

ILLINOIS OCCUPATIONAL SKILL STANDARDS

MACHINING SKILLS CLUSTER

**Adapted from the
National Machining Skill Standards
and
Endorsed for Illinois
by the
Illinois Occupational Skill Standards and
Credentialing Council**

MESSAGE TO ILLINOIS CITIZENS

Dear Citizens of Illinois:

Preparing youth and adults for entry into the workforce and the ability of individuals to contribute to society throughout their lives are critical to the economy of Illinois. Public and private interest in establishing national and state systems of industry-driven skill standards and credentials is growing in the United States, especially for occupations that require less than a four-year college degree. This interest stems from the understanding that the United States will increasingly compete internationally by increasing the skills and productivity of the front-line workforce. The major purpose of skill standards and credentialing systems is to promote education and training investment and ensure that this education and training enables students and workers to meet industry standards that are benchmarked to our major international competitors.

The Illinois Occupational Skill Standards and Credentialing Council (IOSSCC) has been working with industry subcouncils, the Illinois State Board of Education and other partnering agencies to adopt, adapt and/or develop skill standards for high-demand occupations. This document represents the work of the Manufacturing Subcouncil and the associated standards development committee. Through this collaborative effort, skill standards products are being developed for a myriad of industries, occupational clusters and occupations. Upon completion of these products, there will be a period of feedback and comment from business, industry and labor representatives as well as educators.

These documents will serve as a guide to workforce preparation program providers in defining content for their programs and to employers to establish the skills and standards necessary for job acquisition. These standards will also serve as a mechanism for communication among education, business, industry and labor.

We encourage you to review of these standards and share your comments. This effort has involved a great many people from business, industry and labor. Comments regarding their usefulness in curriculum and assessment design as well as needs for inservice and technical assistance in their implementation are critical to our efforts to move forward and improve the documents. A feedback instrument is included with this document.

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We look forward to your comments.

Sincerely,

The Members of the IOSSCC

The Illinois Occupational Skill Standards and Credentialing Council (IOSSCC) endorses occupational skill standards and credentialing systems for occupations that (a) require basic workplace skills and technical training, (b) provide a large number of jobs with either moderate or high earnings, and (c) provide career advancement opportunities to related occupations with moderate or high earnings. The nine-member Council was established by the Occupational Skill Standards Act (PA 87-1210). The council, representing business, industry and labor and working with the Illinois State Board of Education in partnership with the Illinois Community College Board, Illinois Board of Higher Education, Illinois Department of Employment Security and Illinois Department of Commerce and Community Affairs, has created a common vision for workforce development in Illinois.

Vision

It is the vision of the IOSSCC to develop a statewide system of industry-defined and recognized skill standards and credentials for all major skilled occupations providing strong employment and earnings opportunities in Illinois. Information related to occupational employment and earning opportunities is determined by the Illinois Occupational Information Coordinating Committee (IOICC) in cooperation with business and industry.

Subcouncils and Standards Development Committees

The Council developed 14 industry subcouncils (representing all major industries in Illinois) to review, approve and promote occupational skill standards and credentialing systems. In cooperation with organizations such as the Illinois State Chamber of Commerce, the Illinois AFL-CIO, the Illinois Manufacturers' Association and others, the Council established the first five subcouncils in 1995—Agriculture and Natural Resources, Manufacturing, Health and Social Services, Hospitality and Business and Administrative/Information Services.

The remaining subcouncils include Applied Science and Engineering Services, Legal and Protective Services, Transportation and Distribution, Educational Services, Financial Services, Marketing and Retail Trade, Communications, Construction and Energy and Utilities.

The Standards Development Committees, composed of business, labor and education representatives, are experts in the related occupational cluster and work with the product developer to

- develop or validate occupational skill standards,
- identify related academic skills,
- develop or review assessment or credentialing approaches, and
- recommend endorsement of the standards and credentialing system to the industry subcouncil.

Expected Benefits for Employers, Educators, Students and Workers

Occupational skill standards and credentialing systems are being developed and promoted by the IOSSCC to improve Illinois' competitiveness. Such standards and credentialing systems provide a common language for employers, workers, students and education and training providers to communicate skill requirements and quality expectations for all major industry and occupational areas.

For Employers, skill standards will

- Improve employee recruitment and retention by more clearly identifying skill requirements,
- Encourage improved responsiveness and performance of education and training providers,
- Enlarge the pool of skilled workers,
- Focus attention on the importance of training investment.

For Education and Training Providers, skill standards will

- Provide information on all major industries and occupations,
- Contribute to program and curriculum development,
- Strengthen relationships between educators and training providers,
- Improve career planning.

For Students and Workers, skill standards will

- Enable better decision making concerning careers and the training necessary to acquire well-paying jobs.
- Allow more effective communication with employers about what they know and can do,
- Allow more effective work with employers in career development and skill upgrading.

IOSSCC Requirements for Occupational Skill Standards

Any occupational skill standards and credentialing system seeking IOSSCC endorsement must

- represent an occupation or occupational cluster which meets the criteria for IOSSCC endorsement;
- address both content and performance standards for critical work functions and activities for an occupation or occupational area;
- ensure formal validation and endorsement by a representative group of employers and workers within an industry;
- provide for review, modification and revalidation by an industry group a minimum of once every five years;
- award credentials based on assessment approaches that are supported and endorsed by the industry and consistent with nationally recognized guidelines for validity and reliability;
- provide widespread access and information to the general public in Illinois;
- include marketing and promotion by the industry in cooperation with the partner state agencies.

Definitions and Endorsement Criteria

The definitions and endorsement criteria are designed to promote the integration of existing and future industry-recognized standards, as well as the integration of the Illinois academic and occupational skill standards. Because all skill standards must address the critical work functions and activities for an occupation or industry/occupational area, the Council further defined three major components:

- ***Conditions of Performance:*** The information, tools, equipment and other resources provided to a person for a work performance.
- ***Statement of Work:*** A description of the work to be performed by a person.
- ***Performance Criteria:*** The criteria used to determine the required level of performance. These criteria could include product characteristics (e.g., accuracy levels, appearance), process or procedural requirements (e.g., safety, standard professional procedures) and time and resource requirements. The IOSSCC also requires performance criteria to be further specified by detailed individual performance elements and assessment criteria.

The IOSSCC is currently working with the Illinois State Board of Education and other state agencies to integrate the occupational standards with the Illinois academic standards which describe what students should know and be able to do as a result of their education. The Council is also working to integrate workplace skills—problem solving, critical thinking, teamwork, etc.—with both the academic and occupational skill standards.

The Illinois Model

Illinois Occupational Skill Standards describe what people should know and be able to do and how well these skills and knowledge will be demonstrated in an occupational setting. They focus on the most critical work performances for an occupation or occupational area. As seen in the following model, Illinois Occupational Skill Standards contain at least these three areas:

- Performance Skill
- Skill Standard
- Performance Elements and Assessment Criteria

The following sections may also be included at the discretion of the specific standards development committee:

- Performance Area
- Assessment and Credentialing Approach

Illinois Occupational Skill Standards carry a coding at the top of each page identifying the state, fiscal year in which standards were endorsed, subcouncil abbreviation, cluster abbreviation and standard number. For example, the tenth skill standard in the Machining Skills Cluster, which has been developed by the Manufacturing Subcouncil, would carry the following coding: IL.96.MFG.MACH.25.

A model for Illinois Occupational Skill Standards showing the placement of the coding and providing a description of each area within a standard is contained on the following page.

SUMMARY OF WORK TO BE PERFORMED. SUMMARY IS BRIEF AND BEGINS WITH AN ACTION VERB.

IL. FY. SUBCOUNCIL. CLUSTER. STANDARD NO.

Performance Area

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Includes all information, tools, equipment and other resources provided to the learner for performing the work.

WORK TO BE PERFORMED

Provides an overview of the performance with the major elements or steps being described under Performance Elements and Assessment Criteria.

PERFORMANCE CRITERIA

Includes product characteristics (e.g., accuracy levels, appearance) and/or process or procedure requirements (e.g., safety requirements). Time limits are specified whenever possible.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

Statement of the major elements, components or steps of the overall performance and the assessment criteria for determining successful performance. Includes all major tasks, the knowledge to be demonstrated

ASSESSMENT AND CREDENTIALING APPROACH

Optional statement of suggested assessment approaches for the performance

DEVELOPMENTAL PROCESS

The Manufacturing Subcouncil identified machining skills as a major occupational cluster in manufacturing. Machining skills involve the use of cutting tools to shape metal materials in single-part and serial manufacturing by means of milling, turning, grinding, boring and sawing with a variety of conventional and computer numerical control (CNC) machines and associated tooling.

The National Institute for Metalworking Skills (NIMS) has developed national standards for three levels of machining skills. NIMS is composed of a board representing metalworking related companies, trade associations and labor unions. The National Institute for Metalworking Skills developed the national machining skill standards through a nationwide validation process that included regional technical work groups and national surveys.

In Illinois, the national machining skill standards were reformatted to meet requirements of the Illinois Occupational Skill Standards and Credentialing Council (IOSSCC). The Manufacturing Subcouncil established a standards development committee to review and approve the reformatted national machining standards. A copy of the reformatted standards and a survey instrument were sent to the standards development committee members. The survey returns recommended endorsement of the national machining standards and approved the reformatting. The Manufacturing Subcouncil and IOSSCC then voted to endorse the national standards as reformatted.

The IOSSCC-recognized standards will be referred to as the “Illinois Machining Skill Standards adapted from the National Machining Skill Standards to meet the format requirements of the Illinois Occupational Skill Standards and Credentialing Council.”

ASSUMPTIONS FOR MACHINING SKILLS CLUSTER

Skill standards statements assume:

1. Workplace skills (employability skills) are expected of all learners. Socialization skills needed for work are related to lifelong career experience and are not solely a part of the initial schooling process. These are not included with this set of statements.
2. Specific policies and procedures of the worksite will be made known to the learner and will be followed.
3. Time elements outlined for the skill standards result from the experience and consideration of the panel of experts who made up the standards development committee.
4. Skills will progress from simple to complex. Once a skill has been successfully performed, it will be incorporated into more complex skills.
5. Skill standards describe the skill only and do not detail the background knowledge or theory related to the particular skill base. Although the skill standard enumerates steps to successful demonstration, rote approaches to the outcomes are not prescribed.
6. The Machining Skills Cluster includes three levels of standards. Local training providers should review all levels and work cooperatively to identify the level(s) of training each site can provide.
7. The English system of measurement was used in the metalworking skill standards unless otherwise indicated.
8. The time it takes to complete some standards will vary depending on the complexity of the piece being manufactured. Contact the National Institute for Metalworking Skills at 703/281-1610 for current information regarding drawings, equipment list and assessment procedures.

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ILLINOIS OCCUPATIONAL SKILL STANDARDS MACHINING SKILLS CLUSTER

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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.

JOB PROCESS PLANNING

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprint detailing a part requiring milling, drilling, turning or grinding
 Sketches, notes
 Verbal instructions
 Production schedule
 Tool crib with relevant perishable tooling
 Tool crib with relevant precision measuring tools
 Machine tool and accessory inventory
Machinery's Handbook

WORK TO BE PERFORMED

Formulate a set of strategies to manufacture a part and fill out an operation sheet reflecting the chosen strategies including the required speeds and feeds.

PERFORMANCE CRITERIA

The finished job process plan matches the elements of the model plan or alternate relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The process plan matches the model process plan, or an alternative process plan matches standard practices for such a job in the estimation of two designated examiners.
- The applicant answers questions regarding the process plan, the tooling techniques and the equipment it involves.
- Appropriate trade techniques are used to produce the process plan.
- All relevant paperwork is completed and is in order.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

TAP HOLES. USE FILES, SCRAPERS AND COATED ABRASIVES TO DEBURR PARTS. USE ARBOR PRESSES TO PERFORM PRESS FITS. USE BENCH VISES AND HAND TOOLS APPROPRIATELY.

MANUAL OPERATIONS: BENCHWORK

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Part requiring the operations listed above
- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Components required to complete the assembly
- Machinery's Handbook

WORK TO BE PERFORMED

Deburr a part, tap holes, press in a bushing, install a stud and saw the stud to a specified length.

PERFORMANCE CRITERIA

Appropriate trade techniques are used to produce an assembly meeting the following characteristics: no sharp edges or burrs, acceptable threads, accurate stud length, sawed face square to axis of stud and assembled bushing. At completion the assembly meets the blueprint requirements. All relevant paperwork is completed and is in order. The work area is returned to a neat and clean state. Safe practices are used throughout the performance.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is free of sharp edges or burrs.
- The part satisfies the Go/NoGo gage for the threads.
- Length of stud is within 1/32 of basic dimension and square to surface.
- The bushing is assembled using correct techniques and at completion meets the blueprint requirements.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

*ILLINOIS MACHINING SKILL STANDARD, TECHNICAL ELEMENTS, SKILL LEVEL I
Adapted from the National Machining Skill Standards to meet the format requirements
of the Illinois Occupational Skill Standards and Credentialing Council.*

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|-----------------------------|
| Blueprints, sketches, notes | Common workbench |
| Completed process plan | Layout height gage |
| Verbal instructions for the task at hand | Combination set |
| Production schedule | Scriber |
| Tool crib with relevant perishable tooling | Layout ink |
| Tool crib with relevant precision measuring tools | Angle plate |
| Part matching the layout blueprint, material: 1018 Hot Rolled Steel (HRS) | C-clamps |
| Layout surface plate at least 12" x 18" | Parallel-closing clamps |
| Surface gage | Magnifying glass |
| Prick punch | Radius gages |
| Ball-peen hammer | 6" dividers |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Lay out hole locations, radii and surfaces matching the specifications.

