This document contains 397 competencies, grouped into 58 units, for tech prep programs in the engineering technologies cluster. The competencies were developed through collaboration of Ohio business, industry, and labor representatives and secondary and associate degree educators. The competencies are rated either "essential" (necessary to ensure minimal levels of employability by entry employees; must be included in all new tech prep programs) or "recommended." Competency builders are included for each competency. A matrix relates the units to five occupations within the engineering technologies occupational cluster. Some of the groups of competencies covered in the units include the following: employability skills; professionalism; teamwork; professional practices; workplace safety; project management; problem analysis; general administrative functions; economic and business principles; basic computer concepts and applications; quality assurance; technical recording and reporting; supervision; drafting technology; visualization and design for function; computer-assisted design/drafting technology; electricity; fundamentals of electronics technology; analog circuits; digital logic circuits; microcomputer electronics technology; instrumentation control technology; electro-optic technology; electronics troubleshooting and repair; electronic product servicing technology; industrial electricity; wiring methods; electronic assembly and repair; equipment maintenance; industrial manufacturing; electromechanical technology; hydraulics and pneumatics; computerized numerical control; precision machining; metal stamping dies; press technology; sheet metal fabrication; material joining technology; and welding basics. (KC)
Engineering Technologies

State Competency Profile

May 7, 1998
Columbus, Ohio
Engineering Technologies
State Competency Profile

This document is the result of collaboration between a number of individuals and organizations. The Ohio Department of Education and the Ohio Board of Regents provided financial and staff support for the development of the document. Dr. Richard Bailey, Tech Prep Consultant, drafted key units and edited the initial document upon which the current document is based. Guidance in document development was provided by a futuring panel composed of Ohio Business, Industry and Labor Representatives. (See attached list of Futuring Panel Members.)

The current document is a result of a review by a state-wide panel of business/industry/labor representatives and secondary/associate degree educators on May 7, 1998. (The name and institutional affiliation of each panel member is provided on the following pages.) Jan Eley, Akron Area Tech Prep Consortium, Linda Fauber, Lakeland Tech Prep Consortium, Jennie Royer, Stark Tech Prep Consortium, and Julie Daugherty, Eastern Ohio Valley Tech Prep Consortium served as meeting facilitators.

As you review the document, keep in mind the following:

**Essential Competencies**
Those competencies marked *Essential* in the State Competency Profile were determined by the statewide business/industry/labor panel to be necessary to ensure minimal levels of employability. Entry level employees should be able to perform this competency without supervision; therefore, students must be proficient in these competencies at least by the end of the Associate Degree.

*Essential* competencies must be included in all new Tech Prep programs. Tech Prep consortia with current programs in this area will be expected to phase-in essential competencies into their programs as well.

Wording of essential competencies may not be altered. The leveling may only be changed to deliver the competency earlier during the educational process. For example, the leveling of an essential competency in the State Competency Profile may be altered locally from a P or
Proficiency leveling at the end of the Associate Degree to a P or Proficiency by the end of the 12th grade. The reverse is not permissible. For example, a competency leveled P or Proficient by the end of the 12th grade in the State Competency Profile cannot be changed locally to a P or Proficiency by the end of the Associate Degree. For additional information on leveling of competencies, refer to the Leveling Code Sheet.

Competency builders are intended to help define each competency; therefore, the builders may be modified as long as that modification does not change or dilute the intent of the State Panel.

Issues which arise regarding delivery of the essential competencies once the program is implemented will be addressed by a State review panel of business/industry/labor and education representatives with possible revisions to the State Competency Profile at a later date. Any issues identified during the local verification meeting should be conveyed to Tech Prep Curriculum Services by the meeting facilitator.

**Recommended Competencies**
The competencies marked *Recommended* are suggested additions to the State Competency Profile. Each of these competencies should be reviewed during a local competency profile meeting; with a joint panel of business/industry/labor and education representatives deciding whether to include each competency in the local curriculum. The decision should be based upon a consideration of local business needs, as well as priorities and time constraints of the educational process. Wording and leveling of all recommended competencies and builders may be modified.

**Additional Units/Competencies/Builders**
Competencies and/or builders may be added to any unit in the State Competency Profile. Additional units may also be added.

**Occupation Definitions**
Skills may be added to the occupational definitions based on the modifications made during the competency review. Because the definition is based on the skills detailed in the competency profile, only minor modifications should be necessary.

For additional information about this State Tech Prep Competency Profile contact:

Sara Mazak  
Tech Prep Curriculum Services  
Center on Education and Training for Employment  
The Ohio State University  
1900 Kenny Road  
Columbus, Ohio 43210-1090  
614-292-8404
Engineering Technologies Futuring Panel
April 14, 1998
Columbus, Ohio

Linda Fauber
Panel Facilitator

Blaine Lilly, Assistant Professor
Department of Mechanical Engineering
The Ohio State University
Columbus, Ohio

Keith Rosnell, President
MBS Engineering Solutions
Cincinnati, Ohio

Larry Tracewell
Tracewell Systems
Westerville, Ohio

Per Flem
Performance Plastics
Cincinnati, Ohio
Engineering Technologies
State Competency Profile Meeting

Business, Industry, Labor Panel

Beth Adams, Director, Special Projects, Administration
General Tool Company, Cincinnati, Ohio

Perry Ballinger, Telecommunications Engineer, Electronics
First Energy Corporation/Ohio Edison, Massillon, Ohio

Michael Bentley, Maintenance Supervisor
Merillat Industries, Jackson, Ohio

Steve Combs, Training Coordinator, Electrical Department
Delphi Harrison, Dayton, Ohio

Rick Fath, Facilities Manager, Maintenance
XTek, Inc., Cincinnati, Ohio

Hadley Kline, President
Cuyahoga Plastics, Cleveland, Ohio

Robert C. Mitchell, President
Mitchell Electrical Contracting/RCM Construction, Inc., Steubenville, Ohio

Ruel Mitchell, Vice President
Mitchell Electrical Contracting/RCM Construction, Inc., Steubenville, Ohio

Glenn Myres, Senior Electrical Engineer
Malcolm Pirnie, Inc., Columbus, Ohio

Craig A. Petrella, Training Specialist, Craft & Apprentice Training, H.R.
Weirton Steel Corp., Weirton, West Virginia

Lance Rehberg, Supervisor, Tech. Adm., Drawing Management
Sprint, Mansfield, Ohio

Keith Rosnell, President/CEO
MBS Engineering Solutions, Cincinnati, Ohio

Steven Schmidt, Director, Engineering
APSCO Inc., Perry, Ohio
Bob Sintobin, Lab Tech, Elec/Mech
Toledo Technology Academy/Sears, Toledo, Ohio

Alan Smith, Assistant Engineering Manager
Creative Control Designs, Inc., Reynoldsburg, Ohio

Eugene Stepanik, Training Director, Electrical Department
Cleveland Electrical JATC, Valley View, Ohio

Jeff R. VanZant, QC, CNC Program Purchasing Supervisor, Industrial Manufacturing Tech.
Houston Machine Products, Inc., Springfield, Ohio

Mark Winnett, Director, Order Fulfillment, Plant Operations
DAYCO Products, Inc., Swan Hose Plant, Retail Business Unit, Bucyrus, Ohio
Engineering Technologies
State Competency Profile Meeting

Educator Panel

David Ackerman, Electronics Instructor
Belmont Harrison JVS, St. Clairsville, Ohio

Jan Adams, Coordinator, Tech-Prep Educational Partnerships, Applied Science
Firelands College - BGSU, Huron, Ohio

David Andrews, Vocational Education Teacher
Patterson Career Centers, Dayton Public Schools, Dayton, Ohio

Robert Ballinger, Vocational Electronics Educator
Perry High School, Massillon, Ohio

Patrick Beech, CADD Drafting Instructor, T&I
Madison High School, Mansfield, Ohio

Dave Bittner, Engineering Technology Educator
Lakeland Community College, Kirtland, Ohio

Steve Bowman, Quality Support Leader & Supervisor, T&I
Great Oaks Institute of Technology & Career Development, Cincinnati, Ohio

Tracy Burden, Correlated Math Teacher
Madison High School, Mansfield, Ohio

David Campbell, Electronics Instructor
Northwest Career Center, Cincinnati, Ohio

Wayne Caudill, Math/Science Teacher
Muskingum-Perry Career Center, Mid-East Ohio Vocational School District, Zanesville, Ohio

George Clonch, Manufacturing Educator
University of Rio Grande, Rio Grande, Ohio

Dave Copsey, Electronics Instructor, Career & Technology
Clay High School, Oregon, Ohio

Tom Currie, Chair, Electronic Engineering Technology
Columbus State Community College, Columbus, Ohio
Jim Davis, Associate Professor, EET
Muskingum Technical College, Zanesville, Ohio

Ky Davis, Mathematics Instructor
Muskingum Technical College, Zanesville, Ohio

Tim Dean, Electrical Instructor, T&I
Madison High School, Mansfield, Ohio

David Devier, Dean, Industrial & Engineering Technologies
Owens Community College, Toledo, Ohio

Ray A. DiPilla, Program Chair, Electro-Mechanical Engineering Technology
Cincinnati State Technical & Community College, Cincinnati, Ohio

Matthew Dudas, Electronics Instructor
Muskingum-Perry Career Center, Zanesville, Ohio

Daniel Durfee, Professor, Engineering & Science, Environmental Department
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Michael Dyer, Manufacturing Educator
Buckeye Hills Career Center, Rio Grande, Ohio

Maxine Ewig, Project Director
Toledo Technical Academy, Toledo, Ohio

Sophie Garrity, Science Teacher
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Thurman Grass, EET Coordinator
Lima Technical College, Lima, Ohio

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Auburn Career Center, Concord Township, Ohio

Herbert Hall, Chair, Electronics Technology, EET
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Connie Hilty, Applied Communications/English
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Steve Jefferson, CADD Drafting Instructor
Know County Career Center, Mt. Vernon, Ohio

Doug Kepp, Chair, Computer Integrated Manufacturing
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Jason S. Kernahan, Industrial Arts/Tech Prep Manufacturing Instructor
Buckeye Local High School, Rayland, Ohio

Deb Knigga, Communications Administrator
Firelands College - BGSU, Huron, Ohio

Michael Kouse, Electronics Instructor
Ohio Hi-Point Career Center, Bellefontaine, Ohio

Brian Kelly Kurth, Engineering/Mathematics Instructor
Belmont Technical College, St. Clairsville, Ohio

James Laremore, Curriculum Chair, Engineering Technology, Science & Communications Division
Terra Community College, Fremont, Ohio

Tecca Larrick, Engineering Technology Teacher
Buckeye Career Center, New Philadelphia, Ohio

Debbie Massari, Assistant Professor, Mathematics
Cuyahoga Community College, Parma, Ohio

Kathleen McCabe, English Professor
Terra Community College, Fremont, Ohio

Kerry McClure, Instructor, Architecture/Construction Management
Eastland Vocational Satellite, Gahanna Lincoln High School, Gahanna, Ohio

Jim McIntyre, Engineering Technology Teacher
EHOVE Vocational School, Milan, Ohio

Terry Metz, Associate Professor, Physics/Engineering Technology
Marion Technical College, Marion, Ohio

Donald Moran, Engineering Instructor
Central Ohio Technical College, Newark, Ohio

Robert Morley, Tech Prep Instructor
Jefferson County JVS, Bloomingdale, Ohio
James Mumaw, Teaching/Learning Chair, Electronics Technology, Science & Communications Division
Terra Community College, Fremont, Ohio

Michelle Olecki, English Teacher
Madison High School, Mansfield, Ohio

Richard Patterson, Tech Prep Instructor, Engineering
Trumbull County JVS, Kent State University, Warren, Ohio

Harold Pearson, Professor, Robotics
Sinclair Community College, Dayton, Ohio

Mark D. Pumphrey, Manufacturing Engineering Technology Instructor
Muskingum-Perry Career Center, Mid-East Ohio Vocational School District, Zanesville, Ohio

Ron Quillen, Department Head, Industrial Engineering
Stark State College of Technology, Canton, Ohio

Ritch Ramey, Tech Prep Instructor, Engineering
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John W. Romick, Industrial Manufacturing Coordinator
Belmont Career Center, St. Clairsville, Ohio

Joel Rudinger, Engineering Professor
Firelands College - BGSU, Huron, Ohio

Les Ryle, OWA Teacher/Coordinator
Elgin Local Schools, Marion, Ohio

Brent Sanders, Principles of Technology Teacher, T&I
Madison High School, Mansfield, Ohio

Carmen Santone, Tech Prep Instructor, Engineering
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Mike Smith, Engineering Design Teacher
Hamilton City Schools, Hamilton, Ohio

Brian Sneider, Industrial Technology Teacher
Technology Center, Vanguard-Sentinel JVSD, Fremont, Ohio
Ronald Summers, Senior Teacher, Tech Prep Manufacturing  
Springfield-Clark JVS, Springfield, Ohio

Dale Toukonen, Instructor, Tech Prep Computer Integrated Manufacturing Technology  
Auburn Career Center, Concord Township, Ohio

Robert Walder, Associate Professor, Engineering Technology  
Clark State Community College, Springfield, Ohio

Rudy G. Wojtecki, Assistant Professor, MERT  
Kent State University, Trumbull Campus, Warren, Ohio

Jeff Woodson, Faculty, Mechanical Engineering Technology  
Columbus State Community College, Columbus, Ohio

Alexandria S. Yavelak, Applied Math/English Teacher  
Belmont-Harrison Career Center, St. Clairsville, Ohio

Tom Yeater, Engineering Program Director  
North Central Technical College, Mansfield, Ohio

Don Yetzer, Tech Prep Instructor, Engineering Design, T&I  
Colerain Career Center, Cincinnati, Ohio
LEVELING CODES

GRADE LEVEL
12 = by the end of grade 12
AD = by the end of the Associate Degree

DEPTH
I = Introduce (applies to at least three or 25% of the competency builders)
R = Reinforce or add depth (after introducing or proficiency)
P = Proficient (achievement of the competency without supervision)

ACADEMIC CODES
C = Communications related
M = Mathematics related
S = Science related

OTHER (Determined by Business, Industry and Labor Panel)
Essential Competency: Competency is needed to ensure minimal level of employability. Entry level employees should be able to perform this competency without supervision. Competencies required for certification, licensure, and/or national skills standards should be tagged as essential.
Recommended Competency: Competency should be included but is not essential for minimal level of employability.
Delete: Competency should not be included.

