments: An appropriate assortment of basic, fixed, precision, and surface plate inspection tools.
Reference: Machinery's Handbook.

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry	*X*	6.3 Surface Plate Instruments
	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
	4.1 Group Participation		
	4.2 Personal Qualities		

Note to Standards Readers:
A broad consensus regarding whether filling out an inspection plan is essential at Technician I has not emerged. The question remains. Oral defense of the inspection plan has gained the most support at this time. The next most supported position is requiring the candidate to be able to: (1) fill out an inspection plan form, and (2) fill out a data collection sheet with the dimensions actually found on the part.

Duty Area: 3. Quality Control and Inspection
Duty Title: 3.2 Process Control

Duty:
Follow a sampling plan. Inspect the samples for the required data. Enter the data on appropriate charts. Graph the data. Respond to the warning conditions indicated by the process charts.

Performance Standard:
Given the necessary job process sheets for a part, verbal instructions, and the necessary charts and inspection tools, inspect parts according to the sampling plan, collecting the data required for the process control chart. Working with the supplied control and warning limits, place the data, produce new data as needed, graph the data, and take the *Stop or Go* actions as indicated by the results of producing the process control chart. Provide brief verbal explanation regarding the decision taken.

Note: Inspection procedures will include basic inspections of parts and measurement instruments defined in Duties 2.1 and 2.9.

Other Evaluation Criteria:
1.N/A

Accuracy Level: Within a 1/64th for fractions, within .001 for decimals.

Assessment Equipment and Material:
Workstation: A common workbench with a small surface plate.
Material: An appropriate population of product matching the part print specifications and broken up into discrete packages matching the requirements of the sampling plan. X-bar and R charts.
Tooling:
Measuring Instruments: Inspection tools sufficient to carry out the sampling and inspection plan.
Reference: Machinery's Handbook.

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
X	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
X	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and Problem Solving	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
X	4.1 Group Participation		
X	4.2 Personal Qualities		

Duty Area: 4. Process Adjustment and Improvement
Duty Title: 4.1 Process Adjustment-Single Part Production

Duty:
Analyze the performance of a single-part production process. Formulate process adjustments or improvements where appropriate. Where appropriate, notify supervision of the proposed adjustment and/or improvement. Where authorized, carry out the strategies for process adjustment and/or improvement.

Performance Standard:
Given a process plan, part print, inspection process plan, verbal instructions, the necessary tools and equipment, and a part having routine problems being processed, analyze the problem(s), propose a remedy(ies), having been given authorization to implement the process improvement(s), carry it out. Explain the corrective actions and the reasoning used to perform the diagnosis.

Other Evaluation Criteria:
1. N./A

Accuracy Level: +/- 1/64 on all fractions, holes square within .005 per inch, drilled diameters, +.006, -.000. Reamed diameters +.001, -.000, +/-.005 on all decimals unless otherwise specified on the blueprint.

Assessment Equipment and Material:
Workstation: A common workbench, a machine tool with a setup in use.
Material: A part matching the setup, material: Hot rolled mild steel, cutting fluids.
Tooling: Tooling necessary to the setup.
Measuring Instruments: Inspection tools appropriate to the problem presented.
Reference: Machinery's Handbook.

KSAO:

This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Process Adjustment for Single Part Production Duty.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		5.3 GDT Datums, Symbology and Tolerances
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
X	4.1 Group Participation		
	4.2 Personal Qualities		

Duty Area: 4. Process Adjustment and Improvement
Duty Title: 4.2 Participation in Process Improvement

Duty:
As a member of a process team, analyze the performance of a production process. With the team formulate process adjustments or improvements where appropriate. Where appropriate, notify supervision of the proposed adjustments and/or improvement. Where authorized, carry out the strategies for process adjustment and/or improvement.