PERFORMANCE CRITERIA

The layout matches the specifications, paperwork is complete and housekeeping performed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The layout conforms to the requirements of the blueprint and process plan.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|---|
| Blueprints, sketches, notes | Combination drill and countersink |
| Completed process plan | External undercut tools |
| Verbal instructions | 45° chamfer tools |
| Production schedule | Live center |
| Tool crib with relevant perishable tooling | Dead center fitted to the spindle taper |
| Tool crib with relevant precision measuring tools | Magnetic base for a dial indicator |
| Common workbench | Files |
| Engine lathe of 14" x 30" minimum capacity (The lathe may have a quick-change gear box with the threads called for on the blueprint available from the gear box.) | Wrenches as necessary |
| Three-jaw universal scroll chuck | Micrometers |
| Four-jaw independent chuck | Combination set |
| Material matching the requirements of the blueprint, material: 1018 Hot Rolled Steel (HRS) | Thread-pitch gages |
| Tool post | Center gage |
| Right- and left-hand turning tools capable of turning a square shoulder | Pitch micrometer |
| External threading tool matched to print requirements | Thread-ring gages |
| Drill chuck | Dial indicator |
| | 6" rule |
| | 6" vernier, dial or electronic caliper |
| | Surface finish comparison plates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Turn a part to specification by mounting the part between centers. The part specified should have at least three diameters within $\pm .002$ ", one Unified National Coarse (UNC) external thread and one Unified National Fine (UNF) external thread and should require an end-for-end swap.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD**CONDITIONS OF PERFORMANCE****Given the following:**

Blueprints, sketches, notes	External undercut tools
Completed process plan	45° chamfer tools
Verbal instructions	Live center
Production schedule	Dead center fitted to the spindle taper
Tool crib with relevant perishable tooling	Magnetic base for a dial indicator
Tool crib with relevant precision measuring tools	Files
Common workbench	Wrenches as necessary
Engine lathe of 14" x 30" minimum capacity (The lathe may have a quick-change gear box with the threads called for on the blueprint available from the gear box.)	Micrometers
Three-jaw universal scroll chuck	Combination set
Four-jaw independent chuck	Thread-pitch gages
Material matching the requirements of the blueprint, material: 1018 Hot Rolled Steel (HRS)	Center gage
Tool post	Pitch micrometer
Right- and left-hand turning tools capable of turning to a square shoulder	Thread-ring gages
External threading tool matched to print requirements	Dial indicator
Drill chuck	6" rule
Combination drill and countersink	6" vernier, dial or electronic caliper
	Surface finish comparison plates
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Turn a part matching the process plan and the blueprint specifications using chucking methods and techniques. The part specified should have at least three diameters within $\pm .005$ ", one bore within $\pm .005$ ", one Unified National Coarse (UNC) external and one Unified National Fine (UNF) internal thread and should require at least two chuckings or other workholding setup.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|--|
| Blueprints, sketches, notes | Assorted cutters and cutter adapters fitted to the machine spindle |
| Completed process plan | Files |
| Verbal instructions | Magnetic base for indicators |
| Production schedule | Soft jaws for the vise |
| Tool crib with relevant perishable tooling | 2" or larger diameter cutter that may be a face mill |
| Tool crib with relevant precision measuring tools | Required micrometers |
| Machine tool and accessory inventory | Combination set |
| Common workbench | Dial indicator |
| Mill with power feed on the X and Y axes, table capacity of approximately 12" x 36", 40-taper spindle or greater preferred | 6" rule |
| Material matching the requirements of the blueprint, material: 1018 Hot Rolled Steel (HRS) | 6" vernier, dial or electronic caliper |
| 6" milling vise or greater | Adjustable parallels |
| Screws, studs, nuts, washers and clamps sufficient to secure the vise or the part to the table | Edge finder |
| Assorted parallels | Surface finish comparison plates |
| Ball-peen and soft-faced hammers | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Mill a part matching the process plan and the blueprint specifications. The part specified should require squaring up from the unfinished state and require significant material removal. Depth of cuts between .200" and .250" will be required. Calculate, set and use the power feed controls to remove material and establish finishes.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|---|
| Blueprints, sketches, notes | Magnetic base for indicators |
| Completed process plan | Soft jaws for the vise |
| Verbal instructions | Drill chuck |
| Production schedule | Drills |
| Tool crib with relevant perishable tooling | Reamers |
| Tool crib with relevant precision measuring tools | Combination drill and countersink or spotting drill |
| Machine tool and accessory inventory | Countersink and edge finder |
| Common workbench | Coolants and cutting oil |
| Vertical mill, table capacity of approximately 12" x 36" | 0-6 micrometers |
| Material matching the vertical milling blueprint, material: 1018 Hot Rolled Steel (HRS) | Combination set |
| 6" milling vise or greater | Dial indicator |
| Screws, studs, nuts, washers and clamps to secure the vise or part to the table | 6" rule |
| Assorted parallels | 6" vernier, dial or electronic caliper |
| Ball-peen and soft-faced hammers | Adjustable parallels |
| Assorted cutters and cutter adapters fitted to the machine spindle | Depth micrometer |
| Files | Surface finish comparison plates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Mill a part to specification 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".

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

RING TEST GRINDING WHEELS, PERFORM VISUAL SAFETY INSPECTION AND MOUNT AND DRESS A GRINDING WHEEL IN PREPARATION FOR SURFACE GRINDING.

SURFACE GRINDING: GRINDING WHEEL SAFETY

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- MACHine tool and accessory inventory
- Common workbench with a precision surface plate
- Surface grinder
- Magnetic chuck
- Assorted grinding wheels suitable for mounting to the spindle
- Soft-faced hammer
- Assorted wrenches
- Screwdrivers
- Specialty hand tools for the spindle
- Diamond dresser
- Machinery's Handbook

WORK TO BE PERFORMED

Determine which grinding wheels among a group of grinding wheels are suitable for use, mount one on the spindle and dress it in preparation for surface grinding.

PERFORMANCE CRITERIA

The collection of wheels has been separated into acceptable and not acceptable categories. Not acceptable wheels are labeled and secured from use. An acceptable wheel is mounted using safe and appropriate practices, and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The collection of grinding wheels is evaluated correctly.
- The failed grinding wheels are labeled and appropriately secured from future use.
- Appropriate trade techniques are used to evaluate the wheels and mount the sound wheel.

- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced.
For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/201-1610.
- Safe practices are used throughout the performance.

SET UP AND OPERATE MANUAL SURFACE GRINDERS WITH A 10" AND SMALLER DIAMETER WHEEL. PERFORM ROUTINE SURFACE GRINDING, LOCATION OF SURFACES AND SQUARING OF SURFACES. PERFORM WHEEL DRESSING.

**SURFACE GRINDING:
HORIZONTAL SPINDLE,
RECIPROCATING TABLE**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Assorted grinding wheels suitable for mounting to the spindle
Completed process plan	Files
Verbal instructions	Magnetic base for indicators
Production schedule	Surface gage of sufficient size
Tool crib with relevant perishable tooling	Diamond dresser
Tool crib with relevant precision measuring tools	Required micrometers
Machine tool and accessory inventory	Combination set
Common workbench with a precision surface plate	Dial test indicator
Surface grinder with a suitable magnetic chuck	6" rule
Material matching the requirements of the blueprint, material: 1018 Hot Rolled Steel (HRS)	6" vernier, dial or electronic caliper
Magnetic chuck	Adjustable parallels
Assorted parallels	Depth micrometer set
Suitable angle plate or precision grinding vise	Master square or magnetic square
Assorted clamps	Surface finish comparison gages
Composition hammer	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Dress the wheel; produce a part matching the process plan and the blueprint 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.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- The collection of grinding wheels is evaluated correctly.
- The failed grinding wheels are labeled and appropriately secured from future use.
- Appropriate trade techniques are used to evaluate the wheels and mount sound wheels.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND OPERATE DRILL PRESSES. PERFORM ROUTINE DRILL PRESS OPERATIONS.

DRILL PRESS OPERATION

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Reamers
Completed process plan	Countersinks
Verbal instructions	Spot facers
Production schedule	Counterbores
Tool crib with relevant perishable tooling	Centerdrills
Tool crib with relevant precision measuring tools	Various taps
Machine tool and accessory inventory	Scriber
Common workbench	Layout ink
Drill press, Morse taper #3 spindle capacity or greater preferred (The drill press must have a tapping capability or a tapping head accessory.)	Prick punch
Material matching the requirements of the blueprint, material: 1018 Hot Rolled Steel (HRS)	Ball-peen hammer
Cutting fluids	Angle plate
6" drill vise or greater	6" dividers
Screws, studs, nuts, washers and clamps sufficient to secure the vise or part	Surface gage
Assorted parallels	Required micrometers
Composition hammer	Combination set
Assorted Morse taper sleeves fitted to the machine spindle	6" rule
Drill chucks	6" vernier, dial or electronic caliper
Drills	Go/NoGo gage for threads
	Plug gages
	Telescoping gages
	Layout height gage
	Surface finish comparison plates
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

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 four center-drilled locations. Finishing the part will require the finishing of the four center-drilled locations and the layout of a fifth location. 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. The fifth hole, a through hole, must have its location center punched, center-drilled and finished from the layout. The fifth hole will be power tapped.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Power saw with a suitable blade installed
- Part matching the blueprint requirements for material, material: 1018
Hot Rolled Steel (HRS)
- Soft-faced hammer
- Appropriate wrenches
- Tape measure or appropriate rule
- Files
- Machinery's Handbook

WORK TO BE PERFORMED

Saw material to a length matching the cut listed on the process plan.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

DEVELOP AN INSPECTION PLAN AND INSPECT SIMPLE PARTS USING PRECISION TOOLS AND TECHNIQUES. PREPARE REPORTS ON THE COMPLIANCE OF THE PARTS.

PART INSPECTION

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes
 Completed process plan
 Verbal instructions
 Production schedule
 Tool crib with relevant perishable tooling
 Tool crib with relevant precision measuring tools
 Machine tool and accessory inventory
 Common workbench with a small surface plate
 Finished part matching the requirements of the part inspection blueprint
 Inspection-grade gage blocks, angle plates and clamps
 Appropriate assortment of basic, fixed, precision and surface plate inspection tools
Machinery's Handbook

WORK TO BE PERFORMED

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.

PERFORMANCE CRITERIA

The inspection report satisfies the elements of the model report, appropriate techniques were used to gather the data for the report, paperwork is complete, housekeeping is accomplished and safe practices are used.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The inspection report findings match the findings of the model inspection report.
- Appropriate trade techniques are used to produce the inspection findings.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

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.

PROCESS CONTROL

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Common workbench with a small surface plate
- X-bar and R charts
- Inspection tools sufficient to perform the sampling and inspection plan
- Appropriate population of product matching the blueprint specifications and broken up into discrete packages matching the requirements of the sampling plan
- Machinery's Handbook

WORK TO BE PERFORMED

Inspect parts according to the sampling plan, collecting the data required for the process control chart. Working within 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.

PERFORMANCE CRITERIA

The inspection report satisfies the elements of the model report, appropriate techniques were used to gather the data for the report, paperwork is complete, housekeeping is accomplished and safe practices are used.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The inspection report findings match the findings of the model process reports.
- The candidate can successfully answer relevant questions regarding the reports.
- Appropriate trade techniques are used to produce the inspection findings.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

ILLINOIS MACHINING SKILL STANDARD, TECHNICAL ELEMENTS, SKILL LEVEL I
Adapted from the National Machining Skill Standards to meet the format requirements of the Illinois Occupational Skill Standards and Credentialing Council.

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, PERFORM THE STRATEGIES FOR PROCESS ADJUSTMENT AND/OR IMPROVEMENT.

PROCESS ADJUSTMENT IN SINGLE-PART PRODUCTION

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Common workbench
- Machine tool with a setup in use
- Part matching the setup, material: 1018 Hot Rolled Steel (HRS)
- Cutting fluids
- Tooling necessary to the setup
- Inspection tools appropriate to the problem presented
- Machinery's Handbook

WORK TO BE PERFORMED

Analyze a part having routine problems being processed, analyze the problems and propose remedies. Having been given authorization to implement the process improvement, carry it out. Explain the corrective actions and the reasoning used to perform the diagnosis.

PERFORMANCE CRITERIA

The findings match the elements of the model report; relevant questions are answered; appropriate trade techniques are used to generate the findings. Paperwork is completed, safe practices are used and housekeeping is performed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The reported findings match the findings of the model problem reports.
- The applicant answers successfully all relevant questions regarding the reports.
- Appropriate trade techniques are used to produce the findings.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

ANALYZE THE PERFORMANCE OF A PRODUCTION PROCESS AS A MEMBER OF A PROCESS TEAM. WITH THE TEAM, FORMULATE PROCESS ADJUSTMENTS OR IMPROVEMENTS WHERE APPROPRIATE. WHERE APPROPRIATE, NOTIFY SUPERVISION OF THE PROPOSED ADJUSTMENTS AND/OR IMPROVEMENT. WHERE AUTHORIZED, PERFORM THE STRATEGIES FOR PROCESS ADJUSTMENT AND/OR IMPROVEMENT.