Example:
BIL: Essential Recommended Delete

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Competency: XXXXXXXX

Example:
BIL: Essential Recommended Delete

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Competency: YYYYYYYY
Competency Builders:
SSS
XXX M
Occupational Definitions
Engineering Technologies

Electronics Technician—An individual who combines electrical, electronic, and mechanical functions and their interactions. Technical skills should include, but not be limited to:
- quality control and safety devices
- microcomputer applications in industry
- electronic applications of communication equipment
- teamwork skills
- report preparation

Electrical Maintenance Technician—An individual who applies basic engineering principles and technical skills supporting electrical, electronics, and communication engineers. Technical skills should include, but not be limited to:
- electrical circuitry
- prototype development and testing
- systems analysis and testing
- systems maintenance and repair
- instrument calibration
- teamwork skills
- report preparation

Electromechanical Systems/Electrical Maintenance Technician—An individual who applies electrical theory and related knowledge to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial settings. Technical skills should include, but not be limited to:
- causes of electrical or mechanical malfunction or failure of equipment
- preventative and corrective maintenance
- equipment modification and/or replacement
- mechanical and electrical equipment and systems testing, troubleshooting, repair, and modification
- test data analysis and interpretation
- adjustment, calibration, alignment, and modification of circuitry and components
- teamwork skills
- report preparation
Industrial Manufacturing Technician—An individual who applies basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and/or using manufacturing systems and processes. Technical skills should include, but not be limited to:
- machining skills
- print and schematic interpretation
- geometric dimensioning and tolerancing
- basic CADD skills
- basic electrical skills
- computerized numerical control
- programmable logic controllers
- operational diagnosis, repair, and maintenance procedures
- manufacturing methods specification and implementation
- statistical process control
- teamwork skills
- report preparation

CADD Technician—An individual who applies technical knowledge and skills to plan and prepare computerized pictorial interpretations of plans and design concepts for mechanical devices and machinery. Technical skills should include, but not be limited to:
- print and schematic interpretation
- proficient drafting and CADD/CAM skills
- drawing designs from approved sketches
- drawing designs from blueprints, designs, mockups, and photoprints
- layouts, drawings, and schematics depicting function, relationship, and assembly sequence of parts and assemblies
- teamwork skills
- report preparation
# Engineering Technologies Cluster

**ET** = Electronics Technician  
**EM** = Electromechanical Systems/Electrical Maintenance Technician  
**IM** = Industrial Manufacturing Technician  
**CT** = CADD Technician

<table>
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Unit: **Employability Skills**

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**Competency:** Develop a career plan # *

**Competency Builders:**
- Identify current interests and aptitudes
- Identify common barriers to employment
- Describe strategies to overcome employment barriers
- Locate resources for finding employment
- Research job trends
- Identify career options
- Identify advantages and disadvantages of career options (in addition to monetary)
- Identify job requirements
- Investigate education/training opportunities (including speaking with someone in the trade)
- Identify and evaluate personal strengths and weaknesses
- Refine a written educational plan which leads to a specific career field
- Create career passport
COMPETENCY: Prepare for employment # *

COMPETENCY BUILDERS:
- Identify employment sources
- Identify present and future employment opportunities (by geographic location)
- Research job opportunities
- Compare salary ranges and benefit packages
- Compile occupational profile
- Demonstrate ability to accurately complete a job application
- Demonstrate verbal interpersonal communication
- Design resume and cover letter
- Target resume
- Secure references
- Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
- Use follow-up techniques to enhance employment potential
- Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
- Use proper diction in interviews
- Describe methods for handling illegal questions on job application forms and during interviews
- Write letter of application
- Research prospective employer and services performed
- Explain critical importance of personal appearance, hygiene, and demeanor
- Interpret job description
- Demonstrate appropriate interview question and answer techniques
- Demonstrate methods for handling difficult interview questions using simulated role playing exercises
- Evaluate job offers
- Give appropriate notice to employer of job change
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Identify the importance of participating in extracurricular activities (e.g., student government, community projects)
BIL: Essential

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Competency: Evaluate the importance of self-esteem as an employability skill # *

Competency Builders:
Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem
BIL: Essential

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Competency: Demonstrate job retention skills # *

Competency Builders:
- Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
- Exhibit appropriate work habits and attitude
- Demonstrate ability to set priorities
- Identify behaviors to establish successful working relationships
- Identify appropriate methods for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
- Identify opportunities for advancement
- List reasons for termination
- List consequences of being absent frequently from job
- List consequences of frequently arriving late for work
- Demonstrate interpersonal relations skills (e.g., verbal and written)
- Demonstrate negotiation skills
- Demonstrate teamwork
- Follow chain-of-command
- Exhibit appropriate job dedication
**Competency:** Demonstrate knowledge of work ethic # *

**Competency Builders:**
- Define work ethic
- Identify factors that influence work ethic
- Differentiate law and ethics
- Describe how personal values are reflected in work ethic
- Describe how interactions in the workplace affect personal work ethic
- Describe how life changes affect personal work ethic
**Competency:** Exhibit appropriate work ethic

**Competency Builders:**
- Use time-management techniques
- Avoid personal activity during work hours
- Attend work as scheduled
- Adhere to company and/or governmental policies, procedures, rules, and regulations
- Exercise confidentiality
- Demonstrate appropriate human relations skills
- Adhere to rules of conduct
- Accept constructive criticism
- Offer constructive criticism
- Take pride in work
- Resolve conflict
- Manage stress
- Avoid sexual connotations and harassment
- Adjust to changes in the workplace
- Demonstrate punctuality
- Assume responsibility for personal decisions and actions
- Take responsibility for assignments
- Follow chain-of-command
BIL: Essential

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Competency: Apply decision-making techniques # *

Competency Builders:
Identify decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision
Identify ownership of decision to be made
Identify risks
**BIL:** Essential

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**Competency:** Apply problem-solving techniques #

**Competency Builders:**
- Identify problem
- Select appropriate problem solving tools/techniques
- Identify root problem cause(s)
- Track root problem cause(s)
- Identify possible solutions and their consequences (e.g., long term, short term, crisis)
- Use resources to explore possible solutions to problem
- Contrast advantages and disadvantages of each solution
- Identify appropriate action
- Evaluate results
- Identify post-preventive action
- Document results
BIL: Essential

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Competency: Exhibit characteristics for job advancement

Competency Builders:
- Display positive attitude
- Demonstrate knowledge of position
- Perform quality work
- Adapt to changing situations and technology
- Demonstrate capability/responsibility for different positions
- Identify characteristics of effective leaders
- Identify opportunities for leadership in workplace
- Demonstrate initiative to affect change in workplace
- Participate in continuing education/training program
- Respond appropriately to criticism from employer, supervisor, or other employees
- Exhibit awareness of corporate culture
- Prepare for job setbacks
- Exhibit continual growth based on performance evaluation
- Set realistic goals
Unit: Professionalism

BIL: Essential

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Competency: Project professional image # *

Competency Builders:
Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individual's vital role in organization
Exhibit proper etiquette in professionally-related situations
**BIL:** Essential

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**Competency:** Formulate individual and professional goals # A *

**Competency Builders:**
- Set flexible, realistic, and measurable goals
- Identify potential barriers to achieving goals
- Identify strategies for addressing barriers to goal achievement
- Breakdown long-term goals into short-term goals
- Prioritize goals
- Commit to goals
- Adjust goals
- Obtain support for goals
- Reward goal achievement
**BIL:** Recommended

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**Competency:** Organize personal finances # *

**Competency Builders:**
- Explain need for personal management records
- Balance checkbook
- Identify tax obligations
- Analyze how credit affects financial security
- Compare types and methods of investments
- Compare types and methods of borrowing
- Compare types and methods of insurance
- Compare types of retirement options/plans
- Identify discretionary vs. non-discretionary expenditures
BIL: Essential

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Competency: Support community well-being *

**Competency Builders:**
- Identify environmental, educational, and social issues
- Participate in social and/or community/industry activities
- Participate in industry activities and organization
## Competency: Contribute to organizational goals *

### Competency Builders:
- Evaluate personal goals in relation to organizational goals
- Monitor progress by evaluating feedback
- List responsibilities in relation to organizational goals
- Accomplish assigned tasks
- Exercise responsibility in relation to organizational goals
- Set appropriate personal performance standards
- Communicate goals with supervisor and peers
- Demonstrate knowledge of products and services
- Promote organizational image and mission

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**BIL:** Essential

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**Competency:** Demonstrate positive relations in the workplace # *

**Competency Builders:**
- Identify personality types
- Identify methods of working with various personalities
- Identify various management styles
- Support organization expectations
- Support organization decisions
- Accept constructive criticism
- Give constructive feedback
- Adapt to changes in workplace
- List factors to consider before resigning
- Write letter of resignation
BIL: Recommended

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Competency: Manage stressful situations

**Competency Builders:**
- Accept stress as part of daily life
- Identify personal and professional factors contributing to stress
- Describe physical and emotional responses to stress
- Evaluate positive and negative effects of stress on productivity
- Identify strategies for reducing stress
- Identify positive methods to channel stress
- Implement strategies to manage stress
- Create strategies for developing and maintaining support systems
BIL: Essential

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Competency: Analyze effects of family on work and work on family

Competency Builders:
Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work
BIL: Essential

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Competency: Apply lifelong learning skills # *

Competency Builders:
- Define lifelong learning
- Identify factors that cause need for lifelong learning
- Analyze effects of change
- Identify reasons why goals change
- Describe importance of flexibility and adaptability
- Evaluate need for continuing education/training
BIL: Essential

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Competency: Manage professional development *

Competency Builders:
Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills
Unit: Teamwork

BIL: Essential

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Competency: Demonstrate knowledge of teamwork # *

Competency Builders:
Define self-direction
Define responsibility
Define accountability
Differentiate work groups and teams (e.g., internal, external)
Identify conditions essential to teamwork (e.g., problem solving)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of team members
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system
Define mutual respect
Define equality
Define group dynamics (group think)
Provide feedback
Receive feedback
Define communication styles
Define management styles
Define social style
Define continuous improvement
BIL: Essential

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Competency: Demonstrate teamwork *

Competency Builders:
Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members (e.g., talents, skills, abilities)
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Exhibit continuous improvement
Recognize failure as part of learning
BIL: Essential

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Competency: Use teamwork to solve problems # *

Competency Builders:
- Identify appropriate situations for using teams
- Identify quality management processes/techniques
- Identify quality assurance processes/techniques
- Prepare presentation (e.g., business plan & procedure)
- Identify problem
- Use problem-solving process in a team setting (e.g., Brainstorm, Pareto, Fishbone)
- Identify resources
- Gather data
- Analyze data
- Describe solution options
- Implement solution options
- Review solution
- Review case studies
- Document results
BIL: Essential

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Competency: Conduct team meetings *

Competency Builders:
Plan agenda
Set ground rules (Roberts Rules of Order)
Schedule meeting and location
Set time limitations
Invite appropriate personnel
Set next team meeting
Solicit outside speakers as needed
Select scribe
Select meeting leader
Facilitate ground rules
Select facilitator
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, budget, time frame and accountability to tasks
Monitor time
Overcome team impasse
Close meeting on time
Publish minutes in timely manner
Avoid placing individual agendas above the group's agenda
Unit: Professional Practices

BIL: Essential

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Competency: Explain professional responsibilities *

Competency Builders:
- Explain the need for professional and ethical standards
- Explain responsibility of the individual to apply ethical standards
- Identify responsibility to client(s) and employer(s)
- Explain consequences of unprofessional and/or unethical behavior
- Explain importance of conflict resolution in the workplace
BIL: Essential

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Competency: Identify legal and ethical behavior

Competency Builders:
Differentiate between legal and ethical behavior
Explain terms, principles, and characteristics of legal and ethical behavior (e.g., loyalty, discretion, solicitation, competitor, supplier)
Explain legal ramifications of breaching rules and regulations
Explain effects of unethical and/or unlawful behavior
Practice within scope of the profession
Competency: Function as a self-managed employee

Competency Builders:
Propose project (C)
Organize tasks
Manage time
Meet deadlines
Maintain business records (C)
Make long-term and short-term plans
Evaluate progress
Report progress (C)
Delegate project
Acquire appropriate licenses/registrations
Obtain permits and releases
BIL: Essential

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Competency: Follow intellectual property rights and copyright laws

Competency Builders:
- Explain purpose of patent
- Explain purpose of copyright
- Explain purpose of licenses
- Explain purpose of trademarks
- Explain rights of the originator
- Explain rights of the public
- Define confidentiality
- Define proprietary
- Explain legal ownership of proprietary material
- Describe stock image/text usage rights
- Explain negotiation of contracts
- Explain reproduction licensing and residual usage
Unit: Workplace Safety

BIL: Essential

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Competency: Maintain safe working environment

Competency Builders:
- Describe what an MSDS sheet is
- Comply with HMIS material safety data sheets (MSDS) and OSHA regulations
- Comply with all MSDS regulations regarding hazardous materials
- Maintain clean work area by removing waste, keeping alleyways clear, cleaning tools, and preventing spills
- Minimize workplace causes of environmental burdening, pollutants, and poisoning
- Describe pollution solution limits imposed by permits and regulations
- Comply with regulatory guidelines in handling, labeling, and disposal of solutions (e.g., fountain chemicals, inks, wash-up solutions, drum grounding)
- Identify visual equipment controls (e.g., monitors, read outs)
- Identify auditory equipment controls
- Comply with workplace safety rules and procedures
- Comply with personal safety rules and procedures
- Comply with applicable electrical, mechanical, hydraulic and pneumatic safety rules and procedures
- Recycle appropriate materials
- Use preventive maintenance checklists
- Identify location of control panels, shut-off valves, and fire extinguishers
BIL: Recommended

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Competency: Demonstrate knowledge of ergonomics

**Competency Builders:**
Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle/physical force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (e.g., centering one's view of everything around man) design
Unit: Project Management

BIL: Essential

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Competency: Explain project management *

Competency Builders:
- Identify project purpose/goal
- Identify project objectives
- Identify work breakdown structure (WBS)
- Identify resource requirements
- Identify project economics/funding
- Identify risks
BIL: Recommended

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Competency: Plan projects *

Competency Builders:
- Apply responsibility assignment matrix (RAM)
- Apply Gantt or bar charts
- Apply network diagrams
- Apply critical path method (CPM)
- Apply project education and review techniques (PERT)
- Apply software programs
BIL: Essential

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Competency: Implement projects *

Competency Builders:
Monitor project
Control project
Modify project
BIL: Essential

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Competency: Evaluate projects *

Competency Builders:
Analyze performance
Perform critical review of project
Draw project management conclusions
BIL: Recommended

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Competency: Write project summary *

Competency Builders:
List project goals
Document project’s key successes
Document project’s key failures
Analyze costs vs accomplishments
Unit: Problem Analysis

BIL: Essential

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Competency: Appraise situations #

Competency Builders:
Identify concerns
Set priorities
Identify resolution process
Plan resolution
### Competency: Analyze problems #

**Competency Builders:**
- Identify potential problems
- Identify likely causes
- Test for probable causes
- Verify cause
- Identify preventive actions
- Identify contingent actions

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Competency: Analyze decisions #

Competency Builders:
- Identify objective(s)
- Identify alternatives
- Evaluate alternatives
- Assess risks
- Make final choice
- Determine effectiveness of decision
- Document results
Unit: General Administrative Functions

BIL: Essential

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Competency: Maintain work flow #

Competency Builders:
Organize work
Prioritize work
Apply time-management techniques
Complete assigned tasks in a timely manner
Coordinate with team members
**BIL:** Recommended

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**Competency:** Perform telecommunications operations

**Competency Builders:**
- Display telephone etiquette
- Operate equipment
- Listen assertively
- Verify information
- Record messages
- Place calls
- Organize teleconferences
- Use voice mail/messaging systems
- Operate fax/modem machine
- Use e-mail systems
- Use Internet communications services
- Use videoconference facilities
BIL: Recommended

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Competency: Perform scheduling functions #

Competency Builders:
Create calendar/schedule
Maintain and use appointment calendars with accurate addresses and phone numbers
Process requests for appointments
Verify appointments
**BIL:** Essential

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Competency: Manage records#

**Competency Builders:**
- Implement filing system
- Implement retention system
- Perform electronic filing operations
- Maintain inventory records
- Retrieve files
Unit: Economic and Business Principles

BIL: Essential

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Competency: Describe basic economic concepts # *