Performance Standard:
Given a process plan, Part print, inspection process plan, verbal instructions, the necessary tools and equipment, and a routine production process having a problem(s), as a team member, analyze the problem(s), propose a remedy(ies), having been given authorization to implement the process improvement(s), carry it out. Carry out the cause and effort analysis by participating in the development of a fishbone diagram with the team. Explain the fishbone diagram, the corrective actions and the reasoning connecting the fishbone root cause analysis to the remedial actions taken.

Other Evaluation Criteria:
1. N/A

Accuracy Level: +/- 1/64 on all fractions, +/-.005 on all decimals unless otherwise specified on the blueprint.

Assessment Equipment and Material:
Workstation: A team conference area.
Material: Fishbone charts, flip charts, markerboard.
Tooling: Writing tools, markers
Measuring Instruments: Relevant measuring instruments for the problem posed.
Reference: Machinery's Handbook.

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		5.3 GDT Datums, Symbology and Tolerences
X	1.4 Listening		**6. Measurements**
	2. Mathematics	*X*	6.1 Basic Measurements
X	2.1 Arithmetic	*X*	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
	2.3 Applied Algebra	*X*	6.4 Metric Conversion
	2.4 Applied Trigonometry		**7. Metalworking Theory**
X	2.5 Applied Statistics	*X*	7.1 Cutting Theory
	3. Decision Making and	*X*	7.2 Tooling
X	3.1 Applying Decision	*X*	7.3 Material Properties
X	3.2 Basic Problem Solving	*X*	7.4 Machine Tools
	4. Group Skills and Personal Qualities	*X*	7.5 Cutting Fluids and Coolants
X	4.1 Group Participation		
X	4.2 Personal Qualities		

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.

Other Evaluation Criteria:
1. N/A

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.

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.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading		5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		**6. Measurements**
X	1.4 Listening		6.1 Basic Measurements
	2. Mathematics		6.2 Precision Measurements
	2.1 Arithmetic		6.3 Surface Plate Instruments
	2.2 Applied Geometry	*X*	6.4 Metric Conversion
	2.3 Applied Algebra		**7. Metalworking Theory**
	2.4 Applied Trigonometry	*X*	7.1 Cutting Theory
	2.5 Applied Statistics	*X*	7.2 Tooling
	3. Decision Making and	*X*	7.3 Material Properties
X	3.1 Applying Decision	*X*	7.4 Machine Tools
X	3.2 Basic Problem Solving	*X*	7.5 Cutting Fluids and Coolants
	4. Group Skills and Personal Qualities		
X	4.1 Group Participation		
X	4.2 Personal Qualities		

Note to Standards Readers:
This duty standard will be assessed by a checklist which will be employed as other appropriate duty standards are assessed. For example, while observing the candidate's work for duty standard 2.6 for milling, the examiner will also check the candidate against the checklist for this duty standard.

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.

Other Evaluation Criteria:
1. N/A

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.

KSAO:

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

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		**6. Measurements**
X	1.4 Listening	*X*	6.1 Basic Measurements
	2. Mathematics		6.2 Precision Measurements
X	2.1 Arithmetic		6.3 Surface Plate Instruments
	2.2 Applied Geometry	*X*	6.4 Metric Conversion
	2.3 Applied Algebra		**7. Metalworking Theory**
	2.4 Applied Trigonometry	*X*	7.1 Cutting Theory
	2.5 Applied Statistics	*X*	7.2 Tooling
	3. Decision Making and	*X*	7.3 Material Properties
X	3.1 Applying Decision	*X*	7.4 Machine Tools
X	3.2 Basic Problem Solving	*X*	7.5 Cutting Fluids and Coolants
	4. Group Skills and Personal Qualities		
X	4.1 Group Participation		
X	4.2 Personal Qualities		

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 1.000". 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.

Proposed Time: 60 minutes. 15 minutes to grind two drills. 10 minutes to regrind a turning tool. 15 minutes to diagnose a variety of cutter's condition and orally report the recommended action to be taken. 20 minutes to rotate, replace, reseat inserts, or take other appropriate steps to prepare a six to eight inch face mill for return to service.