PROCESS IMPROVEMENT PARTICIPATION

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Team conference area
- Fishbone charts
- Flip charts
- Markerboard
- Writing tools
- Markers
- Relevant measuring instruments for the problem posed
- Machinery's Handbook

WORK TO BE PERFORMED

As a team member, analyze a routine production process having a problem. As a team member, analyze the problem and propose a remedy. Having been given authorization to implement the process improvement, perform it. Perform the cause and effect 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.

PERFORMANCE CRITERIA

The team activities are explained; relevant questions are answered; appropriate trade techniques are applied. Paperwork is completed, housekeeping is performed and safe practices are used.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The team's activities in producing problem resolution reports are successfully explained.
- The applicant answers successfully all relevant questions regarding the reports.
- Appropriate trade techniques are used to produce the findings.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

**KEEP THE DUTY STATION CLEAN AND SAFE FOR WORK.
KEEP THE TOOLS, WORKBENCHES AND MANUAL
EQUIPMENT CLEAN, MAINTAINED AND SAFE FOR WORK.**

**GENERAL HOUSEKEEPING
AND MAINTENANCE**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes
Completed process plan
Verbal instructions
Production schedule
Maintenance, cleaning and housekeeping checklists
Tool crib with relevant perishable tooling
Tool crib with relevant precision measuring tools
Machine tool and accessory inventory
Common workbench
Machine tool work area
Brooms
Brushes
Vacuum cleaner
Waste containers
Occupational Safety and Health Administration (OSHA) guidelines

WORK TO BE PERFORMED

Clean, maintain and respond appropriately to safety hazards on all benchwork tools and conventional and Computer Numerical Control (CNC) machine tools. Maintain the cleanliness of the general work area.

PERFORMANCE CRITERIA

Housekeeping activities match the checklist, questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- Each element of the checklists is performed successfully.
- All relevant questions are answered regarding the maintenance activity.
- Appropriate trade techniques are used to accomplish the work.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Standard machine tool
- Maintenance forms
- Oil
- Grease
- Shop towels
- Hand tools for minor adjustments of guards and tooling
- 6" rule
- Machinery's Handbook

WORK TO BE PERFORMED

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

PERFORMANCE CRITERIA

Maintenance activities match the checklist, relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- Each element of the checklists is performed successfully.
- All relevant questions are answered successfully regarding the maintenance activity.
- Appropriate trade techniques are used to accomplish the work.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

INSPECT AND ASSESS THE CONDITION OF TOOLING. REFURBISH TOOLING WHERE APPROPRIATE. REFER TOOLING FOR REPAIR OR REGRIND WHERE APPROPRIATE.

TOOLING MAINTENANCE

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Wrenches for cutter bodies
Completed process plan	Turning tool blanks
Verbal instructions	Required micrometers
Production schedule	Combination set
Tool crib with relevant perishable tooling	6" rule
Tool crib with relevant precision measuring tools	6" vernier, dial or electronic caliper
Machine tool and accessory inventory	Plug gages
Samples of tooling in various conditions	Telescoping gages
Common workbench	Layout height gage
Pedestal grinder	Dial indicator and base
Drills	Surface plate
Milling cutter bodies with inserts	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Diagnose tooling; perform the procedures to put the tooling back in service. The sample tooling will include turning, milling and drilling tools. These tools will 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.

PERFORMANCE CRITERIA

The elements of the tooling checklist are satisfied, tooling is evaluated and treated appropriately, relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- Each element of the checklists is performed successfully.
- The tooling is evaluated and treated correctly.
- All relevant questions are answered successfully regarding the maintenance activity.
- Appropriate trade techniques are used to accomplish the work.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

PERFORM ASSIGNED MACHINE OPERATION AND MATERIAL HANDLING RESPONSIBILITIES WHILE ADHERING TO SAFE PRACTICES IN ACCORDANCE WITH OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) REQUIREMENTS AND GUIDELINES. DOCUMENT SAFETY ACTIVITIES AS REQUIRED.

**MACHINE
OPERATIONS
AND MATERIAL
HANDLING**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Appropriate materials and containers
- Appropriate handling devices
- Occupational Safety and Health Administration (OSHA) Guidelines

WORK TO BE PERFORMED

Demonstrate safe workplace practices in material handling; machine operations; handling of tooling and 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 Level I Machining Skill Standards 2 - 11.

PERFORMANCE CRITERIA

The elements of the checklist are satisfied, relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- Each element of the checklists is performed successfully.
- All relevant questions are answered successfully regarding the maintenance activity.
- Appropriate trade techniques are used to accomplish the work.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

HANDLE AND STORE HAZARDOUS MATERIALS AS ASSIGNED WHILE ADHERING TO SAFE PRACTICES IN ACCORDANCE WITH OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) AND ENVIRONMENTAL PROTECTION AGENCY (EPA) REQUIREMENTS AND GUIDELINES. DOCUMENT SAFETY ACTIVITIES AS REQUIRED.

**HAZARDOUS
MATERIALS
HANDLING AND
STORAGE**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes
 Completed process plan
 Verbal instructions
 Production schedule
 Tool crib with relevant perishable tooling
 Tool crib with relevant precision measuring tools
 Machine tool and accessory inventory
 Hazardous material and appropriate containers
 Appropriate handling devices
 Appropriate material identification instruments
 Instruments for the measurement of concentration
Machinery's Handbook
 Relevant Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) requirements and guidelines

WORK TO BE PERFORMED

Demonstrate safe workplace practices in the identification, handling and storage of hazardous materials in the performance of all responsibilities.

PERFORMANCE CRITERIA

The elements of the checklist are satisfied, relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- Each element of the checklists is performed successfully.
- All relevant questions are answered successfully regarding the performance activity.
- Appropriate trade techniques are used to accomplish the work.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

WRITE A DETAILED PROCESS PLAN WHICH INCLUDES A QUALITY PLAN FOR A PART REQUIRING MILLING, DRILLING, TURNING OR GRINDING. PRODUCE AN OPERATION SHEET DETAILING THE PROCESS PLAN AND REQUIRED SPEEDS AND FEEDS. PROVIDE SKETCHES AS NEEDED.

JOB PROCESS PLANNING

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprint detailing a part requiring milling, drilling, turning or grinding
- Sketches, notes
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Machinery's Handbook

WORK TO BE PERFORMED

Formulate a set of strategies to manufacture a part and write a detailed process plan including a quality plan for that part. Provide sketches as needed.

PERFORMANCE CRITERIA

The finished process plan matches the elements of the model process plan or the alternate, relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The process plan matches the model process plan, or an alternative plan matches standard practices for such a job in the estimation of two designated examiners.
- All relevant questions are successfully answered regarding the process plan, tooling and equipment it involves. Appropriate trade techniques are used to produce the process plan.
- All relevant paperwork is completed and is in order.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

SET UP AND LAY OUT BOLT CIRCLES, LOCATIONS OF SURFACES RELATED BY NON-RIGHT ANGLES, LOCATIONS OF POINTS OF TANGENCY BETWEEN ARCS AND LINES AND PROFILES OF A LINE WHICH IS NON-ARC BASED.

LAYOUT OF BOLT CIRCLES, ANGLES, POINTS OF TANGENCY AND PROFILES OF A LINE

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Part requiring the operations listed above	Layout height gage
Blueprints, sketches, notes	Combination set
Completed process plan	Scriber
Verbal instructions for basic, routine benchwork, machining and mechanical assembly operations	Layout ink
Production schedule	Prick punch
Tool crib with relevant perishable tooling	Ball-peen hammer
Tool crib with relevant precision measuring tools	Common workbench
Part matching the layout blueprint, material: 1018 Hot Rolled Steel (HRS)	Angle plate
Layout surface plate at least 12" x 18"	C-clamps
Surface gage	Parallel-closing clamps
	Magnifying glass
	Radius gages
	6" dividers
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Lay out a block of material which includes a flange face feature with a 12-hole bolt circle, two examples of tangent radii—one a fillet, the other an external radius—and a defined profile of a line with approximating arcs and their coordinates supplied.

PERFORMANCE CRITERIA

The layout matches the specifications, paperwork is complete and housekeeping is performed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The layout conforms to the requirements of the blueprint and process plan.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.

SET UP AND PERFORM CONTOUR SAWING TO A LAYOUT. CHOOSE AND MOUNT APPROPRIATE BLADES. WELD, BREAK AND REWELD BLADES AS NECESSARY.

**CONTOUR
BANDSAWING**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Combination set
Completed process plan	Scriber
Verbal instructions for the task at hand	Layout ink
Production schedule	Prick punch
Tool crib with relevant perishable tooling	Ball-peen hammer
Tool crib with relevant precision measuring tools	Common workbench
Part matching the material requirements of the print, material: 1018 Hot Rolled Steel (HRS)	Angle plate
Bandsaw adequate to the task	C-clamps
Layout surface plate at least 12" x 18"	Parallel-closing clamps
Surface gage	Magnifying glass
Layout height gage	Radius gages
	6" dividers
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Use a contour bandsaw to produce a part to specification.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM BETWEEN CENTERS TURNING FOR STRAIGHT AND TAPERED TURNING BY OFFSETTING THE TAILSTOCK.

TURNING OPERATIONS: BETWEEN CENTERS TAPER

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Combination drill and countersink
Completed process plan	External undercut tools
Verbal instructions	45° chamfer tools
Production schedule	Live center
Tool crib with relevant perishable tooling	Dead center fitted to the spindle taper
Tool crib with relevant precision measuring tools	Magnetic base for a dial indicator
Common workbench	Files
Engine lathe of 14" x 30" minimum capacity (The lathe may have a quick-change gear box with the threads called for on the blueprint available from the gear box.)	Wrenches as necessary
Three-jaw universal scroll chuck	Micrometers
Four-jaw independent chuck	Combination set
Material matching the requirements of the blueprint, material: 1018 Hot Rolled Steel (HRS)	Thread-pitch gages
Tool post	Center gages
Right- and left-hand turning tools capable of turning to a square shoulder	Pitch micrometer
External threading tool matched to print requirements	Thread-ring gages
Drill chuck	Dial indicator
	6" rule
	6" vernier, dial or electronic caliber
	Surface finish comparison plates
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Produce a part requiring taper turning. The part specified should have at least two straight diameters within ± 0.001 " and an appropriate taper at each end of the part and require a reversal of the part end for end.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|---|
| Blueprints, sketches, notes | Combination drill and countersink |
| Completed process plan | External undercut tools |
| Verbal instructions | 45° chamfer tools |
| Production schedule | Live center |
| Tool crib with relevant perishable tooling | Dead center fitted to the spindle taper |
| Tool crib with relevant precision measuring tools | Magnetic base for a dial indicator |
| Common workbench | Files |
| Engine lathe of 14" x 30" minimum capacity (The lathe may have a quick-change gear box with the threads called for on the blueprint available from the gear box.) | Wrenches as necessary |
| Three-jaw universal scroll chuck | Micrometers |
| Four-jaw independent chuck | Combination set |
| Material matching the requirements of the blueprint, material: 1018 Hot Rolled Steel (HRS) | Thread-pitch gages |
| Tool post | Center gage |
| Right- and left-hand turning tools capable of turning to a square shoulder | Pitch micrometer |
| External threading tool matched to print requirements | Thread-ring gages |
| Drill chuck | Dial indicator |
| | 6" rule |
| | 6" vernier, dial or electronic caliper |
| | Surface finish comparison plates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Produce a group of parts to specification. The part should be similar to a shoulder bushing. The major Outside Diameter (OD) should be 1", the minor Outside Diameter (OD) .750", the Inside Diameter (ID) 1/2" and the overall length should be 1-1/4". The lot size should be 15.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

TURNING OPERATIONS: CHUCKING, OUTSIDE DIAMETER (OD) AND INSIDE DIAMETER (ID) TAPERS USING A TAPER ATTACHMENT

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|---|
| Blueprints, sketches, notes | Combination drill and countersink |
| Completed process plan | External undercut tools |
| Verbal instructions | 45° chamfer tools |
| Production schedule | Live center |
| Tool crib with relevant perishable tooling | Dead center fitted to the spindle taper |
| Tool crib with relevant precision measuring tools | Magnetic base for a dial indicator |
| Common workbench | Files |
| Engine lathe of 14" x 30" minimum capacity and having a taper attachment (The lathe may have a quick-change gear box with the threads called for on the blueprint available from the gear box.) | Wrenches as necessary |
| Three-jaw universal scroll chuck | Micrometers |
| Four-jaw independent chuck | Combination set |
| Material matching the requirements of the blueprint, material: 1018 Hot Rolled Steel (HRS) | Thread-pitch gages |
| Tool post | Center gage |
| Right- and left-hand turning tools capable of turning to a square shoulder | Pitch micrometer |
| External threading tool matched to print requirements | Thread-ring gages |
| Drill chuck | Dial indicator |
| | 6" rule |
| | 6" vernier, dial or electronic caliper |
| | Surface finish comparison plates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Produce a part to specification. The part specified should have at least two diameters within $\pm .002$ ", one bore within $\pm .002$ " and one external and one internal taper and require at least two chuckings or other workholding setup.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM SQUARING UP THE SIX SURFACES OF A BLOCK TO WITHIN $\pm .002$ " AND $.002$ " OVER 4" SQUARENESS.