Competency Builders:
- Identify importance of economic resources
- Explain concept of economic resources
- Explain importance of economic resources
- Explain concept of economic goods and services
- Differentiate between economic goods and services
- Differentiate between needs and wants
- Explain concept of supply and demand
- Explain concept of price
- Explain how supply, demand, and price are related
- Explain concept of private enterprise and business ownership
- Explain concept of profit
- Explain concept of risk
- Explain concept of competition
- Explain relationship among risk, competition, and profit
- Describe global economic and world markets
- Describe economic cycles (e.g., unemployment, recession, inflation, budget deficits)
- Describe economic arena's effect on business (e.g., financial, competitor indicators, industry)
BIL: Essential

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Competency: Describe economic systems # *

Competency Builders:
- Describe free enterprise system
- Describe relationship between government and business
- Describe relationship between labor and management
- Compare types of economic systems
BIL: Essential

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Competency: Understand income statement data # *

Competency Builders:
Identify revenue
Identify overhead expenses
Identify fixed expenses
Identify direct labor
Identify indirect labor
Identify direct and indirect materials
Identify general and administrative expenses
Identify selling expenses
Identify net income
BIL: Recommended

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Competency: Explain equipment depreciation *

Competency Builders:
- Explain straight line
- Explain sum of year's digits
- Explain declining balance
- Explain IRS strategies
BIL: Essential

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Competency: Identify cost and profit influences *

Competency Builders:
Explain importance of loss prevention
Explain importance of maximizing quality
Explain importance of maximizing productivity
Differentiate between specialized training and cross training
Explain labor, management, and government influences on cost /profit
Explain cost/profit influences of retraining
Define impact of seasonal business cycles
BIL:  Recommended

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Competency: Describe economic indicators and trends # A *

Competency Builders:
- Define gross national product and gross domestic product
- Define national debt
- Define impact of interest rates
- Define impact of government spending
- Define impact of seasonal business cycles
- Define impact of inflation, growth, recession, and unemployment
- Define impact of national and world events
- Define impact of the growth of international trade
**BIL:**  Recommended

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**Competency:**  Explain international trade *

**Competency Builders:**
- Describe nature and importance of international trade
- Explain marketing in international trade
- Explain balance of trade concepts
- Describe impact of foreign investment
- Describe the influence of national debt
- Describe the effect of currency exchange rates on international trade
Competency: Explain basic business concepts *

Competency Builders:
Identify functions of business
Explain role of management
Explain role of labor
Explain concept of service as a product
Explain role of administration
Explain role of operations
Identify role of company objectives
Identify importance of ethical business practices
Identify types of ownership
Identify components of a business plan
Calculate break even and payback
Explain role of depreciation in business decisions
Explain role of capital gains
Describe business reporting and information flow
Map interface of departmental functions
Describe business communication channels (e.g., formal, informal)
Explain basic total quality management (TQM/ISO) principles
Explain the effects of bankruptcy
BIL: Essential

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Competency: Explain legal concepts *

Competency Builders:
Define legal terminology
Explain business law concepts
Identify contracts and/or legal documents
Explain relationship of laws and regulations to company contracts, policies, and procedures
Identify laws relating to working conditions, wages and hours, civil rights, social security, disability, unemployment insurance, and exempt vs. nonexempt
### BIL: Essential

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**Competency:** Explain role of marketing # *

**Competency Builders:**
- Identify aspects of sound business image
- Explain purposes of marketing
- Describe functions of marketing
- Describe effects of marketing
- Identify target markets
- Define sales potential
- Explain pricing strategies
- Differentiate among advertising campaigns
- Explain functions of advertising agencies
- Describe sales incentive programs
- Differentiate among types of marketing strategies (e.g., phone, mail, person)
Unit: Basic Computer Concepts and Applications

BIL: Essential

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Competency: Describe personal computer operations # *

Competency Builders:
- Explain how data is stored in main computer memory
- Explain how computer system executes program instruction
- Explain computer storage capacity
- Explain how data is represented
- Describe data storage devices
- Identify types of memory
- Describe back-up and archival disciplines
BIL: Essential

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Competency: Explain information processing cycle *

Competency Builders:
Describe computer languages and their use (e.g., machine, postscript, proprietary, graphic description)
Describe difference between data files and program files
Explain PC/Mac layout
Explain PC/Mac network layout
Explain mini/mainframe network layout
Differentiate among hardware, software, and firmware
Differentiate between open from proprietary architecture
Explain upload/download
BIL: Recommended

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Competency: Explain operating systems # *

Competency Builders:
Identify operating systems and their attributes (e.g., DOS, Unix, Macintosh, Windows)
Describe compatibility issues
Identify cross-platform file conversion tools
Describe how commands handle tasks in operating systems
Describe various input/output systems
Describe the purpose of operating system utilities
Differentiate between a compiler and an interpreter
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**Competency:** Demonstrate basic computer literacy

**Competency Builders:**
- Create directories/folders and sub-directories
- Format disks
- Manipulate files (copy, rename, delete)
- Keyboard proficiently by touch
BIL: Essential

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Competency: Operate computer hardware # *

Competency Builders:
Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., printers, modems, touch screen, digitizers, plotters, graphic tablets, scanners, film recorders, video, laser image setters)
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques
Maintain usage and maintenance logs
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<th>Competency:</th>
<th>Explain operation of peripheral devices # *</th>
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**Competency Builders:**
- Identify peripherals and operating requirements of each
- Identify primary devices used for personal computer auxiliary storage
- Describe how data is stored on diskettes and hard drives
- List speed and storage capacities of computer auxiliary storage devices
- Describe attributes of diskettes and hard disks regarding speed and storage capacity
- List types of disk storage used with large computer systems
- Define role of tape storage in relation to personal and large computers
- Describe security issues related to peripheral devices
- Explain purpose of input devices (e.g., keyboard, mouse, scanners, pens, bar code readers, credit/debit/smart cards, voice, video, gloves)
- Describe operation of output devices (e.g., voice, speaker output devices, printers, plotters, printer sharing units, SCSI interface, video display)
- Describe operation of multimedia (e.g., video, audiosound)
- Describe operation of storage devices (e.g., tape, disk, CD-ROM)
BIL: Essential

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Competency: Operate peripheral devices # *

Competency Builders:
Use appropriate reference materials
Load media devices
Start media devices
Unload media devices
Import, edit, and export video and audio
Set up print devices
Operate scanner devices
Operate print devices
Maintain print devices
Monitor peripheral equipment operations
Perform routine maintenance on peripheral devices
List appropriate control procedures
Transmit via modem
Receive via modem
Search a CD-ROM library
Print information from a CD-ROM library
Describe device driver
**BIL:** Essential

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**Competency:** Store media # *

**Competency Builders:**
- Identify need for data library
- Retrieve stored media (e.g., on-line, off-line, permanent, off-site)
- File stored media (e.g., on-line, off-line, permanent, off-site)
- Initialize media
- Catalog media
BIL: Essential

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Competency: Explain software applications #*

Competency Builders:
Define software types and functions
Describe need for application software
Describe different types of software applications
Explain advantages and disadvantages of integrated and dedicated software
Differentiate features between like applications
List software sources
Explain software copyright laws
Explain data compression techniques
Explain use of passwords/security
Explain desktop productivity tools
Competency: Use word processing packages # *

Competency Builders:
Define word processing terminology
Explain functions of word processing software
Explain word processing applications
Use appropriate reference materials including on-line help
Keyboard efficiently by touch
Use mouse
Initialize diskette
Prepare backup file
Maintain backup file
Update spelling dictionary and spell check
Perform document functions (e.g., locate, rename, delete, save, retrieve, copy)
Perform formatting functions (e.g., center, underline, bold, cut and paste)
Perform redlining functions
Use edit features
Use sort features
Add page numbers to document
Add headers and footers
Print files, pages, screens and blocks of text
Verify accuracy of output
Create a document
Save a document to disk
Retrieve a document from disk
Edit an existing document
Describe word-wrap
Print a document
Store boilerplate material (e.g., templates, stationary files)
Compose documents at keyboard
Tabulate multiple columns
Prepare new documents from existing ones
Merge selected copy with new information
Prepare various types of table options
Format text
Integrate database, spreadsheet and graphic files
Convert documents from one system/version to another
Demonstrate use of computer thesaurus
Use multimedia techniques/resources
Perform merge functions
BIL: Essential

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Competency: Use spreadsheet packages # *

Competency Builders:
Define spreadsheet
Explain basic spreadsheet terminology
Define components of spreadsheets
Describe implementation of spreadsheet operations in business scope
Use mouse
Use spell check
Execute an electronic spreadsheet
Enter data, formulas, and functions
Differentiate between labels and numbers
Speculate using "what if..." questions
Sequence keystrokes in the creation of a macro
Create database within spreadsheet
Perform data query functions
Move around in spreadsheet and correct errors
Create links to other files
Format spreadsheet
Create graphs
Print graphs
Save previously saved files
Load previously saved files
Replicate cells using copy commands
Use electronic spreadsheet to complete business application
Use spreadsheet to plan financial strategies
Prepare spreadsheet
Use multimedia techniques/resources
**BIL:** Essential

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**Competency:** Use databases # *

**Competency Builders:**
- Define database
- Explain terms used in database systems
- Describe common functions of database systems
- Use database to design, create, input, edit, and display fields and records
- Analyze structure of database files
- Perform calculations with a database file
- Alter structure of database file
- Sort records based on multiple fields
- Identify advanced database technology
- Use appropriate reference materials
- Utilize relational database
- Enter elements into database
- Proofread database
- Explain database
- Design report formats
- Import/export data from alternate file formats
- Transfer data to and from remote database
- Link data to and from remote database
- Print reports using data from multiple databases
- Use database files with other application software
- Verify accuracy of output (e.g., edit reports)
- Query databases
**Competency:** Use graphic user interface (GUI) techniques

**Competency Builders:**
- Describe a variety of computer interfaces
- Explain multi-tasking environment
- Use general navigational skills
- Use cut and paste functions
**BIL:** Essential

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**Competency:** Manage software packages

**Competency Builders:**
- Install software packages
- Upgrade software packages
- Document installation and upgrade of software packages
- Apply security levels/procedures to sensitive data
- Manage software preferences
- Manage software conflicts
- Identify system requirements
- Identify licensing issues
BIL: Essential

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Competency: Maintain computer security requirements # *

Competency Builders:
Apply business ethics
Follow security rules, regulations, and codes
Implement security procedures
Document security procedures
Perform security audits
**BIL:** Essential

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**Competency:** Maintain personal computer systems # *

**Competency Builders:**
- Monitor system status and performance
- Run diagnostics, utilities, and anti virus
- Report computer system malfunction(s)
- Report software malfunction(s)
- Identify corrupted files and recovery procedures
- Maintain security
- Maintain hardware/software inventory
- Perform backup procedure(s)
- Perform preventive maintenance
- Demonstrate file management techniques
- Follow log-off and power-down procedure(s)
- Follow equipment maintenance procedures
- Follow quality control procedures
BIL: Essential

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Competency: Demonstrate basic knowledge of networks # *

Competency Builders:
- Explain communications standards
- Describe network structures
- Explain network types and protocols
- Explain network connectivity
- Explain the function of servers in a graphic network
- Describe various network operating systems
- Explain the difference between network software and individual use software
- Use a network to access, file, and store files
BIL: Essential

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Competency: Use a shared environment 

Competency Builders:
List purposes of a network environment
Define electronic mail
Identify advantages and disadvantages of electronic mail
Describe impact of local & wide area networks on mail delivery
Compose electronic messages
Send electronic messages using appropriate format
List categories of electronic mail service
Transmit document using electronic mail system
Use collaboration tools
Monitor electronic mail
Use networked environments
Search database for properties of materials
Conduct literature searches using a variety of on-line tools
Explain access, security, transmission and retrieval
BIL: Essential

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Competency: Demonstrate knowledge of the Internet/Intranet *

Competency Builders:
Define the Internet/Intranet
Explain how the Internet/Intranet works
Explain Internet/Intranet capabilities and limitations
Explain how to connect to the Internet/Intranet via modem, ISDN, etc.
Install Internet/Intranet software
Navigate the World Wide Web
Identify services and tools offered on the Internet/Intranet
Explain bookmarks
Describe security issues
Describe ethical use of the Internet/Intranet
BIL: Essential

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Competency: Use the Internet/Intranet*

Competency Builders:
Define how the Internet can be used for research
Use services and tools offered on the Internet for research
Identify search engines
Use search engines
Evaluate Internet resources and accuracy of information
Access library catalogs on the Internet
Access commercial and government resources
Download files
Use other Internet/Intranet tools and services
Unit: Quality Assurance

BIL: Essential

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Competency: Demonstrate knowledge of quality assurance

Competency Builders:
Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate between prevention and detection
Differentiate between variable and attribute data
Identify types of control charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)
**BIL:** Essential

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**Competency:** Demonstrate knowledge of quality cost implications

**Competency Builders:**
- Identify cost/quality objectives
- Classify costs (e.g., direct and indirect, fixed and variable, methods and standards)
- Classify quality costs (e.g., prevention, evaluation, pre-delivery failure, post-delivery failure)
- Define product liability
- Interpret quality cost reports
- Explain consumerism and liability prevention
- Define safety terms of product
- Identify safety responsibility within organization
- Define contracts and torts
- Differentiate between expressed and implied warranty
- Differentiate between warranty and product liability
- Explain how warranties are part of contract law
- List questions that would need answering in liability claim
**BIL:** Essential

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**Competency:** Demonstrate knowledge of engineering a quality product

**Competency Builders:**
Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (e.g., preventive, evaluation, pre-delivery failures, post-delivery failures)
Describe predictive maintenance
**BIL:** Essential

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**Competency:** Explain importance of interdepartmental relationships to quality assurance

**Competency Builders:**
- Explain need for everyone's commitment in assuring quality
- Explain phrase "Everyone is a customer/supplier"
- Define quality improvement team models
- Explain the importance of top management's support of quality
- Explain project selection
- Explain project implementation
- Explain project evaluation
- Explain continuing improvement
- Describe future trend of experiment design
- Describe future trend of predictive maintenance
**BIL:** Recommended

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**Competency:** Manipulate quality cost data

**Competency Builders:**
- Develop quality cost data
- Translate cost reports
- Graph quality cost data (e.g., pareto)
**BIL:** Recommended

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**Competency:** Manipulate cost control data

**Competency Builders:**
- Develop cost control data
- Analyze cost control reports
- Provide cost control data
- Provide advice on "Make or Buy" decisions (including economical lot size decisions)
BIL: Essential

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Competency: Demonstrate knowledge of basic statistics

Competency Builders:
- Describe data collection methods
- Collect data
- Organize data by flow chart
- Interpret data by cause and effect diagrams
- Define nominal, ordinal, interval, and ratio data
- Define mean, median, and mode
- Explain significance of standard deviation
- Explain normal distribution
BIL: Recommended

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Competency: Demonstrate knowledge of scattergrams

Competency Builders:
Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis
BIL: Recommended

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Competency: Demonstrate knowledge of probability theory

Competency Builders:
Define classical probability
Define empirical probability
Calculate probability for outcomes
### BIL: Recommended

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**Competency:** Demonstrate knowledge of precontrol

**Competency Builders:**
- Explain uses of precontrol
- Calculate precontrol limits
- Explain significance of the limits
- Plot values on a precontrol chart
- Explain "out-of-control" situation
- Make decisions on green, yellow and red conditions
BIL:  Recommended

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Competency:  Demonstrate knowledge of process capability

Competency Builders:
Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate $C_{pk}$ values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution
BIL: Recommended

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Competency: Use quality control charts