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.

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.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading		5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		**6. Measurements**
X	1.4 Listening	*X*	6.1 Basic Measurements
	2. Mathematics	*X*	6.2 Precision Measurements
X	2.1 Arithmetic		6.3 Surface Plate Instruments
X	2.2 Applied Geometry	*X*	6.4 Metric Conversion
	2.3 Applied Algebra		**7. Metalworking Theory**
	2.4 Applied Trigonometry	*X*	7.1 Cutting Theory
	2.5 Applied Statistics	*X*	7.2 Tooling
	3. Decision Making and	*X*	7.3 Material Properties
X	3.1 Applying Decision	*X*	7.4 Machine Tools
X	3.2 Basic Problem Solving	*X*	7.5 Cutting Fluids and Coolants
	4. Group Skills and Personal Qualities		
	4.1 Group Participation		
	4.2 Personal Qualities		

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.

Other Evaluation Criteria:
1. N/A

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.

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.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading	*X*	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		**6. Measurements**
X	1.4 Listening	*X*	6.1 Basic Measurements
	2. Mathematics		6.2 Precision Measurements
X	2.1 Arithmetic		6.3 Surface Plate Instruments
	2.2 Applied Geometry	*X*	6.4 Metric Conversion
	2.3 Applied Algebra		**7. Metalworking Theory**
	2.4 Applied Trigonometry	*X*	7.1 Cutting Theory
	2.5 Applied Statistics	*X*	7.2 Tooling
	3. Decision Making and	*X*	7.3 Material Properties
X	3.1 Applying Decision	*X*	7.4 Machine Tools
X	3.2 Basic Problem Solving	*X*	7.5 Cutting Fluids and Coolants
	4. Group Skills and Personal Qualities		
	4.1 Group Participation		
	4.2 Personal Qualities		

Note to Standards Readers:
Lockout and right-to-know will be accounted for in 6. Material handling here means handling of shafts and overhead cranes etc., and personal protection. The candidate should recognize pinch points, cutting points, and control points. The Examiner will be supplied with safety and other kinds of observation checklists to ensure consistency and thoroughness.

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.

Other Evaluation Criteria:
1. N/A

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.

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.

	1. Written and Oral Communication		**5. Engineering Drawings and Sketches**
X	1.1 Reading		5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking		**6. Measurements**
X	1.4 Listening	*X*	6.1 Basic Measurements
	2. Mathematics		6.2 Precision Measurements
X	2.1 Arithmetic		6.3 Surface Plate Instruments
	2.2 Applied Geometry	*X*	6.4 Metric Conversion
	2.3 Applied Algebra		**7. Metalworking Theory**
	2.4 Applied Trigonometry	*X*	7.1 Cutting Theory
	2.5 Applied Statistics	*X*	7.2 Tooling
	3. Decision Making and	*X*	7.3 Material Properties
X	3.1 Applying Decision	*X*	7.4 Machine Tools
X	3.2 Basic Problem Solving	*X*	7.5 Cutting Fluids and Coolants
	4. Group Skills and Personal Qualities		
X	4.1 Group Participation		
X	4.2 Personal Qualities		

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.

Note: The second simulation will be related to the performance of Duty Standard 4.2-Participation in Process Improvement.

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.

Knowledge, Skills, Abilities, and Other Characteristics

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.

Duty Area	Task	Activity
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.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Read checklists. Read manuals.
6. Safety and environment	Operations and handling Haz-Mat handling & storage Material storage	Read safety instructions.

KSAO Area: 1. Written and Oral Communication
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 includes the completion of forms, information sheets, reports, group meeting materials, and short memos.