IL.96.MFG.MACH.27

MILLING: SQUARING UP A BLOCK

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|---|
| Blueprints, sketches, notes | Magnetic base for indicators |
| Completed process plan | Soft jaws for the vise |
| Verbal instructions | Drill chuck |
| Production schedule | Drills |
| Tool crib with relevant perishable tooling | Reamers |
| Tool crib with relevant precision measuring tools | Combination drill and countersink or spotting drill |
| Machine tool and accessory inventory | Countersink and edge finder |
| Common workbench | Coolants and cutting oil |
| Mill, table capacity of approximately 12" x 36" | 0-6 micrometers |
| Material matching the milling blueprint, material: 1018 Hot Rolled Steel (HRS) | Combination set |
| 6" milling vise or greater | Dial indicator |
| Screws, studs, nuts, washers and clamps to secure the vise or part to the table | 6" rule |
| Assorted parallels | 6" vernier, dial or electronic caliper |
| Ball-peen and soft-faced hammers | Adjustable parallels |
| Assorted cutters and cutter adapters fitted to the machine spindle | Depth micrometer |
| Files | Surface finish comparison plates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Square up a block using a milling machine. The part will require squaring up from the raw state.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|---|
| Blueprints, sketches, notes | Magnetic base for indicators |
| Completed process plan | Soft jaws for the vise |
| Verbal instructions | Drill chuck |
| Production schedule | Drills |
| Tool crib with relevant perishable tooling | Reamers |
| Tool crib with relevant precision measuring tools | Combination drill and countersink or spotting drill |
| Machine tool and accessory inventory | Countersink and edge finder |
| Common workbench | Coolants and cutting oil |
| Mill, table capacity of approximately 12" x 36" | 0-6 micrometers |
| Material matching the milling blueprint, material: 1018 Hot Rolled Steel (HRS) | Combination set |
| 6" milling vise or greater | Dial indicator |
| Screws, studs, nuts, washers and clamps to secure the vise or part to the table | 6" rule |
| Assorted parallels | 6" vernier, dial or electronic caliper |
| Ball-peen and soft-faced hammers | Adjustable parallels |
| Assorted cutters and cutter adapters fitted to the machine spindle | Depth micrometer |
| Files | Surface finish comparison plates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Produce three bores to specification. The part will specify 3 holes in 1" plate. The holes will be between 3/4" and 1-1/2" to locations within +/- .001" and hold diameters within +/- .0005". One hole is to be counterbored to a decimal depth holding +/- .002" and counterbore diameter within +/- .005".

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|--|
| Blueprints, sketches, notes | Assorted cutters and cutter adapters fitted to the machine spindle |
| Completed process plan | Files |
| Verbal instructions | Magnetic base for indicators |
| Production schedule | Soft jaws for the vise |
| Tool crib with relevant perishable tooling | Edge finder |
| Tool crib with relevant precision measuring tools | Coolants and cutting oil |
| Machine tool and accessory inventory | 0-6 micrometers |
| Common workbench | Combination set |
| Vertical mill, table capacity of approximately 12" x 36" | Dial indicator |
| Material matching the milling blueprint, material: 1018 Hot Rolled Steel (HRS) | 6" rule |
| 6" milling vise or greater | 6" vernier, dial or electronic caliper |
| Screws, studs, nuts, washers and clamps to secure the vise or part to the table | Adjustable parallels |
| Assorted parallels | Dept micrometer |
| Ball-peen and soft-faced hammers | Surface finish comparison plates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Mill two keyseats whose characteristics match the American Standards National Institute (ANSI) B17.1 Keys and Keyseat standards.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM THE CUTTING OF A DEEP SLOT USING A STAGGER-TOOTH CUTTER.

MILLING: CUTTING A DEEP SLOT WITH A STAGGER-TOOTH CUTTER

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Assorted cutters
Completed process plan	Cutter adapters and arbors fitted to the machine spindle
Verbal instructions	Files
Production schedule	Magnetic base for indicators
Tool crib with relevant perishable tooling	Soft jaws for the vise
Tool crib with relevant precision measuring tools	Coolants and cutting fluids
Machine tool and accessory inventory	Required micrometers
Standard workbench	Combination set
Mill with power feed on the X and Y axes, table capacity of approximately 12" x 36", 40-taper spindle or greater preferred	Dial indicator
Material matching the requirements of the milling blueprint, material: 1215 Cold Rolled Steel (CRS)	6" rule
6" milling vise or greater	6" vernier, dial or electronic caliper
Screws, studs, nuts, washers and clamps to secure the vise or part to the table	Adjustable parallels
Assorted parallels	Edge finder
Ball-peen and composition hammers	Surface finish comparison plates
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Mill three deep slots, two parallel to one another, the third at right angles to the first two.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM THE DEVELOPMENT OF SURFACES AT A SPECIFIED NON-RIGHT ANGLE USING A ROTARY TABLE. SET UP AND ESTABLISH HOLE LOCATIONS IN VARIOUS RELATIONSHIPS TO ONE ANOTHER USING A ROTARY TABLE. THE HOLES ARE IN THE SAME PLANE. ESTABLISH THE PROFILE OF A RADIUS WITH RESPECT TO TWO SURFACES AND THE CONNECTING POINTS OF TANGENCY.

MILLING: USING A ROTARY TABLE

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Assorted cutters and cutter adapters fitted to the machine spindle
Completed process plan	Files
Verbal instructions	Magnetic base for indicators
Production schedule	Soft jaws for the vise
Tool crib with relevant perishable tooling	Edge finder
Tool crib with relevant precision measuring tools	Coolants and cutting oil
Machine tool and accessory inventory	0-6 micrometers
Common workbench	Combination set
Vertical mill, table capacity of approximately 12" x 36"	Dial indicator
Material matching the milling blueprint, material: 1018 Hot Rolled Steel (HRS)	6" rule
Rotary table sufficient to handle the part	6" vernier, dial or electronic caliper
Milling vise sufficient for the part	Adjustable parallels
Screws, studs, nuts, washers and clamps to secure the vise or part	Depth micrometer
Assorted parallels	Surface finish comparison plates
Ball-peen and soft-faced hammers	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Produce a part requiring two groups of holes arrayed on bolt circles as well as several surfaces at various angles to one another.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND ESTABLISH HOLE LOCATIONS IN VARIOUS RELATIONSHIPS TO ONE ANOTHER USING A DIVIDING HEAD. ESTABLISH THE PROFILE OF A RADIUS WITH RESPECT TO TWO SURFACES AND THE CONNECTING POINTS OF TANGENCY.

MILLING: DIVIDING HEAD OPERATIONS

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Assorted cutters and cutter adapters fitted to the machine spindle
Completed process plan	Files
Verbal instructions	Magnetic base for indicators
Production schedule	Soft jaws for the vise
Tool crib with relevant perishable tooling	Edge finder
Tool crib with relevant precision measuring tools	Coolants and cutting oil
Machine tool and accessory inventory	0-6 micrometers
Common workbench	Combination set
Vertical mill, table capacity of approximately 12" x 36"	Dial indicator
Material matching the milling blueprint, material: 1018 Hot Rolled Steel (HRS)	6" rule
Dividing head sufficient to handle the part	6" vernier, dial or electronic caliper
Milling vise sufficient for the part	Adjustable parallels
Screws, studs, nuts, washers and clamps to secure the vise or part	Depth micrometer
Assorted parallels	Surface finish comparison plates
Ball-peen and soft-faced hammers	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Using a dividing head, mill a part requiring two groups of holes arrayed on an outer diameter, several surfaces at various angles to one another and the profile of a radius with respect to two surfaces and the connecting points of tangency.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM BORING FOR LOCATION, SIZE AND FINISH AND MILL A SLOT FOR LOCATION AND SIZE.

BASIC HORIZONTAL BORING MILL OPERATIONS

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Drill chucks
Completed process plan	Edge finders
Verbal instructions	Drills
Production schedule	Centerdrills and the
Tool crib with relevant perishable tooling	necessary boring bars and
Tool crib with relevant precision	associated cutters
measuring tools	Scriber
Machine tool and accessory inventory	Layout ink
Common workbench with a small	Prick punch
surface plate	Ball-peen hammer
Horizontal boring mill	Angle plate
Material requirements of the boring mill	6" dividers
blueprint, material:	Surface gage
1215 Cold Rolled Steel (CRS)	Required micrometers
Cutting fluids	Combination set
6" drill vises or greater	6" rule
Screws, studs, nuts, washers and clamps	6" vernier, dial or electronic
sufficient to secure the vises, suitable	caliper
angle plates or the part	Dial indicators
Assorted parallels	Plug gages
Composition hammer	Telescoping gages
Assorted Morse taper sleeves fitted to	Layout height gage
the machine spindle	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

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

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|--|
| Blueprints, sketches, notes | Drill chucks |
| Completed process plan | Drills |
| Verbal instructions | Reamers |
| Production schedule | Countersinks |
| Tool crib with relevant perishable tooling | Centerdrills and the necessary taps |
| Tool crib with relevant precision measuring tools | Scriber |
| Machine tool and accessory inventory | Layout ink |
| Standard workbench | Prick punch |
| Radial drill press with capacity adequate to control and drive drills of the diameter specified on the print (The drill press Angle plate must have a tapping cycle or a reversible clutched spindle.) | Ball-peen hammer |
| Material matching the requirements of the print, material: 1215 Cold Rolled Steel (CRS) | Tap wrenches |
| Cutting fluids | 6" dividers |
| 6" drill vise or greater | Surface gage |
| Screws, studs, nuts, washers and clamps sufficient to secure the vise or the part | Required micrometers |
| Assorted parallels | Combination set |
| Composition hammer | 6" rule |
| Assorted Morse taper sleeves fitted to the machine spindle | 6" vernier, dial or electronic caliper |
| | Go/NoGo gage for threads |
| | Plug gages |
| | Telescoping gages |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Set up, centerdrill, drill, countersink and tap a series of holes to specification. Perform other operations as required by the blueprint.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM TAPER REAMING AND SUBSEQUENT PIPE TAPPING.

MACHINE TOOL POWER TAPPING: TAPER REAMING AND PIPE TAPPING

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Drill chucks
Completed process plan	Drills
Verbal instructions	Reamers
Production schedule	Countersinks
Tool crib with relevant perishable tooling	Centerdrills
Tool crib with relevant precision measuring tools	Necessary pipe taps
Machine tool and accessory inventory	Scriber
Standard workbench	Layout ink
Drill press with capacity adequate to control and drive a 1-11½" National Pipe Thread (NPT) (The drill press must have a tapping cycle, a tapping head accessory or a reversible clutched spindle.)	Prick punch
Part matching the material requirements of the drill press blueprint, material: 1215 Cold Rolled Steel (CRS)	Ball-peen hammer
Cutting fluids	Tap wrenches
6" drill vise or greater	Angle plate
Screws, studs, nuts, washers and clamps sufficient to secure the vise or the part	6" dividers
Assorted parallels	Surface gage
Composition hammer	Required micrometers
Assorted Morse taper sleeves fitted to the machine spindle	Combination set
	6" rule
	6" vernier, dial or electronic caliper
	Go/NoGo gage for threads
	Plug gages
	Telescoping gages
	Layout height gage
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

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

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

GRIND A BLOCK'S SIX FACES TO FINISHED DIMENSIONS HAVING TOLERANCES OF +/- .0005" AND SQUARENESS OF .0005" OVER 4" AND 32 MICROINCH SURFACE FINISH. DRESS THE WHEEL AS NECESSARY.

**SURFACE GRINDING:
FINISHING FLATS TO +/- .0005"**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Composition hammer
Completed process plan	Files
Verbal instructions	Magnetic base for indicators
Production schedule	Surface gage of sufficient size
Tool crib with relevant perishable tooling	Diamon dresser
Tool crib with relevant precision measuring tools	Required micrometers
Machine tool and accessory inventory	Combination set
Surface grinder with a suitable magnetic chuck	Gage lock set
Assorted grinding wheels suitable for mounting to the spindle	Dial test indicator
Block squared up on a mill, hardened to 55 to 60 Rockwell c-scale (R _c), material: A2 Tool Steel	6" rule
Standard workbench with a precision surface place	6" vernier, dial or electronic caliper
Suitable environmental controls	Adjustable parallels
Magnetic chuck	Comparator stand for indicators
Assorted parallels	Depth micrometer set
Angle plate or precision grinding vise	Master square or magnetic square
Assorted clamps	Surface condition comparison gages
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Dress the wheel. Grind a part to finish. The part will require the precision finishing of six faces of a block to tolerances common to precision grinding for squareness, size and surface finish characteristics.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM FINISH SURFACE GRINDING OF FLAT SURFACES AT SIMPLE ANGLES WITH RESPECT TO ONE ANOTHER. DRESS THE WHEEL AS NECESSARY.