Competency Builders:
- Identify operational definitions for attribute criteria
- Interpret histogram
- Interpret scattergrams
- Interpret NP chart
- Interpret P chart
- Interpret flowchart
- Interpret cause-and-effect diagram
- Construct P (percentage defective) chart for attributes
- Plot control limits of P chart and data points
- Check chart for out-of-control conditions
- Construct an NP (number defective) chart with control limits and data
- Construct C (count of defects) and U (number of defects per unit) charts
- Check data on C and U charts
- Construct flowchart
- Construct cause-and-effect chart
Recommended

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Competency: Interpret X and R charts

Competency Builders:
Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on X or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens
BIL: Recommended

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Competency: Construct X and R charts

Competency Builders:
- Arrange data into statistical sub-groups
- Explain importance of random sampling
- Compute X (e.g., average of values) and R (e.g., range of values in subgroup) within sample
- Plot in X and R on chart
- Construct control chart with X (grand average) and R (average range) calculated
- Calculate upper and lower control limits for X-chart
- Calculate upper and lower control limits for R-chart
BIL: Recommended

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Competency: Conduct process improvement studies

Competency Builders:
Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, $C_{pk}$)
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system
BIL:  Recommended

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Competency:  Demonstrate knowledge of JIT

Competency Builders:
Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification, and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems, and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)
Competency:  Apply JIT

Competency Builders:
Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions
BIL: Recommended

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Competency: Demonstrate knowledge of inspection

Competency Builders:
- Explain purpose of inspection
- Describe scope of inspection
- Explain purpose of incoming, ongoing, and final inspections
- Explain early detection inspection
- Explain how statistical process control (SPC) aids inspection
- Define types of nonconformance
- Define degrees of nonconformance
- Define corrective action
- Describe when to 100% inspect
- Describe when to sample inspect
- Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
- Define rework, salvage, and scrap
- Describe ethical decisions an inspector may make
- Identify purposes of computer-automated inspection
- Explain advantages and limitations of automated inspection
- Explain disposition of non-conforming material
- Explain basic foolproofing concept to build inspection into process (e.g., poka-yoke)
- Use checksheets to organize and record inspection results
BIL:  Recommended

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Competency:  Inspect machinery, materials, and products

Competency Builders:
Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = 0 (zero) acceptance plan
Interpret instructions in a control plan
BIL: Recommended

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Competency: Demonstrate knowledge of nondestructive testing

Competency Builders:
- Describe purpose of nondestructive testing
- Identify anomalies
- Define defects and discontinuities
- Identify factors contributing to defects and discontinuities
- Describe ultrasonic testing
- Describe advantages and limitations of ultrasonic testing
- Describe industrial radiography
- Compare use of wet and dry particles in magnetic particle inspection
- Explain advantages and limitations of penetrant inspection
- Describe microwave testing
- Describe holographic inspection
- Explain choice of most suitable nondestructive test method
- Describe eddy-current testing
Unit: Quality Assurance for IM

BIL: Essential

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Competency: Demonstrate knowledge of quality assurance

Competency Builders:
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain importance of internal and external customers
Differentiate between prevention and detection
Differentiate between variable and attribute data
Identify types of control charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)
Define cost of quality
Competency: Demonstrate knowledge of engineering a quality product

Competency Builders:
Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (e.g., preventive, evaluation, pre-delivery failures, post-delivery failures)
Describe predictive maintenance
BIL: Essential

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Competency: Demonstrate knowledge of basic statistics

Competency Builders:
Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution
Identify sampling techniques
**BIL:** Essential

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**Competency:** Demonstrate knowledge of scattergrams

**Competency Builders:**
- Construct scattergram
- Interpret for positive, negative, or no correlation between X and Y variables
- Test for significance between one and five percent
- Explain regression analysis
BIL: Recommended

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Competency: Demonstrate knowledge of precontrol

**Competency Builders:**
- Explain uses of precontrol
- Calculate precontrol limits
- Explain significance of the limits
- Plot values on a precontrol chart
- Explain "out-of-control" situation
- Make decisions on green, yellow and red conditions
BIL: Essential

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Competency: Demonstrate knowledge of process capability

Competency Builders:
Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate $C_{pk}$ values that describe process capability and CP
Describe skewed distributions
List probable causes of skewed distribution
BIL: Recommended

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Competency: Use quality control charts

Competency Builders:
- Identify operational definitions for attribute criteria
- Interpret histogram
- Interpret scattergrams
- Interpret NP chart
- Interpret P chart
- Interpret flowchart
- Interpret cause-and-effect diagram
- Construct P (percentage defective) chart for attributes
- Plot control limits of P chart and data points
- Check chart for out-of-control conditions
- Construct an NP (number defective) chart with control limits and data
- Construct C (count of defects) and U (number of defects per unit) charts
- Check data on C and U charts
- Construct flowchart
- Construct cause-and-effect chart
BIL: Recommended

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Competency: Interpret X and R charts

Competency Builders:
Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on X or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens
BIL: Recommended

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Competency: Construct X and R charts

Competency Builders:
- Arrange data into statistical sub-groups
- Explain importance of random sampling
- Compute $X$ (e.g., average of values) and $R$ (e.g., range of values in subgroup) within sample
- Plot in $X$ and $R$ on chart
- Construct control chart with $X$ (grand average) and $R$ (average range) calculated
- Calculate upper and lower control limits for $X$-chart
- Calculate upper and lower control limits for $R$-chart
- Identify various sampling plans and their use
BIL:  Recommended

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Competency: Conduct process improvement studies

Competency Builders:
Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, $C_{pk}$)
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system
Competency: Demonstrate knowledge of JIT

Competency Builders:
Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification, and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems, and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)
**BIL:** Essential

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**Competency:** Apply JIT

**Competency Builders:**
- Maintain system for physical handling and movement of material in-process and in-storage
- Monitor system of physical handling and movement of material in-process and in-storage
- Maintain system for physical handling and movement of finished products
- Monitor system of physical handling and movement of finished products
BIL: Essential

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Competency: Demonstrate knowledge of inspection

Competency Builders:
- Explain purpose of inspection
- Describe scope of inspection
- Explain purpose of incoming, ongoing, and final inspections
- Explain early detection inspection
- Explain how statistical process control (SPC) aids inspection
- Define types of nonconformance
- Define degrees of nonconformance
- Define corrective action
- Describe when to 100% inspect
- Describe when to sample inspect
- Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
- Define rework, salvage, and scrap
- Describe ethical decisions an inspector may make
- Identify purposes of computer-automated inspection
- Explain advantages and limitations of automated inspection
- Explain disposition of non-conforming material
- Explain basic foolproofing concept to build inspection into process (e.g., poka-yoke)
- Use checksheets to organize and record inspection results
BIL: Essential

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Competency: Inspect machinery, materials, and products

Competency Builders:
- Identify critical material characteristics from specification(s) or drawing(s)
- Perform capability studies for machinery and materials acceptance
- Identify appropriate acceptance sampling plan
- Conduct incoming materials inspection using sampling plan criteria
- Identify critical in-process characteristics from specification(s) or drawing(s)
- Demonstrate basic metrology skills
- Conduct in-process inspection
- Identify appropriate inspection reports and follow-up
- Gauge R and R (repeatability and reproducibility)
- Apply geometric tolerancing
- Interpret instructions in a control plan
**BIL:** Essential

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**Competency:** Demonstrate knowledge of nondestructive testing

**Competency Builders:**
- Describe purpose of nondestructive testing
- Identify anomalies
- Define defects and discontinuities
- Identify factors contributing to defects and discontinuities
- Describe ultrasonic testing
- Describe advantages and limitations of ultrasonic testing
- Describe industrial radiography
- Compare use of wet and dry particles in magnetic particle inspection
- Explain advantages and limitations of penetrant inspection
- Describe microwave testing
- Describe holographic inspection
- Explain choice of most suitable nondestructive test method
- Describe eddy-current testing
Unit: Technical Recording and Reporting

BIL: Essential

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Competency: Demonstrate proficiency in technical recording

Competency Builders:
- Describe various documentation procedures
- Interpret specifications or drawings
- Observe process
- Ask open-ended questions
- Record process (e.g., flowchart, step-by-step)
- Identify parameters
- Record accurate, truthful data
- Maintain test logs
- Compile cumulative reference notebook/record
- Measure appropriate parameters
- Draft preventive maintenance and calibration procedures
**BIL:** Essential

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**Competency:** Demonstrate proficiency in technical reporting

**Competency Builders:**
- Use data books and cross reference/technical manuals
- Compose technical memoranda
- Identify type of report or format needed
- Use appropriate format
- Compile relevant data
- Design charts and graphs
- Analyze data
- Draw conclusions
- Explain analytical methods used
- Outline reports
- Write reports
- Present reports
Unit: Supervision

BIL: Recommended

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Competency: Perform supervisory functions

Competency Builders:
- Define supervision
- Conduct task analysis
- Create organizational and/or departmental charts
- Apply company policies and procedures
- Maintain workplace procedures manuals
- Prepare budgets
- Monitor budgets
- Prepare managerial reports
- Analyze daily production reports
- Identify human resources needed
- Maintain appropriate work environment
- Conduct tours
- Facilitate assignments
- Assign work
- Delegate job tasks
- Monitor progress
- Prepare productivity reports
- Provide training for new policies
- Troubleshoot workplace problems
- Coordinate workplace activities
- Appraise performance
- Document personnel issues
- Coordinate administrative duties
Recommended

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**Competency: Coordinate training**

**Competency Builders:**
- Assess training needs
- Secure training resources, materials and equipment
- Train employees
- Evaluate progress of trainee
- Provide feedback
- Solicit feedback
- Receive feedback
- Assess feedback
- Monitor safety procedures
- Interpret labor contracts
- Document training
Unit: Drafting Technology for IM and CT


BIL: Essential

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Competency: Apply basic drafting skills

Competency Builders:
Use drafting equipment
Identify line types (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control/revision block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare working drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements
Identify current ANSI symbols/standards
BIL: Essential

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Competency: Apply intermediate drafting skills

Competency Builders:
Describe types of media and prints
Apply isometric, oblique, and perspective sketching techniques
Prepare isometric, oblique, and perspective sketches
Prepare sectional views
Prepare auxiliary views
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Describe purpose of auxiliary and sectional views
Dimension drawings per current ANSI standards
**BIL:** Essential

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**Competency:** Apply advanced drafting skills

**Competency Builders:**
- Interpret reports and specifications
- Prepare pictorial drawings
- Prepare schematics
- Interpret various drawings
**BIL:** Essential

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**Competency:** Interpret basic prints

**Competency Builders:**
- Visualize object from drawing
- Interpret orthographic projections
- Interpret isometric views
- Interpret sectional views
- Interpret detail and assembly drawings
- Interpret dimensions
- Interpret tolerances
**BIL:** Essential

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**Competency:** Interpret advanced prints

**Competency Builders:**
- Interpret screw thread specifications
- Identify structural steel shapes
- Interpret special symbols
- Interpret electrical, pneumatic/hydraulic drawings
- Interpret schematics
Competency: Demonstrate knowledge of basic geometric dimensioning and tolerancing

Competency Builders:
Identify geometric characteristics and symbols (e.g., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts
Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols
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**Competency:** Convert dimensions and tolerances

**Competency Builders:**
- Convert dimensions and tolerances from English units to metric units
- Convert dimensions and tolerances from metric units to English units
BIL: Essential

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Competency: Apply revision control process

Competency Builders:
- Apply drawing balloons
- Apply documentation (including project filing, back-up material, tracking process)
- Apply change control block
- Apply revision levels
BIL: Essential

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Competency: Demonstrate dimensioning techniques

Competency Builders:
Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system
Competency: Apply geometric dimensioning and tolerancing

Competency Builders:
- Interpret decimal tolerance dimensions
- Calculate clearance fit tolerances of mating parts
- Dimension clearance fit tolerances of mating parts
- Calculate interference fit tolerances of mating parts
- Dimension interference fit tolerances of mating parts
- Calculate tolerances to mating parts using standard fit tables
- Assign tolerances to mating parts using standard fit tables
- Apply positional and form tolerancing symbols
- Apply symbols for true position
- Interpret geometric dimensioning and tolerancing characteristic symbols
- Interpret geometric dimensioning and tolerancing supplementary symbols
- Apply symbols for maximum material control regardless of feature size
- Calculate effects of dimensional stack-up
- Calculate transitional fit tolerances
- Dimension transitional fit tolerances
BIL: Essential

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Competency: Prepare mechanical drawings

Competency Builders:
- Interpret basic mechanical standards and symbols
- Prepare assembly drawings
- Prepare welding drawings
- Prepare bearing drawings
- Prepare casting drawings
- Prepare forging drawings
- Prepare tool drawings
- Prepare molding diagrams
- Prepare drawings with special processed holes
- Prepare stamping drawings
- Prepare numerical control drawings/instructions
- Prepare installation drawings
- Prepare purchase part drawings
- Prepare approval drawings
BIL: Essential

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Competency: Prepare advanced mechanical drawings

Competency Builders:
Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings
Unit: Drafting Technology for ET and EM


BIL: Essential

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Competency: Apply basic drafting skills

Competency Builders:
Use drafting equipment, measuring scales, drawing media, drafting instruments and materials, print duplicating equipment
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block/revision block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements
**BIL:** Essential

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**Competency:** Interpret basic prints

**Competency Builders:**
- Visualize object from drawing
- Interpret orthographic projections
- Interpret isometric views
- Interpret sectional views
- Interpret detail and assembly drawings
- Interpret dimensions
- Interpret tolerances
BIL: Essential

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Competency: Interpret intermediate prints

Competency Builders:
Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics
BIL: Recommended

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Competency: Convert dimensions and tolerances

Competency Builders:
Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units
Competency: Demonstrate dimensioning techniques

Competency Builders:
Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system
Interpret decimal tolerance dimensions
Calculate effects of dimensional stack-up
Competency Builders:
Identify through examination the function of parts related to an automobile
Identify through examination the function of parts related to machine tools
Identify through examination the function of parts related to personal computers
Explain how function is related to part properties (e.g., geometry, material, finish)
Competency: Design/prepare computer model objects for function

Competency Builders:
Develop an alternative design for an existing automobile part
Develop an alternative design for an existing machine tool part
Develop an alternative design for an existing computer part
Prepare a computer model of a house, warehouse, or other building
Prepare a computer model of a manufacturing process
Unit: CADD Fundamentals

BIL: Essential

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Competency: Demonstrate basic use of computer operating system

Competency Builders:
Explain rules for naming files and directories
Manage files
Create directories/subdirectories
Remove directories/subdirectories
Change directories/subdirectories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands
Competency: Operate a CADD system

Competency Builders:
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer, mouse)
Create scaled plots
Operate a printer/plotter (e.g., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer
**BIL:** Essential

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**Competency:** Select entities for action

**Competency Builders:**
- Add or remove entities separately
- Add or remove entities using a window
- Add or remove entities with a crossing-box
- Select entities using a fence
- Select entities by other methods (e.g., last, previous, type, all)
BIL: Essential

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Competency: Create 2-D orthographic drawings

Competency Builders:
Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror)
Edit drawing entities (e.g., offset, trim, extend, break, mirror)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks
BIL: Essential

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Competency: Annotate orthographic drawings

**Competency Builders:**
- Create text styles
- Edit text styles
- Select text styles
- Apply notes
BIL: Essential

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Competency: Dimension orthographic drawings

Competency Builders:
- Apply dimensions per standards
- Edit text
- Control dimension variables/models
Competency: Control display