Performance Requirement:

Given a specific 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 the Writing KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan	Write instructions on the process plan.
2. Job execution	Benchwork Layout Operate machine tools	Write a record of job activities.
3. Quality and inspection	Inspection Control	Write a record of inspection activities.
4. Process improvement	Process adjustment Participation in improvement	Write a record of adjustment and improvement activities.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Write a record of maintenance activities. Fill out history forms.
6. Safety and environment	Operations and handling HazMat handling & storage Material storage	Write a record of the activities involving the handling and storage of standard and hazardous materials.

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.

Duty Area	Task	Activity
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.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Explain the condition of machine tools and the maintenance actions taken.
6. Safety and environment	Operations and handling HazMat handling & storage Material storage	Explain actions bearing on safe practice.

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.

Duty Area	Task	Activity
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: 2. Mathematics
KSAO: 2.1 Arithmetic

KSAO Definition:

Performs addition, subtraction, multiplication, and division of whole numbers without a calculator, and performs calculation of fractions and decimals, as well as conversion to metric measurement with or without a calculator.

Performance Requirement:

Given a specific duty to perform requiring arithmetic operations, conduct arithmetic operations.

Duty Standard Cross Reference Table:

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

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Calculate speeds and feeds. Calculate operation times.
2. Job execution	Benchwork Layout Operate machine tools	Calculate necessary dimensions from the part print.
3. Quality and inspection	Inspection Control	Calculate necessary dimensions from the part print. Calculate statistics required by control charts.
4. Process improvement	Process adjustment Participation in improvement	Calculate the impact of a change of speed or feed.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Calculate the length of time spent in a PM activity.
6. Safety and environment	Operations and handling HazMat handling & storage Material storage	Calculate the volume of material stored.

KSAO Area: **2. Mathematics**
KSAO: **2.2 Applications of Geometry**

KSAO Definition:

Understands and applies basic geometric concepts and terminology which form the analytical foundation of job planning and execution including planes perpendicularity, Cartesian coordinates, concentricity, parallelism, straightness, flatness, circularity, and symmetry, etc.

Performance Requirement:

Given a specific duty to perform requiring the understanding and use of geometric concepts and terminology, perform the required duty and answer questions about the meaning and use of the geometric principles.

Duty standard Cross Reference Table:

This table identifies some of the activities that require the Applications of Geometry KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan	Apply geometry to select and sequence operations.
2. Job execution	Benchwork Layout Operate machine tools	Apply geometry to hold the work appropriately. Apply geometry to produce surfaces correctly.
3. Quality and inspection	Inspection Control	Apply geometry to locate surfaces and centerlines.
4. Process improvement	Process adjustment Participation in improvement	Apply geometry in analyzing operations and sequences.
5. Maintenance	Housekeeping Machine tool PM Tooling maintenance	Apply geometry in troubleshooting a machine tool or cutting tool.

KSAO Area: 2. Mathematics
KSAO: 2.3 Applications in Algebra

KSAO Definition:

Uses standard formulas and arithmetic operations to make required calculations with or without a calculator. Can solve for an unknown in a trade formula.

Performance Requirement:

Given a specific duty to perform requiring the use of formulas and arithmetic operations, conduct the required arithmetic operations using standard formulas.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Applications in Algebra KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Use trade formulas.
2. Job execution	Benchwork Layout Operate machine tools	Use trade formulas.
3. Quality and inspection	Inspection Control	Use trade formulas.

KSAO Area: 2. Mathematics
KSAO: 2.4 Applications in Trigonometry

KSAO Definition:

Uses standard formulas and arithmetic operations to make required calculations with or without a calculator, solving for unknowns in right triangles.

Performance Requirement:

Given a specific duty to perform requiring the use of formulas and arithmetic operations, conduct the required arithmetic operations using standard formulas.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Applications in Trigonometry KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Use trig-based trade formulas.
2. Job execution	Benchwork Layout Operate machine tools	Use trig-based trade formulas.
3. Quality and inspection	Inspection Control	Use trig-based trade formulas.