**SURFACE GRINDING:
FINISHING FLATS
AT SIMPLE ANGLES**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Files
Completed process plan	Magnetic base for indicators
Verbal instructions	Surface gage of sufficient size
Production schedule	Diamond dresser
Tool crib with relevant perishable tooling	Required micrometers
Tool crib with relevant precision measuring tools	Combination set
Machine tool and accessory inventory	Dial test indicator
Standard workbench with a precision surface plate	6" rule
Surface grinder with a suitable magnetic chuck	6" vernier, dial or electronic caliper
Part matching the material requirements of the surface grinding blueprint, material: O1 Tool Steel	Bevel vernier protractor
Magnetic sine chuck	Inspection sine plates and/or sine bars
Sine bars	Gage blocks
Assorted parallels	Adjustable parallels
Angle plate or precision grinding vise	Depth micrometer set
Assorted clamps	Master square or magnetic square
Composition hammer	Surface condition
Assorted grinding wheels suitable for mounting to the spindle	Comparison gages
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Dress the wheel, grind the specified angled surfaces to a finish matching specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been roughed out. Finishing the part will require the precision finishing of the specified surfaces of the block to tolerances common to precision grinding for squareness, size and surface finish characteristics.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM THE PREPARATION AND BALANCING OF A GRINDING WHEEL 14" DIAMETER OR GREATER. PLACE THE WHEEL INTO SERVICE.

GRINDING WHEEL PREPARATION AND BALANCING

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes
 Completed process plan
 Verbal instructions
 Production schedule
 Tool crib with relevant perishable tooling
 Tool crib with relevant precision measuring tools
 Machine tool and accessory inventory
 Standard workbench
 Cylindrical grinder
 Appropriate grinding wheel: A2 Tool Steel
 Wheel balancer, counterweights, wheel arbor
 Dial test indicator and indicator mounting brackets
Machinery's Handbook

WORK TO BE PERFORMED

Prepare for mounting and mount a grinding wheel of 14" diameter or larger. Produce a surface finish of 32 microinches or better on a cylinder of Cold Rolled Steel (CRS).

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The grinding wheel produces 32 microinch or better finishes.
- Appropriate trade techniques and speeds and feeds are used to balance the wheel.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

SET UP AND PERFORM BETWEEN CENTERS GRINDING FOR STRAIGHT DIAMETERS. DRESS THE GRINDING WHEEL AS NECESSARY.

CYLINDRICAL GRINDING

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Assorted grinding dogs
Completed process plan	Composition hammer
Verbal instructions	Assorted grinding wheels
Production schedule	suitable for mounting to
Tool crib with relevant perishable tooling	the spindle
Tool crib with relevant precision	Files
measuring tools	Magnetic base for indicators
Machine tool and accessory inventory	Diamond dresser
Standard workbench	Required micrometer
Cylindrical grinder	Combination set
Part matching the material requirements	Dial test indicator
of the cylindrical grinding blueprint,	6" rule
material: A2 at 55 to 60 Rockwell	Gage blocks
c-scale (R.)	Surface condition comparison
Centers for the headstock and tailstock	gages
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Dress the wheel. Mount the part between centers, and grind the required diameters to finish.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

OPERATE A PLUNGE ELECTRIC DISCHARGE MACHINE.**ELECTRIC DISCHARGE MACHINE (EDM):
OPERATING A PLUNGE EDM****SKILL STANDARD****CONDITIONS OF PERFORMANCE****Given the following:**

Blueprint detailing a part requiring milling, drilling, turning and grinding	Files
Sketches, notes	Magnetic base for indicators
Verbal instructions	Soft jaws for the vise
Production schedule	Assorted hand tools
Tool crib with relevant perishable tooling	Required micrometers
Tool crib with relevant precision measuring tools	Combination set
Machine tool and accessory inventory	Dial indicator
Plunge EDM	6" rule
Workbench	6" vernier, dial or electronic caliper
Part matching the material requirements of the blueprint, material: 1215 Cold Rolled Steel (CRS)	Adjustable parallels
Appropriate workholding device	Edge finder
Screws, studs, nuts, washers and clamps to hold the part to the table	Appropriate tools for determining squareness
Assorted parallels	Surface finish comparison standards
Adapters fitted to the electrode holder	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Perform the EDM operation called out on the process plan in conformance with the blueprint.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

*ILLINOIS MACHINING SKILL STANDARD, TECHNICAL ELEMENTS, SKILL LEVEL II
Adapted from the National Machining Skill Standards to meet the format requirements of the Illinois Occupational Skill Standards and Credentialing Council.*

**ELECTRIC DISCHARGE MACHINE (EDM):
OPERATING A 2-AXIS WIRE EDM**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|--|
| Part requiring the operations listed above | Adapters fitted to the electrode holder |
| Blueprints, sketches, notes | Files |
| Completed process plan | Magnetic base for indicators |
| Verbal instructions | Soft jaws for the vise |
| Production schedule | Assorted hand tools |
| Tool crib with relevant perishable tooling | Required micrometers |
| Tool crib with relevant precision measuring tools | Combination set |
| Machine tool and accessory inventory | Dial indicator |
| Components required to complete the assembly | 6" rule |
| Standard plunge EDM | 6" vernier, dial or electronic caliper |
| Workbench | Adjustable parallels |
| A part matching the material requirements of the blueprint, material:
1215 Cold Rolled Steel (CRS) | Edge finder |
| An appropriate workholding device | Appropriate tools for determining squareness |
| Screws, studs, nuts, washers and clamps to hold the part to the table | Surface finish comparison standards |
| Assorted parallels | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Perform the EDM operation called out on the blueprint and process plan.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

USING A COMPUTER AND EDITOR SOFTWARE, WRITE SIMPLE RS274-D PROGRAMS. SIMPLE PROGRAMS ARE SINGLE PLANE, CUTTER CENTERLINE, LINEAR AND CIRCULAR INTERPOLATION AND SINGLE CUTTER WITH NO CANNED CYCLES.

**COMPUTER NUMERICAL CONTROL (CNC):
WRITING SIMPLE
RS274-D PROGRAMS**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions for the task at hand
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Part matching the layout blueprint, material: 1018 Hot Rolled Steel (HRS)
- Common workbench
- Personal computer
- Software editor
- Printer
- Diskette
- Paper
- Machinery's Handbook
- Electronics Industries Association (EIA) standard RS274-D
- Manual for the machine tool for which the program is being written

WORK TO BE PERFORMED

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

PERFORMANCE CRITERIA

The finished program matches the elements of the model program or alternate. Relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The program matches the model program, or an alternative program matches standard practices for such a program in the estimation of two designated examiners.
- All relevant questions are successfully answered regarding the program, tooling and equipment it involves.
- Appropriate trade techniques are used to produce the program.
- All relevant paperwork is completed and is in order.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the work and the projected work arising from the program.

**COMPUTER NUMERICAL CONTROL
(CNC): OPERATING A CNC MILL****SKILL STANDARD****CONDITIONS OF PERFORMANCE****Given the following:**

Blueprints, sketches, notes	6" milling vise or greater
Completed process plan	Screws, studs, nuts, washers and clamps sufficient to secure the vise or the part to the table
Verbal instructions	Assorted parallels
Production schedule	Ball-peen and composition hammers
Tool crib with relevant perishable tooling	Assorted cutters and cutter adapters fitted to the machine spindle
Tool crib with relevant precision measuring tools	Files
Common workbench	Magnetic base for indicators
Files	Soft jaws for the vise
Wrenches as necessary	Assorted cutters
Micrometers	Required micrometers
Combination set	Adjustable parallels
Thread-pitch gages	Edge finder
Center gage	Appropriate tools for determining squareness
Pitch micrometer	<u>Machinery's Handbook</u>
Thread-ring gages	Operator's manual for the machine tool
Dial indicator	
6" rule	
6" vernier, dial or electronic caliper	
Surface finish comparison plates	
Standard workbench	
CNC mill with continuous path capability on 2½ axes	
Part matching the material requirements of the blueprint, material: 1215 Cold Rolled Steel (CRS)	

WORK TO BE PERFORMED

Operate a CNC mill, change tool values as necessary and replace and qualify tooling as necessary.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

COMPUTER NUMERICAL CONTROL (CNC): OPERATING A CNC LATHE

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|--|
| Blueprints, sketches, notes | Magnetic base for a dial indicator |
| Completed process plan | Files |
| Verbal instructions | Wrenches as necessary |
| Production schedule | Required micrometers |
| Tool crib with relevant perishable tooling | Combination set |
| Tool crib with relevant precision measuring tools | Thread-pitch gages |
| Common workbench | Center gage |
| CNC turning center of adequate capacity | Pitch micrometer |
| Three-jaw universal scroll chuck | Thread-ring gages |
| Four-jaw independent chuck | Dial indicator |
| Part matching the material requirements of the CNC turning blueprint, material: 1215 Cold Rolled Steel (CRS) | 6" rule |
| Right- and left-hand turning tools capable of turning to a square shoulder | 6" vernier, dial or electronic caliper |
| External threading tool matched to the profile of the thread called out on the turning blueprint | Surface finish comparison standards |
| Drill chuck | Appropriate taper ring gages and Prussian blue or taper micrometer or sine bar and indicator |
| Centerdrill | Surface finish comparison plates |
| External undercut tools | <u>Machinery's Handbook</u> |
| Live center | Operator's manual for the machine tool |
| Dead center fitted to the spindle taper | |

WORK TO BE PERFORMED

Operate CNC lathe, change tool values as necessary and replace and qualify tooling as necessary.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM THE INSPECTION OF PROFILES IN SHADOW AND IN REFLECTION.

INSPECTION: OPTICAL COMPARATOR

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes
 Completed process plan
 Verbal instructions
 Production schedule
 Tool crib with relevant perishable tooling
 Optical comparator and necessary drafting supplies and equipment
 Finished part matching the blueprint
 Vellum or tracing paper
 Tooling appropriate to the presentation of a part on an optical comparator
 Precision tools needed to operate the comparator
Machinery's Handbook

WORK TO BE PERFORMED

Inspect a part's specified profiles. Produce data necessary to describe the compliance of the profiles.

PERFORMANCE CRITERIA

The inspection report satisfies the elements of the model report, appropriate techniques were used to gather the data for the report, paperwork is complete, housekeeping is accomplished and safe practices are used.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The inspection report findings match the findings of the model inspection report.
- Appropriate trade techniques are used to produce the inspection findings.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Coordinate Measuring Machine (CMM)
- Finished part matching the blueprint
- Tooling appropriate to the setup of a part on a CMM
- Precision tools needed to establish the setup
- Machinery's Handbook

WORK TO BE PERFORMED

Inspect a part's geometry. Produce data necessary to describe the compliance of the part.

PERFORMANCE CRITERIA

The inspection report satisfies the elements of the model report; appropriate techniques were used to gather the data for the report. Paperwork is complete, housekeeping is accomplished and safe practices are used.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The inspection report findings match the findings of the model inspection report.
- Appropriate trade techniques are used to produce the inspection findings.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

PARTICIPATE AS A TEAM MEMBER IN A CAPABILITY STUDY. PERFORM THE REQUIRED STATISTICAL CALCULATIONS TO SUPPORT THE CAPABILITY STUDY. WITH THE ASSISTANCE OF THE TEAM LEADER, PREPARE THE NECESSARY SHOP REPORTS FOR THE CAPABILITY STUDY.

PARTICIPATION IN CAPABILITY STUDIES

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Common workbench with a precision surface plate
- Statistical study data
- Capability study plan
- Calculator with statistical functions or computer with statistical software
- Calculator manual or software manual
- Machinery's Handbook

WORK TO BE PERFORMED

Participate as a team member in support of the development of a capability study. With the direction of the team leader, provide all the machining expertise and statistical calculation needed to satisfy the requirements of the capability study.

PERFORMANCE CRITERIA

Explain the process capability study. Relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The team's activities in producing capability studies are explained successfully.
- All relevant questions are answered successfully regarding the studies.
- Appropriate trade techniques are used to produce the studies.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation being studied.
- Safe practices are used throughout the performance.

**BENCH OPERATIONS:
HAND LAPPING****SKILL STANDARD****CONDITIONS OF PERFORMANCE****Given the following:**

Blueprints, sketches, notes
Completed process plan
Verbal instructions
Production schedule
Tool crib with relevant perishable tooling
Tool crib with relevant precision measuring tools
Machine tool and accessory inventory
Common workbench with a lapping plate that can be fixed in place
Part ground to the lapping blueprint, material:
 1215 Cold Rolled Steel (CRS)
Lapping compound and cleaning solution with appropriate disposal for both
Wipes
Optical flats
Indicators
Electronic gages
Laboratory grade surface plate
Transfer gage
Machinery's Handbook

WORK TO BE PERFORMED

Hand lap a surface to flatness and finish requirements.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND PERFORM CONTOUR SAWING TO A LAYOUT WHICH REQUIRES THE PART TO BE SAWED AT ANGLES WITH RESPECT TO THE TOP AND/OR BOTTOM. CHOOSE AND MOUNT APPROPRIATE BLADES. WELD, BREAK AND REWELD BLADES AS NECESSARY.