Competency Builders:
Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views
**BIL:** Essential

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**Competency:** Extract entity and drawing information

**Competency Builders:**
Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties)
Unit: Intermediate CADD


BIL: Essential

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Competency: Manage symbols and attributes

Competency Builders:
Create blocks/cells/templates
Create nested blocks/templates/cells
Insert blocks and drawings/templates/cells
Redefine blocks/templates/cells
Edit blocks/templates/cells
Create/apply/modify attributes
BIL: Essential

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Competency: Create 2-D isometric drawings

Competency Builders:
- Explain isometric projection
- Manipulate isometric snap and grid settings
- Toggle isometric planes (e.g., left, right, top)
- Create text styles for each plane
- Create dimension styles
- Create isometric ellipses
**BIL:** Essential

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**Competency:** Use external/internal routines

**Competency Builders:**
- Load AutoLISP programs
- Execute AutoLISP programs
- Export CAD files
- Import CAD files
- Export text/graphic files
- Import text/graphic files
Unit: Advanced CADD


BIL: Essential

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Competency: Create 3-D solid models

Competency Builders:
Differentiate B-rep solid modeling and Constructive Solid Geometry (CSG) modeling
Create solid primitives
Modify solid primitives
Create swept solids
Use Boolean operations to create complex solids (e.g., unions, subtractions, intersections, separations)
Fillet solid models
Chamfer solid models
Extract mass properties from a solid model
Create 2-D profiles and sections from a solid model
Explain the limitations of solid modeling
List intersection properties
BIL: Essential

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Competency: Apply advanced display control

Competency Builders:
Use clipping planes to section a model
Apply perspective views
Place camera and target points to locate views
Place lights for rendering
Control lights for rendering
Create rendered images of surface and solid models
Define camera viewpoints and angle of rotation
Control display angle (e.g., d-view, v-point)
BIL:  Recommended

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Competency:  Write CADD sub-routines

Competency Builders:
Perform simple math functions
Perform nested math functions
Write a routine which prompts for user input, performs calculations, and creates or edits geometry
Identify common error codes
Format a program to display balanced parentheses and nesting of functions
Write a program including an "if/then/else" statement
**BIL:** Essential

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**Competency:** Configure a CADD station

**Competency Builders:**
- Install CADD software
- Configure display drivers
- Configure printer/plotter drivers
- Configure input drivers
BIL: Essential

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Competency: Prepare electrical/electronic CADD drawings

Competency Builders:
- Interpret basic electric/electronic standards and symbols
- Prepare schematic drawings
- Prepare cable drawings
- Prepare component drawings
- Prepare logic diagrams
- Prepare control panel drawings
- Prepare connection drawings
- Prepare interconnection drawings
- Prepare printed circuit board drawings
- Prepare harness drawings
- Prepare packaged drawings
- Prepare wiring diagrams
- Prepare enclosure drawings
- Prepare installation drawings
- Prepare flow charts
- Prepare symbol library
BIL: Essential

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Competency: Prepare pneumatic/hydraulic CADD drawings

Competency Builders:
- Interpret basic pneumatic/hydraulic standards and symbols
- Prepare piping drawings
- Prepare isometric drawings
- Prepare sectional diagrams
- Prepare graphical symbols
- Prepare process and instrumentation diagrams
- Prepare combination diagrams
- Prepare pump and motor drawings
- Prepare cylinder and piston diagrams
- Prepare valve drawings
- Prepare pump section drawings
- Prepare installation drawings
- Prepare symbol library
BIL: Essential

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Competency: Prepare structural CADD drawings

Competency Builders:
Use structural and reinforcing concrete manuals and technical tables
Detail structural beam connections
Detail concrete reinforcements
Prepare materials take off list
Draw structural framing plans and elevations
Identify welding symbols
Prepare symbol library
**BIL:** Recommended

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**Competency:** Create custom menus and linetypes

**Competency Builders:**
- Demonstrate search routines when using a text editor
- Write screen menus and macros
- Write tablet menus and macros
- Write cascading pop-down menus and macros
- Write icon menus and macros
- Write button menus and macros
- Write other customizable CADD files (e.g., ACADD.PCP)
- Edit other customizable CADD files (e.g., ACADD.PCP)
- Formulate custom linetype
- Formulate a linetype composed of long dashes
- Formulate a linetype composed of lines, dashes, and dots
Competency: Create 3-D models

Competency Builders:
Differentiate between extrusions, wireframes, surface models, and solid models
Create user coordinate systems
Manipulate user coordinate systems
Use cylindrical coordinates
Use spherical coordinates
Use .XYZ filters
Project geometry from one plane to another
Define B-rep surfaces
Differentiate B-rep surfaces and non-uniform rational B-splines (NURB's)
Create tabulated surfaces
Create ruled surfaces
Create revolved surfaces
Create edge surfaces (e.g., coon's patch)
Apply surface meshes to 3-D wireframes
Modify visibility of the edges of faces
Dimension a 3-D model for both isometric and orthographic drawings
Control dimension scale with regard to plotting scale
Unit:  Basic Electricity
The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by Electronic Industries Association and the Electronics Industries Foundation. Source: Raising the Standard: Electronics Technician Skills for Today and Tomorrow. June 1994.

**BIL:** Essential

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**Competency:** Demonstrate proficiency in electrical fundamentals

**Competency Builders:**
Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple and Peltier effects
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchhoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Demonstrate electrostatic discharge (ESD) preventative procedures
Competency: Demonstrate proficiency in DC circuits

Competency Builders:
Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Operate power supplies for DC circuits
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principles of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits
Competency: Demonstrate proficiency in AC circuits

Competency Builders:
Analyze properties of an AC signal
Describe principles and operational characteristics of sinusoidal and non-
sinusoidal wave forms
Identify AC sources
Describe principles and operational characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operational characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use Thévenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operational characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings, and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operational characteristics of frequency selective filter circuits
Calculate gain (dB) using logarithmic tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning systems (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (f) and phase relationships
Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Explain simple AC generator action
Explain simple AC motor action
Calculate Power Factor in AC circuits
Explain Power Factor correction in reactive loads
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits
Unit: Fundamentals of Electronics Technology
The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: Raising the Standard: Electronics Technician Skills for Today and Tomorrow. June 1994.

BIL: Essential

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Competency: Demonstrate proficiency in discrete solid-state devices

Competency Builders:
Describe properties of semiconductor materials
Describe operating characteristics and applications of PN junctions
Demonstrate operation of diode circuits
Troubleshoot diode circuits
Repair diode circuits
Describe operating characteristics and applications of bipolar transistors
Describe operating characteristics and applications of field effect transistors (e.g., FET + s/MOSFET + s)
Describe operating characteristics and application of special diodes/transistors
Describe operating characteristics and applications of opto-electronic devices (e.g., gate isolators, interrupt sensors, infrared sensors)
Describe operating characteristics and applications of single-stage amplifiers
 Demonstrate the operation of the single-stage amplifiers
Troubleshoot single-stage amplifiers
Repair single-stage amplifiers
Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC)
Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC)
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate curve tracers
Operate transistor testers
BIL: Recommended

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Competency: Describe manufacturing of electronic devices and micromechanisms

Competency Builders:
List properties of electronic packaging materials
Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits
Describe joining and assembly of electronic components
Describe coating and etching processes
List principles of packaging electronic components
Describe manufacture of miniature devices
Describe testing of joints
Describe reliability of electronic product testing
Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)
Describe methods of fabrication
Competency: Distinguish between analog and digital phenomena and circuits

Competency Builders:
Describe the analog and digital measurement techniques of physical parameters (e.g., temperature, time, current, number of items coming down a production line)
Distinguish between an analog and a digital clock
Describe the instruments used to measure analog signals
Describe the instruments used to measure analog digital signals
Describe how an analog signal can be converted to a digital signal
Describe how a digital signal can be converted to an analog signal
Unit: **Electronic Noise**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:** Essential

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**Competency:** Identify sources of electronic noise

**Competency Builders:**
- Define and explain intrinsic noise sources
- Define and explain active and passive device noise
- Explain conductively coupled noise
- Explain common impedance noise coupling
- Explain noise coupling by electric and magnetic fields
Competency: Explain how to measure electronic noise

Competency Builders:
- Explain the use of "The Decibel" in noise characterization
- Explain the standard "Noise Units" and weighing functions
- Explain signal to noise ratios
**BIL:** Essential

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**Competency:** Explain techniques used to reduce electronic noise

**Competency Builders:**
- Explain noise reduction at the source
- Explain noise coupling reduction
- Explain noise reduction at the "Receiver"
- Explain grounding techniques
- Explain shielding techniques
- Explain opto-electric isolation
Unit: Analog Circuits
The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:** Essential

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Competency: Explain linear power supply regulator circuits

**Competency Builders:**
- Explain the need for voltage and current regulation
- Explain how a fast linear regulator can reduce ripple
- Define the output impedance of both an ideal and a practical voltage regulator
- Define the output impedance of both an ideal and a practical current regulator
- Explain how the linear voltage regulator can be made adjustable
Competency: Describe linear power amplifiers

Competency Builders:
Define a linear amplifier
Explain the use and operation of D.C. servo motor drivers
Explain the use and operation of audio power amplifiers
Explain what is meant by the bandwidth of power amplifiers
Explain the transient response of power amplifiers
Explain phase distortion in power amplifiers
### Competency: Describe operational amplifiers

#### Competency Builders:
- Explain the significance of high open circuit gain
- Explain the significance and characteristics of the summing junction
- Explain offset and its adjustment
- Explain the significance of differential inputs
- Explain the unity gain buffer and line driver
- Explain the analog voltage adder/subtractor
- Describe/implement a current amplifier
- Describe/implement a charge amplifier
- Describe/implement an integrator
- Define integrator "wind up"
- Explain why "reset" is necessary in an integrator
- Describe/implement a differentiator
- Describe/implement a single pole low pass filter
- Prepare a Bode plot for a single pole low pass filter
Competency: Describe instrumentation amplifiers

Competency Builders:
Explain how an instrumentation amplifier differs from a simple operational amplifier
Describe the signal types, levels, and environments that require instrumentation amplifiers for signal processing
Explain the significance of balanced input impedance
Demonstrate how an instrumentation amplifier can be constructed from operational amplifiers
Describe the characteristics of the resistors needed to make an instrumentation amplifier from an operational amplifier
BIL: Essential

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Competency: Describe analog active filters

Competency Builders:
Describe need and uses of electronic active filters
Describe a single pole low pass filter
Describe a single pole high pass filter
Describe a band pass filter
Describe multi-pole low pass filters
Unit: Digital Logic Circuits

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: Raising the Standard: Electronics Technician Skills for Today and Tomorrow. June 1994.

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Competency: Use binary arithmetic

Competency Builders:
Identify features of positional numbering systems
Identify mathematical forms of notation
Perform number system conversions (e.g., binary to decimal, octal to binary)
Perform binary mathematical operations (e.g., addition, subtraction)
Use coded systems (e.g., BCD-Binary Coded Decimal)
Demonstrate binary code for decimal numerals 0-9
**BIL:** Essential

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**Competency:** Use Boolean algebra

**Competency Builders:**
- Explain basic functions of Boolean algebra
- Identify signal levels that represent Boolean algebra
- Perform Boolean operations
- Write Boolean theorems
- Draw light switching schematic circuits for OR, AND, NOT and exclusive OR
- Draw logic diagrams for OR, AND, NOT, exclusive OR
- Draw truth tables for OR, AND, NOT, and exclusive OR
BIL: Essential

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Competency: Explain digital logic elements

Competency Builders:
Differentiate between types of digital logic families
Describe digital logic gates, AND, OR, NOT
Describe R-S (Reset-Set) flip-flops
Describe J-K clocked flip-flops
Describe shift registers
Describe encoders and decoders
Describe the binary full adder
**BIL:** Essential

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**Competency:** Explain digital logic and pulse circuits

**Competency Builders:**
- Implement the exclusive OR circuit using AND, OR, and NOT gates
- Describe digital counters
- Describe digital clocks and timers
- Describe the schmidt trigger
- Describe the monostable (single shot) multivibrator
- Describe the astable (free running) multivibrator
Unit: Microcomputer Electronics Technology
The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: Raising the Standard: Electronics Technician Skills for Today and Tomorrow. June 1994.

**BIL:** Essential

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**Competency:** Demonstrate basic proficiency in microcomputer systems

**Competency Builders:**
- Describe essential components of microcomputers and their functions
- Describe principles and operation of BUS concepts (e.g., VESA, EISA)
- Describe principles and operation of types of memory circuits
- Identify operating systems (e.g., DOS, OS/2, UNIX)
- Describe microprocessor instructions sets
- Describe principles and operation of microprocessor machine code
- Demonstrate use of microprocessor machine code
- Disassemble microprocessor machine code
- Identify types of input and output devices and peripherals
- Describe principles and operation of storage devices
- Interface input and output ports to peripherals
- Demonstrate ability to interface peripherals
- Identify central processing unit building blocks and their uses
- Identify the levels of computer languages
BIL: Essential

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Competency: Demonstrate basic proficiency in computer systems architecture

Competency Builders:
Describe the principles and operation of computer system architecture
Operate computer system architecture
Repair computer system architecture
Describe the principles and operation of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Repair or replace volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Define individual system blocks
Draw systems configuration in block detail
Interpret computer acronyms
Describe priorities and interrupts at systems level
Identify direct memory access data handling system(s)
Define functions of advanced memory techniques (e.g., virtual, pipeline, cache)
Troubleshoot a microcomputer system
BIL:  Essential

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Competency:  Demonstrate proficiency in software fundamentals

Competency Builders:
Load operating system software
Run operating system software
Load diagnostic software
Run diagnostic software
Construct flow charts
Analyze flow charts
Explain computer languages and their uses
Write a simple computer program
Write program documentation
Describe firmware applications
Identify the need for backup
Describe security measures
Describe virus protection
BIL: Essential

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Competency: Describe elements of communication interfacing

Competency Builders:
Define common EIA, IEEE, and CCITT communication standards (e.g., EIA 232 and 485, IEEE 488)
Identify sync devices
Identify async devices
Identify types of network (e.g., token ring, ethernet)
Identify networking levels or layers
Identify protocols
Identify packet switching
Identify multiuser systems
Operate network analyze devices
Identify network analyzer devices (e.g., breakout box, sniffers)
BIL: Recommended

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Competency: Describe peripheral equipment interfaces

Competency Builders:
Define printer types and interface controllers
Explain the operation of typical magnetic tape equipment and interface controllers
Identify disk equipment and interface controllers
Define environmental requirements for peripherals and media
Unit: Instrumentation Control Technology

BIL: Essential

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Competency: Describe instrument loops

Competency Builders:
Use Instrumentation Society of America (ISA) symbology
Describe types of transducers (e.g., flow, level, pressure, temperature)
Describe transducer signal types and levels
Describe elements of a control loop (e.g., transmitter, indicator, controller, transducer, control valve)
Describe modes of control operation (e.g., manual, automatic, cascade, program)
Describe details of flow loop (e.g., orifice plate, segmental wedge, differential pressure transmitters (electronic and pneumatic), magnetic, turbine type transmitters, local indicators, controller, transducer, control valve)
Describe types of transducers used in level control loops
Describe details of pressure transducers
Describe details of temperature transducers (thermocouples and thermistors)
Describe details of infrared and photosensors
Describe details of proximity/vibration sensors
Describe details of speed/acceleration sensors
Describe details of resolvers and encoders
Describe details of linear voltage detection transformers (LVDT)
### Competency: Calibrate loop elements