KSAO Area: 2. Mathematics
KSAO: 2.5 Applications of Statistics

KSAO Definition:

Uses standard formulas and arithmetic operations to calculate means, medians, modes, and ranges with or without a calculator.

Performance Requirement:

Given a specific duty to perform requiring the use of formulas and arithmetic operations, conduct the required statistical calculations using standard formulas.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Applications of Statistics KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Use SPC as part of a process plan.
3. Quality and inspection	Inspection Control	Use SPC to control quality.
4. Process improvement	Process adjustment Participation in improvement	Use SPC to analyze process performance.
6. Safety and environment	Operations and handling HazMat handling & storage Material storage	Use SPC to evaluate safety performance.

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.

Duty Area	Task	Activity
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.

Duty Area	Task	Activity
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.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Work cooperatively in developing a process plan, taking input from supervisors and coworkers.
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.

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

KSAO Area: 5. Engineering Drawings and Sketches
KSAO: 5.1 Standard Orthographic Prints

KSAO Definition:

Interprets orthographic blueprints.

Performance Requirement:

Given a standard orthographic print and a finished part from that print, prepare a checklist of dimensions necessary to determine the part's compliance.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Standard Orthographic Blueprint KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Gather geometric and dimensional data from a print to sequence operations.
2. Job execution	Benchwork Layout Operate machine tools	Gather geometric and dimensional data from a print to perform a layout.
3. Quality and inspection	Inspection Control	Gather geometric and dimensional data from a print to perform the inspection of a finished part.

KSAO Area: 5. Engineering Drawings and Sketches
KSAO: 5.2 GDT Orthographic Prints

KSAO Definition:

Interprets GDT orthographic prints.

Performance Requirement:

Given a GDT print and a finished part from that print, prepare a checklist of dimensions necessary to determine the part's compliance.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the GDT Orthographic Prints KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Gather geometric and dimensional data from a GDT print to sequence operations.
2. Job execution	Benchwork Layout Operate machine tools	Gather geometric and dimensional data from a GDT print to perform a layout.
3. Quality and inspection	Inspection Control	Gather geometric and dimensional data from a GDT print to perform the inspection of a finished part.

KSAO Area: 5. Engineering Drawings and Sketches
KSAO: 5.3 Datums, Symbology and Tolerances

KSAO Definition:

Identify the common symbols, the use of datum references and tolerances used in GD&T

Performance Requirement:

Given a GDT blueprint identify the meaning of various given symbols and datum planes. Identify part dimensions using GD&T tolerances.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the GDT Datum, Symbology and Tolerancing KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Using symbols and tolerances identify basic contours of a part
2. Quality and inspection	Inspection Control	Gather geometric and dimensional data from a GDT blueprint to perform the inspection of a finished part.

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 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.

Duty Area	Task	Activity
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 which call for the use of basic measuring tools on a finished part.

KSAO Area: 6. Measurement
KSAO: 6.2 Precision Measuring Instruments

KSAO Definition:

Recognizes and applies precision measuring instruments such as micrometers, vernier, dial, and electronic calipers, dial indicators, precision transfer tools such as telescoping gages and adjustable parallels.

Performance Requirement:

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

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Precision Measuring Instruments KSAO.

Duty Area	Task	Activity
2. Job execution	Benchwork Layout Operate machine tools	Determine the concentricity of a turned part to a lathe's spindle using an indicator.
3. Quality and inspection	Inspection Control	Inspect the dimensions of a finished part which call for the use of precision measuring tools.

KSAO Area: 6. Measurement
KSAO: 6.3 Surface Plate Instruments

KSAO Definition:

Recognizes and applies appropriately precision tools and instruments for surface plate work such as precision angle plates and tool blocks, precision transfer gages, and precision height gages.

Performance Requirement:

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

Duty standard Cross Reference Table:

This table identifies some of the activities that require the Surface Plate Instruments KSAO.

Duty Area	Task	Activity
3. Quality and inspection	Inspection Control	Inspect a part using surface plate instruments.