ANGLE CONTOUR BANDSAWING

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Layout ink
Completed process plan	Prick punch
Verbal instructions	Ball-peen hammer
Production schedule	Angle plate
Tool crib with relevant perishable tooling	C-clamps
Tool crib with relevant precision measuring tools	Magnifying glass
Machine tool and accessory inventory	Combination set
Standard workbench and appropriate bandsaw	Radius gages
Part matching the bandsaw blueprint, material: 1215 Cold Rolled Steel (CRS)	6" dividers
Scriber	Surface gage
	Layout height gage
	Files
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Finish saw a part to the layout maintaining the required angular relationships of the finish with respect to the top and/or bottom.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|--|
| Blueprints, sketches, notes | External undercut tools |
| Completed process plan | 45° chamfer tools |
| Verbal instructions | Assorted tool blanks for form tools |
| Production schedule | Live center |
| Tool crib with relevant perishable tooling | Dead center fitted to the spindle taper |
| Tool crib with relevant precision measuring tools | Magnetic base for a dial indicator |
| Machine tool and accessory inventory | Files |
| Standard workbench | Wrenches as necessary |
| Three-jaw universal scroll chuck | Required micrometers |
| Four-jaw independent chuck | Combination set |
| Tool room engine lathe (The lathe may have a quick-change gear box with the threads called for on the blueprint available from the gearbox.) | Dial indicator |
| Pedestal grinding machine to offhand grind form tools | 6" rule |
| Part matching the material requirements of the turning blueprint, material: 1215 Cold Rolled Steel (CRS) | 6" vernier, dial or electronic caliper |
| Tool post | Surface finish comparison plates |
| Right- and left-hand turning tools capable of turning to a square shoulder | Optical comparator |
| Drill chuck | Appropriate taper ring gages and Prussian blue or taper micrometer or sine bar and indicator |
| Centerdrill | Inspection templates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two diameters composed of a taper and two tangent radii.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|---|--|
| Blueprints, sketches, notes | Centerdrill |
| Completed process plan | External undercut tools |
| Verbal instructions | 45° chamfer tools |
| Production schedule | Live center |
| Tool crib with relevant perishable tooling | Dead center fitted to the spindle taper |
| Tool crib with relevant precision measuring tools | Magnetic base for a dial indicator |
| Machine tool and accessory inventory | Files |
| Standard workbench | Wrenches as necessary and cutting fluids |
| Steady rest | Required micrometers |
| Three-jaw universal scroll chuck | Combination set |
| Four-jaw independent chuck | Thread-pitch gages |
| Tool room engine lathe (The lathe may have a quick-change gear box with the threads called for on the blueprint available from the gear box.) | Center gage |
| Part matching the requirements of the turning blueprint, material: 1215 Cold Rolled Steel (CRS) | Pitch micrometer |
| Tool post | Thread-ring and plug gages |
| Right- and left-hand turning tools capable of turning to a square shoulder | Dial Indicator |
| External threading tool matched to the profile of the thread called out on the turning blueprint | 6" rule |
| Drill chuck | 6" vernier, dial or electronic caliper |
| | Dial bore gages |
| | Surface finish comparison plates |
| | Indicator |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified will extend far enough from the spindle to require the support of a steady rest to facilitate boring on its ends. The part will have at least two bores within $\pm .001$ ", one Unified National Coarse (UNC) external thread and one Unified National Fine (UNF) external thread and will require the reversal of the part end for end.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|---|
| Blueprints, sketches, notes | Centerdrill |
| Completed process plan | Drills |
| Verbal instructions | External undercut tools |
| Production schedule | 45° chamfer tools |
| Tool crib with relevant perishable tooling | Live center |
| Tool crib with relevant precision measuring tools | Dead center fitted to the spindle taper |
| Machine tool and accessory inventory | Magnetic base for a dial indicator |
| Standard workbench | Files |
| Tool room engine lathe | Wrenches as necessary |
| Three-jaw universal scroll chuck | Cutting fluids |
| Four-jaw independent chuck | Required micrometers |
| Part matching the material requirements of the turning blueprint, material: 1215 Cold Rolled Steel (CRS) | Combination set |
| Tool post | Dial indicator |
| Follower rest | 6" rule |
| Steady rest | 6" vernier, dial or electronic caliper |
| Right- and left-hand turning tools capable of turning to a square shoulder | Surface finish comparison plates |
| Drill chuck | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified will have at least three diameters within $\pm .001$ ", one of which will be an extended turn which will benefit from the use of a follower rest.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|--|
| Blueprints, sketches, notes | Drills |
| Completed process plan | External undercut tools |
| Verbal instructions | 45° chamfer tools |
| Production schedule | Live center |
| Tool crib with relevant perishable tooling | Magnetic base for a dial indicator |
| Tool crib with relevant precision measuring tools | Files |
| Machine tool and accessory inventory | Wrenches as necessary |
| Standard workbench | Required micrometers |
| Tool room engine lathe | Combination set |
| Three-jaw universal scroll chuck | Thread-pitch gages |
| Four-jaw independent chuck | Center gage |
| 300 series stainless steel, except 303 | Pitch micrometer |
| Tool post | Thread-ring gages |
| Right- and left-hand turning tools capable of turning to a square shoulder | Dial indicator |
| External threading tool matched to the profile of the thread called out on the turning blueprint | 6" rule |
| Drill chuck | 6" vernier, dial or electronic caliper |
| Centerdrill | Surface finish comparison plates |
| | <u>Machinery's Handbook</u> |

WORK TO BE PERFORMED

Produce a part matching the process plan and the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two diameters within $\pm .001$ ", one Unified National Coarse (UNC) external thread and one Unified National Fine (UNF) external thread.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Files
Completed process plan	Wrenches as necessary
Verbal instructions	Required micrometers
Production schedule	Combination set
Tool crib with relevant perishable tooling	Dial indicator
Tool crib with relevant precision measuring tools	6" rule
Machine tool and accessory inventory	6" vernier, dial or electronic caliper
Standard workbench	Bevel vernier protractor
Appropriate milling machine	Tooling ball
Part matching the requirements of the compound angle blueprint, material: 1215 Cold Rolled Steel (CRS)	Precision pins
Required cutters and adapters	Sine bar
Milling vise	Sine plate
Toolmaker's vise	Gage blocks
Sine plates	Surface plate
Tilting tables	Surface finish comparison plates
Clamps and studs	Calculator with trig functions
Magnetic base for a dial indicator	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Mill compound angles. Inspect the angles using a sine bar or sine plate.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

*ILLINOIS MACHINING SKILL STANDARD, TECHNICAL ELEMENTS, SKILL LEVEL III
Adapted from the National Machining Skill Standards to meet the format requirements of the Illinois Occupational Skill Standards and Credentialing Council.*

SET UP AND MILL CURVED SURFACES THROUGH LINEAR MOVES OF VARYING LENGTHS USING METHODS OF APPROXIMATION FROM TAPERS, RADII, INTERPOLATION AND SECTIONED TEMPLATES.

MILLING: MANUAL CONTOUR MILLING

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Clamps and studs
Completed process plan	Magnetic base for a dial indicator
Verbal instructions	Files
Production schedule	Wrenches as necessary
Tool crib with relevant perishable tooling	Required micrometers
Tool crib with relevant precision measuring tools	Combination set
Machine tool and accessory inventory	Dial indicator
Standard workbench	6" rule
Part matching the material requirements of the blueprint, material: 1215 Cold Rolled Steel (CRS)	6" vernier, dial or electronic caliper
Required cutters and adapters	Bevel vernier protractor
Milling vise	Tooling ball
Toolmaker's vise	Precision pins
Sine plates	Surface finish comparison plates
Tilting tables	<u>Machinery's Handbook</u>
Template material	

WORK TO BE PERFORMED

Mill surfaces which are composed of nonlinear profiles.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Clamps and studs
Completed process plan	Magnetic base for a dial indicator
Verbal instructions	Files
Production schedule	Wrenches as necessary
Tool crib with relevant perishable tooling	Required micrometers
Tool crib with relevant precision measuring tools	Combination set
Machine tool and accessory inventory	Dial indicator
Standard workbench	6" rule
Appropriate milling machine	6" vernier, dial or electronic caliper
Part matching the material requirements of the blueprint, material: 1215 Cold Rolled Steel (CRS)	Dial bore gages
Required cutters and adapters	Surface finish comparison plates
Boring bars and single point boring tools	<u>Machinery's Handbook</u>
Milling vise	
Rotary table with power take off	

WORK TO BE PERFORMED

Bore and mill surfaces, diameters and radii to match the blueprint.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

**PREPARE GRINDING WHEELS FOR MOUNTING
A CYLINDRICAL GRINDER OR SURFACE GRINDER.
MOUNT THE WHEEL AND GRIND A 16 MICROFINISH
ON A SURFACE. DRESS AS NECESSARY.**

**GRINDING: SELECTION,
INSPECTION, SETUP AND
WHEEL BALANCING**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes
Completed process plan
Verbal instructions
Production schedule
Tool crib with relevant perishable tooling
Tool crib with relevant precision measuring tools
Machine tool and accessory inventory
Standard workbench and cylindrical grinder
Appropriate grinding wheels
Wheel balancer, counterweights, wheel arbor
Dial test indicator
Indicator mounting brackets
Machinery's Handbook

WORK TO BE PERFORMED

Given a wheel and appropriate equipment, prepare the wheel to go into service.

PERFORMANCE CRITERIA

The collection of wheels has been separated into acceptable and not acceptable categories, not acceptable wheels are labeled and secured from use, an acceptable wheel is mounted using safe and appropriate practices and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The collection of grinding wheels is evaluated correctly.
- The failed grinding wheels are labeled and appropriately secured from future use.
- Appropriate trade techniques are used to evaluate the wheels and to balance and mount the sound wheel.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary with the complexity of the operation.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|--|
| Blueprints, sketches, notes | Files |
| Verbal instructions | Magnetic base for indicators |
| Production schedule | Diamond dresser |
| Tool crib with relevant perishable tooling | Required micrometers |
| Tool crib with relevant precision measuring tools | Combination set |
| Machine tool and accessory inventory | Dial test indicator |
| Standard workbench and cylindrical grinder | 6" rule |
| Part matching the requirements of the cylindrical grinding blueprint, material: 1215 Cold Rolled Steel (CRS) | Gage blocks |
| Centers for the headstock and tailstock | Surface condition comparison gages |
| Assorted grinding dogs | Appropriate taper ring gages and Prussian blue or taper micrometer or sine bar and indicator |
| Composition hammer | <u>Machinery's Handbook</u> |
| Assorted grinding wheels suitable for mounting to the spindle | |

WORK TO BE PERFORMED

Mount a part, rough finished as a Morse taper, between centers; and grind the required tapered diameter to finish. Dress the wheel as necessary.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND GRIND ID AND OD SURFACES ON A UNIVERSAL GRINDING MACHINE OR ID/OD GRINDER.

GRINDING: GRINDING INSIDE DIAMETER (ID) AND OUTSIDE DIAMETER (OD) SURFACES

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Part requiring the operations listed above	Three- and four-jaw grinder's chucks
Blueprints, sketches, notes	Composition hammer
Completed process plan	Assorted grinding wheels suitable for mounting to the spindle
Verbal instructions	Files
Production schedule	Magnetic base for indicators
Tool crib with relevant perishable tooling	Diamond dresser
Tool crib with relevant precision measuring tools	Required micrometers
Machine tool and accessory inventory	Dial bore gages
Components required to complete the assembly	Dial test indicator
Standard workbench and ID/OD grinder	6" rule
Part matching the material requirements of the blueprint, material: 1215 Cold Rolled Steel (CRS)	Gage blocks
Workholders	Surface condition comparison gages
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Mount a part, rough finished on Outside Diameters and Inside Diameters, in an appropriate workholder; and grind the diameters to the required finish. Grind the shoulders as necessary. Dress the wheel.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND GRIND TAPERS ON A UNIVERSAL GRINDER.

GRINDING: GRINDING TAPERS ON A UNIVERSAL GRINDER

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Files
Completed process plan	Magnetic base for indicators
Verbal instructions for the task at hand	Live center
Production schedule	Tailstock
Tool crib with relevant perishable tooling	Diamond dresser
Tool crib with relevant precision measuring tools	Required micrometers
Standard workbench and universal grinder	Dial bore gages
Part matching the material requirements of the blueprint, material: 1215 Cold Rolled Steel (CRS)	Dial test indicator
Workholders	6" rule
Three- and four-jaw grinder's chucks	Gage blocks
Centers	Surface condition comparison gages
Drive dogs	Appropriate taper ring gages and Prussian blue or taper micrometer or sine bar and indicator
Indexers	<u>Machinery's Handbook</u>
Composition hammer	
Assorted grinding wheels suitable for mounting to the spindle	

WORK TO BE PERFORMED

Mount a part, rough finished on Outside Diameters and Inside Diameters, in an appropriate workholder; and grind the tapered diameters to the required finish. Dress the wheel.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SET UP AND GRIND CURVED AND IRREGULAR SURFACES BY USING LINEAR INCREMENTAL MOVES, TAPERS, RADII, INTERPOLATION AND APPROXIMATION WITH THE AID OF A VISUAL COMPARATOR AND A RADIUS DRESSER.