#### Competency Builders:
- Identify manufacturer's requirements
- Identify loop requirements
- Verify function of test equipment
- Set up test procedure
- Perform calibration
- Record results

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**Competency:** Build control loops

**Competency Builders:**
- Build flow loop
- Build level control loop
- Build pressure loop
- Build temperature loop
**BIL:** Recommended

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**Competency:** Perform calculations

**Competency Builders:**
- Calculate orifice plate sizing
- Calculate flow transmitter differential pressure
- Calculate control valve sizing
**BIL:** Essential

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**Competency:** Describe distributed control systems

**Competency Builders:**
- Describe various types of Input/Output (I/O) Signals
- Describe various types of alarms
- Describe system architecture
BIL: Essential

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Competency: Describe types of controller action

Competency Builders:
- Describe proportional control action (P)
- Describe proportional and integral control action (PI)
- Describe proportional, integral, and derivative control action (PID)
BIL: Essential

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Competency: Perform loop tuning

Competency Builders:
Troubleshoot loops
Demonstrate effect of using only a proportional parameter
Demonstrate effect of using only proportional and integral parameters
Demonstrate effect of various values for proportional, integral, and derivative tuning parameters
Demonstrate loop training using "open loop" step testing
Demonstrate loop tuning using Ziegler Nichols method
Unit: Electro-optic Technology

BIL: Essential

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Competency: Demonstrate knowledge of light principles

Competency Builders:
Describe the characteristics of light sources
Describe radiometric and photometric quantities in the measurement of light using light meters and related equipment
Describe the properties of light
Demonstrate the properties of light
Describe maximum permissible exposure (MPE)
Competency: Demonstrate knowledge of optical systems

Competency Builders:
Describe the characteristics and properties of optical materials
Describe the use of optical components (e.g., lenses, beam splitters)
Describe the principles and operation of optical systems (e.g., ray tracing, refraction)
Demonstrate the use of optical systems (e.g., convergence, focusing, divergence)
Troubleshoot optical systems
Describe the advantages and disadvantages of fiber optics
BIL: Essential

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Competency: Demonstrate knowledge of lasers

Competency Builders:
- Describe the principles of laser operations (e.g., population inversion, coherence)
- Describe laser classifications
- Describe the principles and operation of powering and pumping lasers
- Describe temporal characteristics
- Describe spatial characteristics
- Describe laser safety
Competency: Describe laser energy applications

Competency Builders:
Describe the principles and operation of ion lasers
Describe the principles and operation of solid lasers
Describe the principles and operation of semiconductor lasers
Describe the principles and operation of dye lasers
Describe the principles and operation of lasers in welding, cutting, and drilling
Describe the principles and operation of lasers in data recordings and manipulating
Describe the principles and operation of lasers in environmental testing and monitoring
Describe the principles and operation of lasers in nondestructive testing
Describe the principles and operation of lasers in range finding, alignment and angle testing
Describe the principles and operation of fiber optics in laser systems
Describe the principles and operation of a laser in a communication system
Describe the advantages and disadvantages of fiber optics
Describe the principles of using lasers in medicine
Describe the principles of using lasers in holography/interferometry
BIL: Recommended

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Competency: Perform laser applications

Competency Builders:
- Demonstrate the operation of various ion lasers
- Demonstrate the operation of solid lasers
- Demonstrate the operation of semiconductor lasers
- Demonstrate the operation of dye lasers
- Demonstrate CW and pulsed operation
- Demonstrate the use of lasers in welding, cutting, and drilling
- Demonstrate the use of lasers in data recording and manipulating
- Demonstrate the use of lasers in environmental testing and monitoring
- Demonstrate the use of lasers in nondestructive testing
- Demonstrate the use of lasers in range finding, alignment, and angle testing
- Demonstrate the use of a laser communication system
- Troubleshoot laser applications
- Repair laser applications
Unit: Electronics Troubleshooting and Repair

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: Raising the Standard: Electronics Technician Skills for Today and Tomorrow. June 1994.

BIL: Essential

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Competency: Demonstrate troubleshooting skills

Competency Builders:
- Explain role of preventive maintenance
- Differentiate normal and abnormal operations
- Explain troubleshooting procedures
- Explain logical actions taken to troubleshoot
- Identify and use proper troubleshooting aids and tools
- Demonstrate knowledge of safety rules for troubleshooting and repair procedures
- Maintain troubleshooting and repair records
- Interpret prints
- Use manufacturer's manuals, schematics, and troubleshooting charts
- Isolate faults, shorts, and open circuits
- Explain techniques for identifying thermal failures
BIL: Essential

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Competency: Apply troubleshooting and repair techniques to DC circuits

Competency Builders:
- Identify noise problems
- Isolate faults in series, parallel and series parallel
- Isolate faults in bridge circuits
- Isolate faults in DC power supplies
- Perform polarity check
- Repair faults
**BIL:** Essential

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**Competency:** Apply troubleshooting and repair techniques to AC circuits

**Competency Builders:**
- Isolate faults in capacitive circuits
- Isolate faults in inductive circuits
- Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
- Isolate faults in RC, RL, and RLC circuits
- Isolate faults in frequency selective filter circuits
- Repair faults
BIL: Essential

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Competency: Apply troubleshooting and repair techniques in discrete solid-state devices

Competency Builders:
- Isolate faults in diode circuits
- Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
- Isolate faults in transistor circuits
- Isolate faults in operational amplifier circuits
- Repair faults
Competency: Apply troubleshooting and repair techniques to analog circuits

Competency Builders:
Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults
BIL: Essential

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Competency: Apply troubleshooting and repair techniques to digital circuits

Competency Builders:
- Identify noise problems
- Isolate faults in multiplexer and demultiplexer circuits
- Isolate faults in digital display circuits
- Isolate faults in logic gates
- Isolate faults in flip-flops
- Isolate faults in registers and counters
- Isolate faults in clock and timing circuits
- Isolate faults in arithmetic-logic circuits
- Isolate faults in encoders and decoders
- Isolate faults in digital-display devices
- Repair faults
BIL: Essential

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Competency: Apply troubleshooting and repair techniques to a microcomputer system

Competency Builders:
- Isolate faults to systems boards
- Isolate faults to memory circuits
- Isolate faults to data storage devices
- Isolate faults in power supplies
- Troubleshoot I/O ports
- Isolate faults in I/O interface circuitry
- Use diagnostic software
- Repair faults
BIL: Essential

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Competency: Apply troubleshooting and repair techniques to manufacturing systems

Competency Builders:
Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring
Unit: Electronics Troubleshooting and Repair for IM

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: Raising the Standard: Electronics Technician Skills for Today and Tomorrow. June 1994.

BIL: Essential

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Competency: Demonstrate troubleshooting skills

Competency Builders:
- Explain role of preventive maintenance
- Differentiate normal and abnormal operations
- Explain troubleshooting procedures
- Explain logical actions taken to troubleshoot
- Identify and use proper troubleshooting aids and tools
- Demonstrate knowledge of safety rules for troubleshooting and repair procedures
- Maintain troubleshooting and repair records
- Interpret prints
- Use manufacturer's manuals, schematics, and troubleshooting charts
- Isolate faults, shorts, and open circuits
**BIL:** Essential

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**Competency:** Apply troubleshooting and repair techniques to manufacturing systems

**Competency Builders:**
- Identify individual process blocks of assembly line or process
- Identify process block interfaces
- Demonstrate steps required for efficient systems troubleshooting
- Isolate system faults to process block
- Isolate block faults using schematics
- Isolate block faults using programmable controller indicators
- Isolate block faults using voltmeter
- Repair block faults by replacing fault component or wiring
Unit: Electronic Product Servicing Technology

BIL: Recommended

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Competency: Demonstrate proficiency in surface mounted devices

Competency Builders:
Describe the principles and operation of types of surface mounted devices (SMDs) for DC, AC, and solid-state circuits
Describe the proper procedure for handling static sensitive devices (ESD prevention)
Locate defective SMDs using appropriate troubleshooting techniques
Replace SMDs using appropriate troubleshooting techniques
**BIL:** Recommended

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**Competency:** Demonstrate proficiency in radio and television receiving systems

**Competency Builders:**
- Interpret radio and television receiving system block diagrams
- Describe the principles and operation of a superhetrodyne receiver
- Construct a superhetrodyne receiver
- Align a superhetrodyne receiver
- Troubleshoot a superhetrodyne receiver
- Repair a superhetrodyne receiver
- Describe the principles of video signal generation
- Describe the principles and operation of TV circuits
- Troubleshoot TV circuits
- Repair TV circuits
- Perform operating systems check to radio and television receiving systems
- Adjust radio and television systems
- Describe High Definition Television systems
- Operate video analyzers
- Operate National Television Signal Codes (NTSC) generators
- Operate cathode ray tube (CRT) analyzers
- Operate stereo generators
BIL: Recommended

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Competency: Demonstrate proficiency in video recording and playback systems

Competency Builders:
- Describe characteristics associated with recording and playback systems
- Interpret video recording system block and circuit diagrams
- Identify operational status of video recording systems (mechanical and electronic)
- Perform operating systems check to video recording systems
- Adjust video recording systems
- Describe the operating characteristics and application of BETA, VHS and 8mm test equipment
- Demonstrate the operating characteristics and application of BETA, VHS and 8mm test equipment
- Operate vectorscopes and wave form monitors
- Describe the operating characteristics and application of BETA, VHS and 8mm recorders and playback systems
- Describe the operating characteristics and application of camcorders
- Demonstrate the operating characteristics and application of camcorders
- Troubleshoot video recording systems
- Repair video recording systems
- Describe electronic chemicals (e.g., solvents, lubricants, anticorrosives)
BIL: Recommended

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Competency: Demonstrate proficiency in laser disc systems

Competency Builders:
Describe characteristics associated with laser disc systems
Interpret laser disc system blocks and circuit diagrams
Describe the operation of laser disc systems
Demonstrate the operation of laser disc systems
Describe the principles and operation of interactive video
Troubleshoot laser disc systems
Repair laser disc systems
BIL: Recommended

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Competency: Demonstrate proficiency in home electronics systems

Competency Builders:
Describe characteristics associated with home automation systems (e.g., computers and peripherals)
Interpret home automation systems block and circuit diagrams
Describe the operation of home automation systems
Replace home automation systems
Describe the principles and operation of fax machines
Demonstrate the operation of fax machines
Describe characteristics associated with electronic security systems
Describe the installation of an electronic security systems
Demonstrate the operation of electronic security systems
Troubleshoot home electronics systems
Repair home electronics systems (e.g., replace and align electronic components)
BIL: Recommended

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Competency: Demonstrate proficiency in audio systems

Competency Builders:
- Describe the principles and operation of audio systems
- Interpret audio systems block and circuit diagrams
- Demonstrate the operation of audio systems
- Describe the principles and operation of digital audio tape (DAT)
- Describe the principles and operation of digital compact cassette (DCC)
- Troubleshoot audio systems
- Repair audio systems (e.g., replace audio components)
**Competency:** Demonstrate proficiency in antenna systems (CATV/SATV)

**Competency Builders:**
- Describe the principles and operation of antennae systems
- Demonstrate the installation of antenna systems
- Describe the principles and operation of a CATV system
- Demonstrate the operation of a CATV system
- Describe the principles and operation of a SATV system
- Demonstrate the operation of a SATV system
- Troubleshoot antenna systems
- Repair antenna systems (e.g., replace and align antenna components)
Unit: Programmable Logic Controllers (PLCs)

BIL: Essential

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Competency: Differentiate among instrumentation and control

Competency Builders:
- Describe characteristics associated with automatic controls
- Define proportional control
- Define integral control
- Define derivative control
- Describe advantages of using proportional, integral or derivative control
- Describe disadvantages of using proportional, integral or derivative control
**BIL:** Essential

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**Competency:** Explain basic operation of PLCs

**Competency Builders:**
- Describe basic applications of PLCs
- Identify program symbols and language functions
- Describe function of block transfers
- Describe operation of timers, counters, and sequences
- Describe operation of analog I/O modules
- Describe operation of servo motion control
- Describe the principles and operation of PLCs
BIL: Essential

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Competency: Demonstrate use of PLCs

Competency Builders:
- Draw block diagram of a PLC
- Define individual blocks of a PLC
- Use operator's and/or manufacturer's manual(s)
- Translate relay logic to logic for a PLC
- Use function of block transfers
- Operate timers, counters and sequencers
- Operate analog I/O modules
- Operate servo motion control
- Install a PLC
- Connect controller to sensors
- Describe test procedures for new installation of a PLC
- Troubleshoot hardware faults on a PLCs
- Use safety interlock
- Describe use of Graphic Programmable Panel (GPP)
- Write a statement and ladder logic program
- Document a statement and ladder logic program
- Use a PLC program
- Troubleshoot a program for a PLC
- Repair a program for a PLC
**BIL:** Recommended

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**Competency:** Apply robot fundamentals

**Competency Builders:**
- Describe the operation of robotic work cells
- Operate robotic work cells
- Troubleshoot robotic work cells
- Repair robotic work cells
- Classify robots according to industry criteria
- Identify robot power drive types
- Describe positioning in terms of axis, actuators and coordinate system
- Identify types of control systems and sensors
- Apply different methods of programming (e.g., teach, off-line)
- Write simple programs to exercise robot functions
- Join programs to perform full function
- Identify principles of robot safety
- Describe operation of various sensors used in robot control
- Interface sensors to robot
- Interface robots
- Define open loop and closed loop control
- Design a simple automated system to perform manufacturing operation
- Identify operation of end-effectors
Unit: Communications Electronics Technology for ET

BIL: Recommended

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Competency: Describe transmission line applications

Competency Builders:
- Explain power conversion
- Describe principles and operation of two wire and four wire transmission lines
- Describe principles and operation of coaxial cable
- Describe principles and operation of microwave guide
- Describe principles and operation of fiber optics
**BIL:** Recommended

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**Competency:** Demonstrate proficiency in transmitters and receivers

**Competency Builders:**
- Explain the purpose of Federal Communication Commission (FCC) rules and regulations
- Describe principles and operation of RF amplifiers
- Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, DSSC, Pulse Modulation)
- Construct modulators/demodulators
- Operate modulators/demodulators
- Describe principles and operation of microwave and satellite communication systems
- Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)
BIL: Recommended

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Competency: Describe various types of multiplexing systems

Competency Builders:
Describe principles and operation of analog multiplexing systems (e.g., CATV)
Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)
BIL: Recommended

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Competency: Troubleshoot transmitters and receivers

Competency Builders:
Isolate system faults in CRT modulation/demodulation circuits
Isolate system faults in RF transmitters and receivers
Isolate system faults in RF modulation/demodulation circuits
**Competency:** Demonstrate basic proficiency in data communications

**Competency Builders:**
Describe principles and operation of data communications, signaling systems, codes, formats and protocols
Describe principles and operation of parallel and serial ports
Describe principles and operation of synchronous and asynchronous signals
Describe principles and operation of data modems
Operate data modems
Describe principles and operation of fax machines
Describe principles and operation of various types of networks (e.g., ethernet, token ring)
Demonstrate operation of various types of networks
Describe and demonstrate proper techniques for cable termination (e.g., UTP, COAX, FIBER)
BIL: Recommended

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Competency: Troubleshoot data communications

Competency Builders:
Isolate system faults in data modems
Isolate system faults in various types of networks
Isolate system faults in various types of cable
Isolate system faults in various types of carrier systems
BIL: Recommended

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Competency: **Demonstrate basic proficiency in fiber optic communications systems**