KSAO Area: 6. Measurement
KSAO: 6.4 Metric Conversion

KSAO Definition:

Convert all measurements to metrics.

Performance Requirement:

Given a part print with English tolerances shown. Convert all tolerances to metrics

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Metric Conversion KSAO.

Duty Area	Task	Activity
2. Job execution	Benchwork Layout Operate machine tools	Determine part tolerances in metrics
3. Quality and inspection	Inspection Control	Inspect the dimensions of a finished part to metric tolerances

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 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.

Duty Area	Task	Activity
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.

KSAO Area: 7. Metalworking Theory
KSAO: 7.2 Tooling

KSAO Definition:

Recognizes a wide variety of cutting tools, tool holding devices, and work holding devices. Understands the appropriate application of these cutters and devices.

Performance Requirement:

Given a print and a part to be made, select appropriate tooling, tool-holders, and work-holding devices to carry out the manufacture of the part.

Duty Standard Cross Reference Table:

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

Duty Area	Task	Activity
2. Job execution	Benchwork Layout Operate machine tools	Select cutters, tool holders, and work-holders appropriate to machine operations.

KSAO Area: 7. Metalworking Theory
KSAO: 7.3 Material Properties

KSAO Definition:

Recognizes common materials and their principal properties relevant to machining tasks. Recognizes differences between ferrous and non-ferrous, magnetic, and ductile materials. Understands the changes which heat-treat impart to materials.

Performance Requirement:

Given a print and a part to be manufactured, predict its machinability based upon its appearance, call-out on the print, and its supplied hardness value.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Material Properties KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan	Predict speeds and feeds, as well as tooling requirements, based on known properties of a material.
2. Job execution	Benchwork Layout Operate machine tools	Respond to cutting conditions imposed by material properties as predicted by the process plan and actually experienced in machining the material.

KSAO Area: 7. Metalworking Theory
KSAO: 7.4 Machine Tools

KSAO Definition:

Recognizes the common classes of machine tools, understands the function of the major subsystems of the machine tools, selects and applies a given machine tool appropriately.

Performance Requirement:

Given a selection of machine tools, a print, and a part to be machined, identify the appropriate machine. Explain the selection and what distinguished that choice from the other possibilities.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Machine Tools KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Select appropriate machine tools for a given set of operations.
2. Job execution	Benchwork Layout Operate machine tools	Operate machine tools to execute a specific operation.
3. Quality and inspection	Inspection Control	Participate in a machine-capability study.

KSAO Area: 7. Metalworking Theory
KSAO: 7.5 Cutting Fluids and Coolants

KSAO Definition:

Recognizes, selects, and applies appropriate coolants and coolant delivery systems.

Performance Requirement:

Given a set of machining operations, identify the appropriate coolant and delivery system for the operations.

Duty Standard Cross Reference Table:

This table identifies some of the activities that require the Cutting Fluids and Coolants KSAO.

Duty Area	Task	Activity
1. Job planning	Prepare a process plan.	Select appropriate coolants and delivery systems for a given set of operations.
2. Job execution	Benchwork Layout Operate machine tools	Operate machine tools to execute a specific operation using specified coolants and coolant delivery systems.

KSAO 8.1 Word Address Program Codes

KSAO Definition:

Develop a knowledge of basic word address programming codes, and Cartesian Coordinates Understand incremental and absolute positioning and cutter compensation.

Performance Requirement:

Given a list of standard word address codes match all word codes to their proper definition. Given 10 lines of a word address CNC program describe what function will be performed when read by a machine. Provided a simple part drawing chart the X and Y coordinates necessary to drive a tool around the periphery of the part.

Reference: Student is not allowed to use the Machinery's Handbook

Duty Standard Cross Reference Table:

This table describes some of the activities that require this KSAO

Duty Area	**Task**	**Activity**
Job Planning	Process Planning	Identify needed word address codes
Job Execution	CNC Programming	Define tool path