GRINDING: CONTOUR GRINDING

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Assorted grinding wheels suitable for mounting to spindle
Completed process plan	Files
Verbal instructions	Magnetic base for indicators
Production schedule	Radius dresser
Tool crib with relevant perishable tooling	Diamond dresser
Tool crib with relevant precision measuring tools	Required micrometers
Common workbench	Dial test indicator
Standard workbench and profile grinder	6" rule
Part matching the material requirements of the blueprint, material: A2 Tool Steel	Gage blocks
Workholders	Visual comparator
Grinder's vise	Surface condition comparison gages
Composition hammer	
<u>Machinery's Handbook</u>	

WORK TO BE PERFORMED

Mount the part in an appropriate workholder, and grind the profile to the required finish. Dress the wheel as necessary.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes	Files
Completed process plan	Magnetic base for indicators
Verbal instructions	Assorted hand tools
Production schedule	Required micrometers
Tool crib with relevant perishable tooling	Combination set
Tool crib with relevant precision measuring tools	Dial indicator
Common workbench	6" rule
4-axis wire Electric Discharge Machine (EDM) and a workbench	6" vernier, dial or electronic caliper
Part matching the material requirements of the blueprint, material: 1215 Cold Rolled Steel (CRS)	Adjustable parallels
Appropriate workholding device	Edge finder
Screws, studs, nuts, washers and clamps sufficient to secure the part to the table	Appropriate tools for determining squareness
Assorted parallels	Surface finish comparison standards
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Perform the EDM operation called out on the process plan.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

USING A COMPUTER AND EDITOR, WRITE SOPHISTICATED RS274-D PROGRAMS. SOPHISTICATED PROGRAMS WILL CONTAIN VARIOUS COMBINATIONS OF CHANGE OF PLANE AND CANNED CYCLES AND EMPLOY MULTIPLE TOOLS; CUTTER OFFSETS AND LINEAR, CIRCULAR AND HELICAL INTERPOLATION AS WELL AS REQUIRE THE MATCHING OF SURFACES ALONG LINES AND POINTS OF TANGENCY IN THREE AXES. STORE THE RESULTS ON COMPUTER MEDIA.

**COMPUTER NUMERICAL
CONTROL (CNC):
ADVANCED MANUAL
RS274-D
PROGRAMMING**

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- Blueprints, sketches, notes
- Completed process plan
- Verbal instructions
- Production schedule
- Tool crib with relevant perishable tooling
- Tool crib with relevant precision measuring tools
- Machine tool and accessory inventory
- Common workbench
- Personal computer
- Software editor
- Printer
- Diskette
- Paper
- Machinery's Handbook
- Electronics Industries Association (EIA) standard RS274-D
- Relevant manuals for the machine tool for which the program is being written

WORK TO BE PERFORMED

Write a program to drive a collection of tooling through the toolpaths needed to produce the part shown on the blueprint. The program will require change of tools, change of planes and use of "canned cycles" and tool offsets. Use a computer to write and store the program.

PERFORMANCE CRITERIA

The program matches the elements of the model program or alternate program, relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

ASSESSMENT AND CREDENTIALING APPROACH

- The program matches the model program, or an alternative program matches standard practices for such a program in the estimation of two designated examiners.
- All relevant questions are successfully answered regarding the program, tooling and equipment it involves.
- Appropriate trade techniques are used to produce the program.
- All relevant paperwork is completed and is in order.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the work and the projected work arising from the program.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Blueprints, sketches, notes
Completed process plan
Verbal instructions
Production schedule
Tool crib with relevant perishable tooling
Tool crib with relevant precision measuring tools
Machine tool and accessory inventory
Personal computer
Graphics-based tool path modeler/editor
Software editor
Printer
Diskette
Paper
Machinery's Handbook
Electronics Industries Association (EIA) standard RS274-D
Relevant manuals for the machine tool for which the program is being written

WORK TO BE PERFORMED

Use a graphics-based software package to develop a program to drive a collection of tooling through the toolpaths needed to produce the part shown on the blueprint. The program will require change of tools, change of planes and use of "canned cycles" and tool offsets.

PERFORMANCE CRITERIA

The program matches the elements of the model program or alternate program, relevant questions are answered, appropriate safety and trade techniques are employed and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The program matches the model program, or an alternative program matches standard practices for such a program in the estimation of two designated examiners.
- All relevant questions are successfully answered regarding the program, tooling and equipment it involves.
- Appropriate trade techniques are used to produce the program.
- All relevant paperwork is completed and is in order.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the work and the projected work arising from the program.

SKILL STANDARD**CONDITIONS OF PERFORMANCE****Given the following:**

Blueprints, sketches, notes	Assorted cutters and cutter adapters fitted to the machine spindle
Completed process plan	Files
Verbal instructions	Magnetic base for indicators
Production schedule	Soft jaws for the vise
Tool crib with relevant perishable tooling	Required micrometers
Tool crib with relevant precision measuring tools	Combination set
Machine tool and accessory inventory	Dial indicator
Common workbench	6" rule
CNC mill with continuous path capability on 2½ axes	6" vernier, dial or electronic caliper
Part matching the material requirements of the blueprint, material: 1215 Cold Rolled Steel (CRS)	Adjustable parallels
6" milling vise or greater	Edge finder
Screws, studs, nuts, washers and clamps sufficient to secure the vise or the part to the table	Appropriate tools for determining squareness
Assorted parallels	Surface finish comparison plates
	<u>Machinery's Handbook</u>

WORK TO BE PERFORMED

Set up the tooling and workpiece. Qualify the workpiece to the control. Prepare tools or load tools into tool magazine as required; qualify the tools to the control with respect to the work; match their identity to the program. Establish initial tool values or offsets. The part specified should have at least two steps with $\pm .001$ " tolerances, one Unified National Coarse (UNC) tapped hole and an arc/tangent surface and require the use of at least one "canned cycle" available on the mill.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|--|
| Blueprints, sketches, notes | Dead center fitted to the spindle taper |
| Completed process plan | Magnetic base for a dial indicator |
| Verbal instructions | Files |
| Production schedule | Wrenches as necessary |
| Tool crib with relevant perishable tooling | Required micrometers |
| Tool crib with relevant precision measuring tools | Combination set |
| Machine tool and accessory inventory | Thread-pitch gages |
| Common workbench | Center gage |
| CNC turning center of adequate capacity | Pitch micrometer |
| Three-jaw universal scroll chuck | Thread-ring gages |
| Four-jaw independent chuck | Dial indicator |
| Part matching the material requirements of the CNC turning blueprint, material: 1215 Cold Rolled Steel (CRS) | 6" rule |
| Right- and left-hand turning tools capable of turning to a square shoulder | 6" vernier, dial or electronic caliper |
| External threading tool matched to the profile of the thread called out on the turning blueprint | Surface finish comparison plates |
| Drill chuck | Appropriate taper ring gages and Prussian blue or taper micrometer or sine bar and indicator |
| Centerdrill | <u>Machinery's Handbook</u> |
| External undercut tools | |
| Live center | |

WORK TO BE PERFORMED

Set up the tooling and workpiece. Qualify the workpiece to the control. Prepare tools or load tools into tool magazine as required; qualify the tools to the control with respect to the work; match their identity to the program. Establish initial tool values or offsets. The part specified should have at least two diameters within ± 0.001 ", one Unified National Coarse (UNC) external thread, one Unified National Fine (UNF) external thread and an appropriate taper at each end of the part and require an end-for-end swap.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

- | | |
|--|--|
| Blueprints, sketches, notes | 45° chamfer tools |
| Completed process plan | Live center |
| Verbal instructions | Dead center fitted to the spindle tape |
| Production schedule | Magnetic base for a dial indicator |
| Tool crib with relevant perishable tooling | Files |
| Tool crib with relevant precision measuring tools | Wrenches as necessary |
| Machine tool and accessory inventory | Required micrometers |
| Common workbench | Combination set |
| CNC turning center of adequate capacity | Thread-pitch gages |
| Three-jaw universal scroll chuck | Center gage |
| Four-jaw independent chuck | Pitch micrometer |
| Part matching the material requirements of the CNC turning blueprint, material: 1215 Cold Rolled Steel (CRS) | Thread-ring gages |
| Right- and left-hand turning tools capable of turning to a square shoulder | Dial indicator |
| External threading tool matched to the profile of the thread called out on the blueprint | 6" rule |
| Drill chuck | 6" vernier, dial or electronic caliper |
| Centerdrill | Surface finish comparison plates |
| Drills | Appropriate taper ring gages and Prussian blue or taper micrometer or sine bar and indicator |
| Endmills | <u>Machinery's Handbook</u> |
| External undercut tools | |

WORK TO BE PERFORMED

Set up the tooling and workpiece. Qualify the workpiece to the control. Prepare tools or load tools into tool magazine as required; qualify the tools to the control with respect to the work; match their identity to the program. Establish initial tool values or offsets. The part specified should have at least two diameters within $\pm .001$ ", one Unified National Coarse (UNC) external thread, one Unified National Fine (UNF) external thread, an appropriate taper at each end of the part and a keyseat and crosshole requiring the secondary milling capability of the center.

PERFORMANCE CRITERIA

The part meets specifications, production and safety practices are appropriate and paperwork is completed.

PERFORMANCE ELEMENTS AND ASSESSMENT CRITERIA

- The part is produced to specification.
- Appropriate trade techniques and speeds and feeds are used to produce the part.
- All relevant paperwork is completed and is in order.
- The work area is returned to a neat and clean state.
- The time will vary according to the complexity of the part being produced. For current blueprints, equipment list and suggested times, contact the National Institute for Metalworking Skills at 703/281-1610.
- Safe practices are used throughout the performance.

Academic Skills	Skills (and related knowledge) contained in the subject areas and disciplines addressed in most national and state educational standards, including English, mathematics, science, etc.
Assessment	A process of measuring performance against a set of standards through examinations, practical tests, performance observations and/or the completion of work portfolios.
Content Standard	A specification of what someone should know or be able to do to successfully perform a work activity or demonstrate a skill.
Critical Work Functions	<p>Distinct and economically meaningful sets of work activities critical to a work process or business unit which are performed to achieve a given work objective with work outputs that have definable performance criteria. A critical work function has three major components:</p> <ul style="list-style-type: none"> • Conditions of Performance: The information, tools, equipment and other resources provided to a person for a work performance. • Work to Be Performed: A description of the work to be performed. • Performance Criteria: The criteria used to determine the required level of performance. These criteria could include product characteristics (e.g., accuracy levels, appearance), process or procedure requirements (e.g., safety, standard professional procedures) and time and resource requirements. The IOSSCC requires that these performance criteria be further specified by more detailed individual performance elements and assessment criteria.
Credentialing	The provision of a certificate or award to an individual indicating the attainment of a designated set of knowledge and skills and/or the demonstration of a set of critical work functions for an industry/occupational area.
Illinois Occupational Skill Standards and Credentialing Council (IOSSCC)	Legislated body representing business and industry which establishes skill standards criteria, endorses final products approved by the industry subcouncil and standards development committee and assists in marketing and dissemination of occupational skill standards.
Industry	Type of economic activity, or product or service produced or provided in a physical location (employer establishment). They are usually defined in terms of the Standard Industrial Classification (SIC) system.

Industry Subcouncil	Representatives from business/industry and education responsible for identifying and prioritizing occupations for which occupational performance skill standards are adapted, adopted or developed. They establish standards development committees and submit developed skill standards to the IOSSCC for endorsement. They design marketing plans and promote endorsed skill standards across the industry.
Knowledge	Understanding the facts, principles, processes, methods and techniques related to a particular subject area, occupation or industry.
Occupation	A group or cluster of jobs, sharing a common set of work functions and tasks, work products/services and/or worker characteristics. Occupations are generally defined in terms of a national classification system including the Standard Occupational Classification (SOC), Occupational Employment Statistics (OES) and the Dictionary of Occupational Titles (DOT).
Occupational Cluster	Grouping of occupations from one or more industries that share common skill requirements.
Occupational Skill Standards	Specifications of content and performance standards for critical work functions or activities and the underlying academic, workplace and occupational knowledge and skills needed for an occupation or an industry/occupational area.
Occupational Skills	Technical skills (and related knowledge) required to perform the work functions and activities within an occupation.
Performance Standard	A specification of the criteria used to judge the successful performance of a work activity or the demonstration of a skill.
Product Developer	Individual contracted to work with the standard development committee, state liaison, industry subcouncil and IOSSCC for the adaptation, adoption or development of skill standards content.
Reliability	The degree of precision or error in an assessment system so repeated measurements yield consistent results.
Skill	A combination of perceptual, motor, manual, intellectual and social abilities used to perform a work activity.
Skill Standard	Specifies the knowledge and competencies required to perform successfully in the workplace.

Standards Development Committee	Incumbent workers, supervisors and human resource persons within the industry who perform the skills for which standards are being developed. Secondary and postsecondary educators are also represented on the committee. They identify and verify occupational skill standards and assessment mechanisms and recommend products to the industry subcouncil for approval.
State Liaison	Individual responsible for communicating information among all parties (IOSSCC, subcouncil, standard development committee, product developer, project director, etc.) in skill standard development.
Third-Party Assessment	An assessment system in which an industry-designated organization (other than the training provider) administers and controls the assessment process to ensure objectivity and consistency. The training provider could be directly involved in the assessment process under the direction and control of a third-party organization.
Validity	The degree of correspondence between performance in the assessment system and job performance.
Workplace Skills	The generic skills essential to seeking, obtaining, keeping and advancing in any job. These skills are related to the performance of critical work functions across a wide variety of industries and occupations including problem solving, leadership, teamwork, etc.

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APPENDIX E

I. Occupational Definition and Justification

A. Occupational Definition

The Manufacturing Subcouncil identified machining skills as a major occupational cluster in manufacturing. Machining skills involve the use of cutting tools to shape metal materials in single-part and serial manufacturing by means of milling, turning, grinding, boring and sawing with a variety of conventional and computer numerical control (CNC) machines and associated tooling.