**Competency Builders:**
- Describe and demonstrate proper techniques for fiber splicing
- Demonstrate techniques for fiber termination
- Describe basic characteristics of optics such as reflection, total reflection, and refraction
- Describe characteristics and components of fiber optic cables
- Describe bandwidth and attenuation limitations for fiber optic systems
- Describe technique of wavelength multiplexing in fiber optic cables
- Describe characteristics of various types of light sources and light detectors used in fiber optic systems
- Describe components of fiber optic transmission systems
- Describe transformation of data signals into light pulses
- Operate a simple fiber optic data transmission system
- Describe proper techniques of fiber termination
- Describe characteristics of multi mode and single mode systems
BIL: Recommended

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Competency: Demonstrate proficiency in RF systems safety

Competency Builders:
Demonstrate safety procedures for working with RF systems antennae and support structures (e.g., towers)
Demonstrate safety procedures for working with RF systems high voltage/power supply
Demonstrate safety procedures for working with RF generators
Demonstrate safety procedures for working in RF radiating environments
BIL: Recommended

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Competency: Demonstrate basic proficiency in antenna systems

Competency Builders:
Describe the principles and operation of single element antennae (e.g., 1/4 wave dipole, longwire, vertical)
Describe the principles and operation of multi-element antennae (e.g., point-to-point, broadcast)
Describe the principles and operation of impedance matching of antennae systems
Describe antennae systems measurement
Unit: Communications Electronics Technology for EM

BIL: Recommended

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Competency: Describe transmission line applications

Competency Builders:
- Explain power conversion
- Describe principles and operation of two wire and four wire transmission lines
- Describe principles and operation of coaxial cable
- Describe principles and operation of microwave guide
- Describe principles and operation of fiber optics
BIL: Recommended

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**Competency:** Demonstrate proficiency in transmitters and receivers

**Competency Builders:**
- Explain the purpose of Federal Communication Commission (FCC) rules and regulations
- Describe principles and operation of RF amplifiers
- Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, DSSC, pulse modulation)
- Construct modulation/demodulation device
- Operate modulation/demodulation device
- Describe principles and operation of microwave and satellite communication systems
- Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)
- Describe principles of spread spectrum communications
- Describe RS232/RS485 Bus
**BIL:** Recommended

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**Competency:** Describe various types of multiplexing systems

**Competency Builders:**
- Describe principles and operation of analog multiplexing systems (e.g., CATV)
- Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)
- Describe principles and operation of CRT modulation
BIL: Recommended

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Competency: Troubleshoot transmitters and receivers

Competency Builders:
Isolate system faults in RF amplifiers
Isolate system faults in CRT modulation/demodulation circuits
Isolate system faults in RF transmitters and receivers
Isolate system faults in RF modulation/demodulation circuits
BIL: Recommended

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Competency: Demonstrate basic proficiency in data communications

Competency Builders:
Describe principles and operation of data communications, signaling systems, codes, formats and protocols
Describe principles and operation of parallel and serial ports
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Describe principles and operation of data modems
Operate data modems
Describe principles and operation of fax machines
Describe principles and operation of types of carrier systems
Describe principles and operation of various types of networks (e.g., ethernet, token ring)
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Describe proper techniques for cable termination (e.g., UTP, COAX, FIBER)
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BIL: Recommended

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Competency: Troubleshoot data communications

Competency Builders:
- Isolate system faults in data modems
- Isolate system faults in various types of networks
- Isolate system faults in various types of cable
- Isolate system faults in various types of carrier systems
Competency: Demonstrate basic proficiency in fiber optic communications systems

Competency Builders:
Describe proper techniques for fiber splicing
Demonstrate proper techniques for fiber splicing
Demonstrate techniques for fiber termination
Describe basic characteristics of optics such as reflection, total reflection, and refraction
Describe characteristics and components of fiber optic cables
Describe band width and attenuation limitations for fiber optic systems
Describe technique of wavelength multiplexing in fiber optic cables
Describe characteristics of various types of light sources and light detectors used in fiber optic systems
Describe components of fiber optic transmission systems
Describe transformation of data signals into light pulses
Operate a simple fiber optic data transmission system
Describe proper techniques of fiber termination
Describe characteristics of multi mode and single mode systems
Unit:  Industrial Electricity

BIL:  Essential

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Competency:  Explain basic industrial electricity theory

Competency Builders:
Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body
BIL: Essential

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Competency: Use the National Electrical Code (NEC), International and OSHA Codes

Competency Builders:
- Use NEC to identify correct materials
- Use NEC to identify correct methods
- Use NEC to identify correct applications
- Use NEC to identify correct safety procedures
- Identify and use European Economic Commission (EEC) codes
- Use lock-out, tag-out procedures
- Identify hazardous areas
Competency: Explain operation of electrical distribution systems

Competency Builders:
Follow NEC, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution
**BIL:** Essential

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**Competency:** Maintain basic electrical systems

**Competency Builders:**
- Replace electrical cords
- Replace batteries
- Replace fuse(s)
- Replace switches and other sensors
- Replace plugs and sockets
- Replace control panel components (e.g., relays, motor starters)
- Replace AC motors (e.g., 3 phase, single phase)
- Replace DC motors
BIL: Essential

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Competency: Interpret electrical/electronic drawings

Competency Builders:
Interpret basic electric/electronic standards and symbols (e.g., IEC, IEEE)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production drawings and assembly drawings
**BIL:** Essential

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**Competency:** Demonstrate proficiency in direct current (DC) circuits

**Competency Builders:**
- Describe voltage, current, resistance, power, and energy
- Solve algebraic problems to include exponential (prerequisite to DC)
- Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
- Apply Ohm's Law
- Construct parallel circuits
- Construct series circuits
- Construct series parallel and bridge circuits
- Define voltage divider circuits (loaded and unloaded)
- Construct DC circuits that demonstrate the maximum power transfer theory
- Solve problems in electrical units utilizing metric units
- Describe the principles and operation of electrochemical supplies
- Apply Kirchhoff's laws
- Interpret color codes and symbols to identify electrical components and values
- Measure properties of a circuit using analog and digital meters and oscilloscopes
- Measure conductance and resistance of conductors and insulators
- Describe magnetic properties of circuits and devices
- Describe the physical and electrical characteristics of capacitors and inductors
- Describe RC and RL time constants
- Set up power supplies for DC circuits
- Operate power supplies for DC circuits
- Apply Thevenin's and Norton's theorems
BIL: Essential

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**Competency:** Demonstrate proficiency in alternating current (AC) circuits

**Competency Builders:**
Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter, and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks
Identify harmonics problems
Correct harmonics problems
Unit:  Wiring Methods

BIL:  Essential

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Competency:  Apply National Electrical Code (NEC) and National Fire Protection Act (NFPA) regulations

Competency Builders:
Use NEC and NFPA to identify correct materials
Use NEC and NFPA to identify correct methods
Use NEC and NFPA to identify correct applications
Use NEC and NFPA to identify correct safety procedures
BIL: Essential

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Competency: Explain circuit protectors

Competency Builders:
- Explain grounding/bonding methods
- Explain ground-fault circuit interrupters
- Explain overcurrent/short circuit protection
- Explain thermal protective devices
- Explain difference between ground-fault interrupter and ground-fault protection
BIL: Essential

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Competency: Install wiring

Competency Builders:
- Describe functions of permits and licensing requirements
- Interpret prints
- Verify on-site dimensions
- Install electrical boxes and panels
- Describe overhead and underground service
- Calculate load size conductors
- Identify proper color coding
- Lay out conduit runs
- Install rigid conduit
- Install nonmetallic rigid conduit
- Install cable trays
- Install flexible conduit
- Install liquid-tight flexible conduit
- Pull conductors
- Install ground bonding systems
- Install various wire connectors
- Inspect rough installation
- Prepare for agency inspection
- Install bus-duct(s), bus-plug(s), and bus-drop(s)
- Install EMT
BIL: Essential

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Competency: Finish wiring

Competency Builders:
- Install plugs and switches
- Test plugs and switches
- Install fixtures
- Test fixtures
- Install overcurrent protection
- Test overcurrent protection
- Install ground-fault interrupters (GFI)
- Test ground-fault interrupters (GFI)
- Install circuit breakers
- Test circuit breakers
- Label circuit breakers
- Update prints and schematics
BIL: Essential

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Competency: Prepare for electrical/electromechanical equipment installation

Competency Builders:
- Identify electrical requirements for equipment
- Interpret NEC, NFPA, IEC, and state and local electrical codes
- Identify a power distribution source/requirements
- Interpret symbols
- Interpret schematics/drawings
- Prepare site
BIL: Essential

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Competency: Install electrical/electromechanical equipment

Competency Builders:
Build control panel
Install electrical motor control systems
Install electrical motors
Install sensors and various input devices
Install energy-management systems (e.g., lighting, HVAC, load-shedding)
Test equipment and circuits
Connect power to equipment
Test power to equipment
**BIL:** Essential

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**Competency:** Interpret schematics and diagrams

**Competency Builders:**
- Identify circuit function
- Interpret electrical symbols
- Interpret block and ladder diagrams
- Interpret schematics
**BIL:** Essential

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**Competency:** Trace circuits to locate problems

**Competency Builders:**
- Identify circuit type or subsystem
- Locate specific circuits
- Apply proper troubleshooting technique(s)
- Analyze AC signals using VOM, oscilloscope, or tick tracer
BIL: Essential

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Competency: Maintain electrical systems

Competency Builders:
Diagnose failure
Explain root cause of failure
Review schematic or ladder diagram
Repair or replace defective electrical apparatus
Document corrective action needed or taken
**BIL:** Essential

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**Competency:** Use soldering tools

**Competency Builders:**
Select appropriate soldering tools and supplies for job
Perform soldering and desoldering techniques (e.g., micro-miniature, standard)
**Competency:** Install Class II systems

**Competency Builders:**
- Define Class II systems
- Comply with local, state, and federal codes (e.g., NEC, NFPA)
- Install communication system
- Install control system
- Install lighting system
- Install security systems
- Install energy management monitoring systems
- Maintain systems
- Verify system operation
Unit: Electrical Test and Measurement Equipment

BIL: Essential

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Competency: Demonstrate proficient use of electrical test equipment

Competency Builders:
- Describe function and operation of logic probe and logic analyzer
- Describe function and operation of power monitor
- Describe function and operation of signal generator
- Describe function and operation of spectrum analyzer
- Describe function and operation of AC/DC hi-pot
- Describe function and operation of time-domain reflectometer (TDR)
- Describe function and operation of megger
- Describe function and operation of curve tracer/analogger
- Apply test equipment to DC circuits
- Apply test equipment to AC circuits
- Apply test equipment to solid-state devices
- Apply test equipment to digital circuits
- Apply test equipment to analog circuits
- Apply test equipment to microprocessors
BIL: Essential

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Competency: Demonstrate proficient use of electrical measurement equipment

Competency Builders:
Describe function and operation of analog volt-ohm-meter (AVOM)
Describe function and operation of digital volt-ohm-meter (DVOM)
Describe function and operation of clamp-on amp meter
Describe function and operation of oscilloscopes
Apply measurement equipment to DC circuits
Apply measurement equipment to AC circuits
Apply measurement equipment to solid-state devices
Apply measurement equipment to digital circuits
Apply measurement equipment to analog circuits
Apply measurement equipment to microprocessors
Unit: Electronic Assembly and Repair

BIL: Essential

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Competency: Perform basic soldering of electrical components

Competency Builders:
Prepare surfaces to be soldered
Select appropriate solder
Select appropriate flux
Select appropriate soldering iron temperature
Select appropriate soldering iron tip shape
Select appropriate flux remover
Select appropriate surface sealant
Inspect solder joints under microscope
Identify good and bad solder joints – SMT and PTH
Measure solder joint resistance of good and bad joints
Demonstrate solder techniques for SMD components
Demonstrate techniques for soldering to terminals
BIL: Recommended

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Competency: Perform basic repair of electronic boards

Competency Builders:
- Demonstrate removal of SMD
- Demonstrate removal of PTH components
- Demonstrate PCB track repair
- Demonstrate use of solder removal tools
BIL: Recommended

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Competency: Operate wave soldering machine

Competency Builders:
Inspect surfaces to be soldered
Select appropriate solder
Select appropriate flux
Set all machine parameters (e.g., temperature, wave amplitude, transport velocity)
Inspect solder joints of completed printed circuit boards
Unit: Equipment Installation

BIL: Essential

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Competency: Explain installation procedures

Competency Builders:
- Explain relocation procedures for new equipment in an existing facility
- Explain the use of anchors and isolators
- Explain procedures for moving and installing new equipment
- Explain leveling and aligning procedures
- Explain test run guidelines
- Explain safety precautions for equipment installation procedures
- Explain grounding procedures
- Explain installation of utilities (e.g., electricity, air, water, drains)
**Competency:** Prepare for equipment installation

**Competency Builders:**
- Identify equipment requirements (including safety)
- Identify maintenance services needed
- Identify method of moving and equipment needed
- Identify measuring devices
- Calculate weights
- Follow manufacturer's specifications and manuals
- Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
- Read drawings/schematics
- Revise drawings if applicable
- Interpret prints
BIL: Essential

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Competency: Install Equipment

Competency Builders:
- Prepare site
- Use measuring devices
- Calculate weight
- Follow manufacturer's specifications
- Use appropriate moving equipment
- Align equipment to layout specifications
- Apply electrical, mechanical, hydraulic, and/or pneumatic principles
BIL: Essential

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Competency: Explain rigging functions

Competency Builders:
- Estimate the weight of a load
- Find the center of gravity
- Identify the rigging and slings used in maintenance work
- Explain safety inspection procedures for rigging, ropes, and slings
- Perform safety inspection procedures for rigging, ropes, and slings
- Identify rope fiber types
- Tie rigging knots, bends, and hitches
- Identify types of wire rope
- Cut wire rope assemblies and termination's
- Identify cranes and hoists
- Identify and explain scaffolding types
- Identify safety equipment (e.g., safety harness, nets)
BIL: Essential

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Competency: Perform rigging functions

Competency Builders:
- Perform safety inspection procedures for rigging, ropes, and slings
- Tie rigging knots, bends, and hitches
- Cut wire rope
- Seize wire rope
- Splice wire rope
- Erect a scaffold per new OSHA standards
- Rig safety harness and nets
Unit: Equipment Maintenance

BIL: Essential

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Competency: Perform housekeeping

Competency Builders:
Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs, and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor
**BIL:** Essential

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**Competency:** Perform recordkeeping

**Competency Builders:**
- Explain reasons for keeping maintenance records
- Explain reasons for keeping cost records
- Complete work order
- Complete internal requisition
- Complete external requisition
- Complete time cards
- Complete job status reports
- Complete equipment failure reports
- Record preventive maintenance activities
- Record repair activities
- Read job orders and process sheets
- Locate tooling and set up information
- File reports
- Prepare new/replacement equipment recommendations
BIL: Essential

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Competency: Inspect machine systems

Competency Builders:
- Explain planned maintenance
- Explain predictive maintenance measures
- Explain preventive maintenance measures (e.g., lubrication)
- Log machine histories
- Explain machine system(s) calibration
- Inspect linkages and lever mechanisms
- Inspect drive couplings
- Inspect clutches
- Inspect roller ball bearings
- Inspect safety systems
- Analyze system failure
- Make minor adjustments/repairs
- Coordinate maintenance services
**BIL:** Essential

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**Competency:** Perform machine maintenance