The National Institute for Metalworking Skills (NIMS) has developed national standards for three levels of machining skills. The Manufacturing Subcouncil voted to endorse these national standards for Illinois as reformatted to meet the format requirements of the Illinois Occupational Skill Standards and Credentialing Council (IOSSCC).

The IOSSCC-recognized standards will be referred to as the “Illinois Machining Skill Standards adapted from the National Machining Skill Standards to meet the format requirements of the Illinois Occupational Skill Standards and Credentialing Council.”

These machining skills are used predominately in the following occupations recognized by the Tooling and Manufacturing Association in their analysis of labor market needs in Illinois.

- Machinist
- Machine Tool Setters and Set-up Operators
- Metal Processing Machine Setters and Setup Operators
- Combination Machine Setters and Setup Operators
- Numerical Control Machine Setters and Setup Operators
- Tool and Die/Mold Maker

B. Employment and Earnings Opportunities

These machining occupations have a generally favorable employment outlook in Illinois according to the Illinois Occupational Information Coordinating Committee (IOICC) based on data provided by the Tooling and Manufacturing Association and the Illinois Department of Employment Security. These machining occupations are projected to have a large number of job openings in the future due to growth and replacement needs.

These machining occupations also meet the IOSSCC earnings criteria based on data provided by the IOICC and shown below. These earnings represent the range between the 25th and the 75th percentile.

- Machinist \$23,570-\$31,990
- Machine Tool Setters and Set-up Operators \$15,930-\$22,190
- Metal Processing Machine Setters and Setup Operators \$20,700-\$27,560
- Combination Machine Setters and Setup Operators \$24,090-\$31,200
- Numerical Control Machine Setters and Setup Operators \$24,770-\$33,090

According to the wage surveys of the Tooling and Manufacturing Association, individuals with these machining skills can earn salaries substantially higher than those shown above.

C. Career Opportunities and Education and Training Requirements

Machining skills meet the IOSSCC criteria for education and training requirements and career opportunities. Machining skills require basic workplace skills and advanced technical training for all three skill levels. The workplace skill requirements are detailed in the knowledge, skills and other attributes provided in the standards document. The technical skill requirements are detailed in the technical elements portion of the standards document.

II. Occupational Standards and Credentials**A. Occupational Skill Standards**

The Machining Skill Standards Levels I-III as developed by the NIMS meet all IOSSCC content requirements and have been translated into the IOSSCC format. The translation to IOSSCC formats required no major changes in the national standards.

B. Assessment and Credentialing System

The National Institute for Metalworking Skills (NIMS) is developing both written and performance examinations for Machining Skills Levels I-III. These examinations are now being pilot-tested and will be available for use in Illinois. The assessment and credentialing process meets all IOSSCC criteria.

III. Industry Support and Commitment**A. Industry Commitment for Development and Updating**

The National Institute for Metalworking Skills conducted a national validation of the national machining skill standards through regional technical groups and national surveys. The Illinois Manufacturing Subcouncil established a standards development committee to approve the national standards and the reformatting of the standards. This standards development committee received a mail survey with the reformatted standards. The survey returns recommended endorsement of the national standards and approval of the reformatting. The Manufacturing Subcouncil then voted to endorse the national standards as reformatted.

The NIMS is committed to maintaining and updating the national machining skill standards for use in Illinois and other states. The NIMS board is composed of representatives of leading industry and trade associations and unions in the industry.

B. Industry Commitment for Marketing

The NIMS and affiliated Illinois organizations are committed to promoting and marketing the national machining standards and credentialing system in Illinois. The NIMS and the Tooling and Manufacturing Association have committed to promote the standards in Illinois.

-
- A. Developing an Employment Plan**
1. Match interests to employment area.
 2. Match aptitudes to employment area.
 3. Identify short-term work goals.
 4. Match attitudes to job area.
 5. Match personality type to job area.
 6. Match physical capabilities to job area.
 7. Identify career information from counseling sources.
 8. Demonstrate a drug-free status.
-
- B. Seeking and Applying for Employment Opportunities**
1. Locate employment opportunities.
 2. Identify job requirements.
 3. Locate resources for finding employment.
 4. Prepare a resume.
 5. Prepare for job interview.
 6. Identify conditions for employment.
 7. Evaluate job opportunities.
 8. Identify steps in applying for a job.
 9. Write job application letter.
 10. Write interview follow-up letter.
 11. Complete job application form.
 12. Identify attire for job interview.
-
- C. Accepting Employment**
1. Apply for social security number.
 2. Complete state and federal tax forms.
 3. Accept or reject employment offer.
 4. Complete employee's Withholding Allowance Certificate Form W-4.
-
- D. Communicating on the Job**
1. Communicate orally with others.
 2. Use telephone etiquette.
 3. Interpret the use of body language.
 4. Prepare written communication.
 5. Follow written directions.
 6. Ask questions about tasks.
-
- E. Interpreting the Economics of Work**
1. Identify the role of business in the economic system.
 2. Describe responsibilities of employee.
 3. Describe responsibilities of employer or management.
 4. Investigate opportunities and options for business ownership.
 5. Assess entrepreneurship skills.
-
- F. Maintaining Professionalism**
1. Participate in employment orientation.
 2. Assess business image, products and/or services.
 3. Identify positive behavior.
 4. Identify company dress and appearance standards.
 5. Participate in meetings in a positive and constructive manner.
 6. Identify work-related terminology.
 7. Identify how to treat people with respect.

G. Adapting to and Coping with Change	<ol style="list-style-type: none"> 1. Identify elements of job transition. 2. Formulate transition plan. 3. Identify implementation procedures for a transition plan. 4. Evaluate the transition plan. 5. Exhibit ability to handle stress. 6. Recognize need to change or quit a job. 7. Write a letter of resignation.
H. Solving Problems and Critical Thinking	<ol style="list-style-type: none"> 1. Identify the problem. 2. Clarify purposes and goals. 3. Identify solutions to a problem and their impact. 4. Employ reasoning skills. 5. Evaluate options. 6. Set priorities. 7. Select and implement a solution to a problem. 8. Evaluate results of implemented option. 9. Organize workloads. 10. Assess employer and employee responsibility in solving a problem.
I. Maintaining a Safe and Healthy Work Environment	<ol style="list-style-type: none"> 1. Identify safety and health rules/procedures. 2. Demonstrate the knowledge of equipment in the workplace. 3. Identify conservation and environmental practices and policies. 4. Act during emergencies. 5. Maintain work area. 6. Identify hazardous substances in the workplace.
J. Demonstrating Work Ethics and Behavior	<ol style="list-style-type: none"> 1. Identify established rules, regulations and policies. 2. Practice cost effectiveness. 3. Practice time management. 4. Assume responsibility for decisions and actions. 5. Exhibit pride. 6. Display initiative. 7. Display assertiveness. 8. Demonstrate a willingness to learn. 9. Identify the value of maintaining regular attendance. 10. Apply ethical reasoning.
K. Demonstrating Technological Literacy	<ol style="list-style-type: none"> 1. Demonstrate basic keyboarding skills. 2. Demonstrate basic knowledge of computing. 3. Recognize impact of technological changes on tasks and people.
L. Maintaining Interpersonal Relationships	<ol style="list-style-type: none"> 1. Value individual diversity. 2. Respond to praise or criticism. 3. Provide constructive praise or criticism. 4. Channel and control emotional reactions. 5. Resolve conflicts. 6. Display a positive attitude. 7. Identify and react to sexual intimidation/harassment.
M. Demonstrating Teamwork	<ol style="list-style-type: none"> 1. Identify style of leadership used in teamwork. 2. Match team member skills and group activity. 3. Work with team members. 4. Complete a team task. 5. Evaluate outcomes.

WRITTEN AND ORAL COMMUNICATION		LEVELS		
		1	2	3
READING	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.	•	•	•
WRITING	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. This writing includes the use of coherent paragraphs composed of complete sentences.	•	•	•
SPEAKING	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.	•	•	•
LISTENING	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.	•	•	•

MATHEMATICS		LEVELS		
		1	2	3
ARITHMETIC	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.	•		

Continued

	1	2	3
APPLICATIONS OF GEOMETRY			
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.	•		
GEOMETRY OF SIMPLE ANGLES AND PROFILES OF A LINE			
Applies principles of Euclidean geometry to the production of simple angles and profiles of a line.		•	
GEOMETRY OF COMPOUND ANGLES, PROFILES OF A LINE AND PROFILES OF A SURFACE			
Applies principles of Euclidean geometry to the production of compound angles, profiles of a line and profiles of a surface.			•
COORDINATE AXES, CARTESIAN AND POLAR			
Identifies points on a line, in a plane and in three space using Cartesian and polar coordinates.		•	
APPLICATIONS IN ALGEBRA			
Uses standard formulas and arithmetic operations to make required calculations with or without a calculator. Can solve for an unknown in a trade formula.	•		
APPLICATIONS IN TRIGONOMETRY			
Uses standard formulas and arithmetic operations to make required calculations with or without a calculator, solving for unknowns in right triangles.	•		
TRIGONOMETRY FOR CNC TOOLPATHS			
Applies trigonometry to the solution of geometric position problems for CNC toolpaths. Decomposes position problems to the solution of right and oblique triangles.		•	
APPLICATIONS OF STATISTICS			
Uses standard formulas and arithmetic operations to calculate means, medians, modes and ranges with or without a calculator.	•		
STATISTICS FOR CAPABILITY STUDIES			
Applies statistical tools to the development of statistical process monitoring and control tools.		•	

DECISION MAKING AND PROBLEM SOLVING**LEVELS****APPLYING DECISION RULES**

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

1	2	3
•	•	•

BASIC PROBLEM SOLVING

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.

•	•	•
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SOCIAL SKILLS AND PERSONAL QUALITIES**LEVELS****SOCIAL SKILLS**

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

1	2	3
•	•	•

PERSONAL QUALITIES

Identifies and demonstrates the appropriate personal qualities in performing major job duties and maintaining positive employment relations.

•	•	•
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ENGINEERING DRAWINGS AND SKETCHES**LEVELS****STANDARD ORTHOGRAPHIC BLUEPRINTS**

Interprets orthographic blueprints.

1	2	3
•		

ISOMETRIC AND ORTHOGRAPHIC SKETCHING

Sketches orthographic and isometric projections of parts or details to support nonverbal communication.

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GDT ORTHOGRAPHIC BLUEPRINTS

Interprets GDT orthographic blueprints.

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INTERPRETING ENGINEERING DRAWINGS: GEOMETRIC DIMENSIONING AND TOLERANCING

Reads and interprets GDT drawings with multiple datums.

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INTERPRETING ENGINEERING DRAWINGS: AUXILIARY VIEWS

Reads and interprets engineering drawings having multiple auxiliary views.

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MEASUREMENT	LEVELS		
	1	2	3
BASIC MEASURING INSTRUMENTS			
Recognizes and applies basic measuring instruments such as rules, protractors and basic transfer tools such as simple inside and outside calipers.	•	•	
PRECISION MEASURING INSTRUMENTS			
Recognizes and applies precision measuring instruments such as micrometers; vernier, dial and electronic calipers; dial indicators; and precision transfer tools such as telescoping gages and adjustable parallels.	•		
SURFACE PLATE INSTRUMENTS			
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.	•		
MANUAL COORDINATE MEASURING MACHINES			
Applies the capacities of CMMs to inspection.		•	•

METALWORKING THEORY	LEVELS		
	1	2	3
CUTTING THEORY			
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.	•	•	
TOOLING			
Recognizes a wide variety of cutting tools, tool-holding devices and work-holding devices. Understands the appropriate application of these cutters and devices.	•		
MATERIAL PROPERTIES			
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 imparts to materials.	•		
MACHINE TOOLS			
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.	•		

Continued

METALWORKING THEORY *Continued***LEVELS****EDM: ELECTRODE SELECTION AND DESIGN**

1	2	3
	•	

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

CNC MACHINE TOOLS

1	2	3
	•	

Uses and applies the concepts of how CNC machine tools operate.

CNC TOOLING

1	2	3
	•	

Uses and applies the concepts of tooling with properties customized to the CNC environments of mills and lathes.

CUTTING FLUIDS AND COOLANTS

1	2	3
•		
	•	

Recognizes, selects and applies appropriate coolants and coolant delivery systems.
Identifies and applies the properties of coolants and/or cutting fluids with respect to the tooling, materials, material condition and the machine tool and its delivery systems. Takes the appropriate safety-related measures.

APPLIED MATERIALS**LEVELS****APPLY THE PROPERTIES OF VARIOUS METALS TO CUTTING PROBLEMS**

1	2	3
	•	

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

APPLY THE PROPERTIES OF VARIOUS NON-METALS TO CUTTING PROBLEMS

1	2	3
	•	

Determines appropriate cutting techniques based partially upon cutting properties of a material.

COMPUTERS**LEVELS****TYPING**

1	2	3
	•	

Types a short program.

USE THE BASIC SERVICES OF AN OPERATING SYSTEM

1	2	3
	•	

Formats a diskette. Creates and stores a data file. Retrieves a data file. Changes and resaves a data file.

COMPUTER AIDED MANUFACTURING TECHNOLOGY**LEVELS****COMPUTER-AIDED MANUFACTURING SOFTWARE**

1	2	3
		•

Applies computer-aided manufacturing software to the development of information necessary to manufacture parts.