**Competency Builders:**
- Use operator's and manufacturer's manuals
- Operate individual machines
- Diagnose malfunctions
- Apply lockout/tagout procedure
- Disassemble defective section
- Clean equipment
- Lubricate equipment
- Check equipment for wear and alignment
- Repair or replace defective parts
- Test machine for performance
- Make minor adjustments to equipment
- Prepare planned maintenance schedules
- Explain breakdown maintenance
- Review analysis with operator
BIL: Essential

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Competency: Maintain and properly use hand tools

Competency Builders:
Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment
**BIL:** Essential

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**Competency:** Maintain and properly use portable power tools

**Competency Builders:**
- Demonstrate use and care of light-duty and heavy-duty drills
- Demonstrate use and care of electric hammers
- Demonstrate use and care of pneumatic drills and hammers
- Demonstrate use and care of power screwdrivers and impact wrenches
- Demonstrate use and care of linear motion saws
- Demonstrate use and care of circular saws
- Demonstrate use and care of routers and planes
- Demonstrate use and care of belt, pad, and disc sanders
- Demonstrate use and care of grinders and shears
- Demonstrate use and care of explosive actuated tools
- Demonstrate use and care of electric lifts
**BIL:** Essential

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**Competency:** Maintain and properly use stationary equipment

**Competency Builders:**
- Demonstrate use and care of mechanical presses
- Demonstrate use and care of hydraulic presses
- Demonstrate use and care of drill presses
- Demonstrate use and care of bench grinders
- Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
- Demonstrate use and care of band saws
- Demonstrate use and care of pipe threaders
- Demonstrate use and care of metal brakes
- Demonstrate use and care of power shears
Unit: Industrial Engineering Basics

BIL: Essential

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Competency: Apply knowledge of workstation design

Competency Builders:
- Participate in development of overall plant layout
- Identify minimal movement of materials and parts throughout production line
- Plan operator's access to materials and tools
- Eliminate unnecessary body moves (e.g., bends, turns, stoops, hand movements)
- Identify physical safety items (e.g., equipment, temperature, fumes, light)
- Identify methods to prevent operator from reaching across moving parts
- List type of material handling equipment for operation
- Calculate bench space needs for process and storage
- Calculate machine controls to position operator efficiently
- Physically simulate operation
- Review total process for simplification
Competency: Demonstrate knowledge of ergonomics

**Competency Builders:**
- Define ergonomics
- Identify risk factors
- Define maximum permissible limit (MPL) and action limit (AL) for lifting
- Define cumulative trauma disorder (CTD)
- Identify susceptibility factors for CTD
- Identify need for mats and footrest for standing jobs
- Identify need for appropriate working heights of chairs, stools, workbenches, equipment
- Identify need for adequate lighting
- Explain use of anthropometric design
- Explain use of rest pauses
- Minimize extreme joint movement
- Minimize use of excessive muscle force
- Minimize repetitive tasks
- Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
- Minimize awkward body positions
BIL: Essential

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Competency: Apply knowledge of methods engineering

Competency Builders:
Define methods engineering
Define goals of methods engineering (e.g., quality, increase productivity, decrease per unit cost)
Set sequence of production operations
Set sequence of needed inspections
Recommend methods to shorten process time
Recommend alternate operations
Recommend ways to eliminate operations
Ascertain if operations can be performed within facilities
Test machine capability
Follow documentation procedures
BIL: Essential

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Competency: Apply knowledge of standards engineering

Competency Builders:
- Estimate times by computer simulation
- Use predetermined time system (e.g., MTM family)
- Use work sampling
- Define reach, grasp, move position, turn, apply pressure, and release
- Define standard time
- Define performance rating
- Define allowances
- Identify leveling factors (e.g., skill levels, effort, work area conditions, consistency)
- Identify allowance factors (e.g., fatigue, delay, personal)
- Calculate production rate
- Write job description data
- Complete job status reports
- Analyze job evaluation data
Unit: Industrial Manufacturing Technology


BIL: Essential

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Competency: Describe industrial manufacturing processes

Competency Builders:
Identify safety related items
Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature
Explain mechanical and chemical properties of ferrous and non-ferrous metals
Explain industrial manufacturing process
Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases
Develop flow chart and process sheets
Explain preventive maintenance and calibration procedures
Explain need for manufacturing documentation (e.g., ISO 9000)
Define quality process
**BIL:** Essential

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**Competency:** Demonstrate knowledge of materials requirements planning (MRP)

**Competency Builders:**
- Define materials requirements planning
- Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
- Interpret master production schedule and bill of materials
- Explain inventory carrying cost and economic order quantity
- Describe the use of the computer in MRP
- Calculate net requirements
BIL: Essential

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Competency: Demonstrate knowledge of material supply process (MSP)

Competency Builders:
Describe role of purchase requisitions and/or purchase orders
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving
BIL: Essential

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**Competency:** Demonstrate knowledge of plant layouts

**Competency Builders:**
Describe the importance of flexibility
Differentiate among product layout, process layout, fixed position layout, and cellular layout
Describe the type of production suited to each layout
Describe advantages and disadvantages of each layout
Describe importance of flexibility of material flow
Differentiate straight-line, U-shaped, convoluted, and comb patterns
Describe advantages and disadvantages of each pattern
BIL: Recommended

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Competency: Demonstrate knowledge of quality control process of materials handling

Competency Builders:
Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions
Explain importance of product protection, identification and storage
Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)
BIL: Essential

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Competency: Apply statistical process control techniques

Competency Builders:
Describe (SPC) statistical process control and its applications
Describe a sampling plan
Inspect parts for necessary data
Plot on appropriate control charts
Analyze a manufacturing process
Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance
Unit: Basic Materials Science

BIL: Essential

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Competency: Demonstrate basic knowledge of metallurgy

Competency Builders:
Define metallurgy
Define metal forming (e.g., general process)
Identify forming industries (e.g., stamping, forging, fabricating)
Describe metal forming principles
Describe the metal forming process
Identify frequently used metals
Describe the crystalline structures of metals
Use periodic chart to evaluate metals
List chemical properties of common metals
List physical properties of common metals
Describe measures of metal strength
Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy
Explain secondary finishing operations (e.g., paint, anodizing)
**Competency Builders:**
Describe process of heat treating
Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)
Competency: Demonstrate basic knowledge of metal characteristics and formability

Competency Builders:
- Explain metal and formability basics
- Explain metal grades and coatings
- Explain part contour analysis
- Explain tensile test
- Explain LDH test
- Explain bend test
- Explain hold expansion test
- Explain R-value test
- Explain hardness test
- Explain cup test
- Explain friction test
- Explain surface test
- Explain interpretation of metal characteristics tests
- Describe blank/die interactions (e.g., friction)
- Describe friction and forming process
- Describe circle grid basics
- Describe circle grid applications
- Describe formability diagnostics
- Describe the documentation process
**BIL:** Essential

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**Competency:** Demonstrate basic knowledge of casting

**Competency Builders:**
- Identify frequently used metals
- Describe crystalline structures of metals
- Use periodic chart in evaluating metals
- List chemical properties of common metals
- List physical properties of common metals
- Define permanent mold casting
- Define shell mold casting
- Define sand casting and pattern making
- Define die casting
- Identify basic casting terms
- Identify advantages/disadvantages of casting processes
BIL: Essential

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Competency: Demonstrate basic knowledge of iron and its alloys

Competency Builders:
Define iron and its alloys
Describe iron manufacturing process
Describe the structure of iron and its alloys
List chemical properties of iron and its alloys
List physical properties of iron and its alloys
Describe iron and alloys property variables
Describe measures of strength for iron and its alloys
Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis
**BIL:** Essential

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**Competency:** Demonstrate basic knowledge of aluminum and its alloys

**Competency Builders:**
- Define aluminum and its alloys
- Describe aluminum manufacturing process
- Describe the structure of aluminum
- List chemical properties of aluminum
- List physical properties of aluminum
- Describe aluminum property variables
- Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
- Perform tensile test
- Perform Brinell test
- Perform chemical analysis
Competency: Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)

Competency Builders:
- Define copper and its alloys
- Describe copper manufacturing process
- Describe the structure of copper
- List chemical properties of copper
- List physical properties of copper
- Describe copper property variables
- Describe measures of copper strength
- Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
- Perform tensile test
- Perform Brinell test
- Perform chemical analysis
Competency: Demonstrate basic knowledge of plastics and polymers

Competency Builders:
- Define thermo-analysis testing (e.g., melt flow, moisture control)
- Define plastics and polymers
- Describe plastics and polymers manufacturing processes
- Describe structure of plastics and polymers
- List chemical properties of plastics and polymers
- List physical properties of plastics and polymers
- Differentiate thermoset and thermoplastic
- Describe plastics and polymer property variables
- Describe measure of plastic and polymer strength
- Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding
- Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)
- Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)
- Perform tensile test
- Perform R-value test
BIL: Essential

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Competency: Demonstrate basic knowledge of ceramics

Competency Builders:
List ingredients of ceramic products
List qualities of ceramic products
Describe quality control tests (e.g., compressive strength test, wear resistance test, temperature resistance test)
BIL: Essential

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Competency: Demonstrate basic knowledge of concrete

Competency Builders:
Describe the formation of concrete
List types of cements and their uses
Define qualities of concrete (e.g., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)
List tests used in concrete production (e.g., slump test, test of fineness modules)
List protective practices used after pouring
Describe concrete tools and applications (e.g., float, chairs)
### BIL: Essential

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**Competency:** Demonstrate knowledge of corrosion and protection

**Competency Builders:**
- Identify causes of corrosion
- Identify types of corrosion
- List solutions to minimize problems
- Identify corrosion testing
Competency: 
Demonstrate basic knowledge of rubber manufacturing

Competency Builders:
Explain history of rubber industry
Compare properties of natural rubber with those of synthetic rubber
Explain how natural rubber is manufactured
Explain vulcanization, mastication, and cure systems
Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)
Explain press and autoclave curing
Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)
Explain rubber testing (e.g., tensile, durometer)
Unit: Mechanical Power Transmission

BIL: Essential

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Competency: Demonstrate knowledge of basic mechanics

Competency Builders:
- Explain working forces of torque, tension, and compression
- Explain the laws of motion
- Explain how to calculate work in several ways
- Explain the function of simple machines including levers, inclined plane, wedge wheel and axle, pulley and screw, gears
- Explain the types of power and the method of producing power
- Explain the laws of friction
- Explain mechanical efficiency
- Apply basic knowledge of physics
- Apply basic knowledge of stress, strain, and fatigue
- Calculate speed changes
Competency: Describe mechanical power transmission systems

Competency Builders:
- Describe the principles and operation of compound and reverted gear trains
- Describe the principles and operation of internal and planetary gear trains
- Describe the principles and operation of helical and bevel gear trains
- Describe the principles and operation of rack and pinion, worm and wheel, and block and screw mechanisms
- Describe the principles and operation of counter rotating mechanisms and differentials
- Describe the principles and operation of spring mechanisms, pulley blocks, and differentials
- Describe the principles and operation of chain, belt and disc drives and universal joints
- Describe the principles and operation of clutch and coupling mechanisms
- Describe the principles and operation of braking mechanisms
- Describe the necessity for proper alignment and fit of mechanical devices
- Describe the necessity for proper balance of system components
- Describe proper component matching (e.g., sheave sets, gear sets)
BIL: Essential

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Competency: Use bearings

Competency Builders:
Define bearing
Identify types of bearings and their applications
Identify installation method
Install bearings
Maintain bearings (e.g., lubrication)
Remove bearings
Identify bearing failure modes
BIL: Essential

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Competency: Use seals

Competency Builders:
Define seal
Identify types of seals and their applications
Identify installation method
Install seals
Maintain seals
Remove seals
Identify failure modes
Competency: Use gears

Competency Builders:
Define gears
Identify types of gears, their materials, and their applications
Identify installation method
Install gears
Maintain gears (e.g., lubrication)
Remove gears
Identify failure modes
BIL: Essential

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Competency: Use sheaves

Competency Builders:
Define sheaves
Identify types, tolerances, and materials of sheaves and their applications
Identify installation method
Install sheaves
Maintain sheaves
Remove sheaves
Identify failure modes
**BIL:** Essential

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**Competency:** Use belts and pulleys

**Competency Builders:**
Define belts and pulleys
Identify types of belts and pulleys and their applications
Identify installation method
Install belts and pulleys
Maintain belts and pulleys
Remove belts and pulleys
Identify failure modes
BIL: Essential

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Competency: Use sprockets and chains

Competency Builders:
Define sprockets and chains
Identify types of sprockets and chains and their applications
Identify installation method
Install sprockets and chains
Maintain sprockets and chains
Remove sprockets and chains
Identify failure modes
BIL: Essential

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Competency: Use cams and levers

Competency Builders:
Define cams and levers
Identify types of cams and levers and their applications
Identify installation method
Install cams and levers
Maintain cams and levers
Remove cams and levers
Identify failure modes
BIL: Essential

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Competency: Use clutches and brakes

Competency Builders:
Define clutches and brakes
Identify types of clutches and brakes and their applications
Identify installation
Install clutches and brakes
Maintain clutches and brakes
Remove clutches and brakes
Identify failure modes
Competency: Install drive components

Competency Builders:
Identify types of couplings and their applications
Install solid coupling
Install jaw coupling
Install molded rubber coupling
Install chain type coupling
Install a clutch
Install brakes
Align bearings, bushing, and cams
Install V-belts and adjust tensions
Install a V-belt and manually adjustable sheaves
Adjust a V-belt and manually adjustable sheaves
Install a V-belt with spring loaded adjustable sheaves
Explain the purposes and advantages of a chain drive system
Explain the function of speed reducers
Explain the function of gears and variable speed reducers
Install shafts
Align shafts
Mount drive sprockets and chains
Mount sheaves and pulleys
Mount gears on open gear drives
Align gears on open gear drives
Install a mechanical clutch system
Install adjustable speed drives
Troubleshoot adjustable speed drives
Explain the operation of fluid couplings
Install fluid couplings
Install torque converters
Perform preventive maintenance on drive components
Inspect completed work
Describe types of fit and tolerances
Explain importance of balance
BIL: Essential

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Competency: Describe the operation of mechanisms, linkages and levers

Competency Builders:
- Describe class one, two, three, and compound levers
- Describe the principles and operation of rocker arm and bell crank linkages and combined mechanisms
- Describe the principles and operation of four-bar mechanisms (crank, rocker, and double rocker)
- Describe the principles and operation of drag link and intermediate mechanisms
- Describe the principles and operation of four-bar variations
- Describe the principles and operation of cam mechanisms
- Describe the principles and operation of pivoted follower mechanisms
- Describe the principles and operation of toggle, quick return, and ratchet mechanisms
- Describe the principles and operation of geneva mechanisms
BIL: Essential

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Competency: Apply knowledge of lubricants

Competency Builders:
- Explain the function of lubricants
- Explain the properties of oil lubricants and factors determining the selection of lubricants
- Identify types and functions of lubricant additives
- Describe types of circulating oils and their purposes
- Describe lubricating systems, including the charts and methods used
- Demonstrate proper grease application
- Demonstrate proper lubricant storage and handling
- Lubricate a piece of industrial equipment
- Identify specified lubricant or equivalent
- Explain lubricant recovery and disposal
- Explain use of oil analysis reports
Unit: Fundamentals of Machine Anatomy

BIL: Essential

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Competency: Interpret specifications for a machine

Competency Builders:
- Identify power source
- Identify power transmission
- Identify hydraulic/pneumatic actuators
- Identify materials
- Identify fits/tolerances
- Identify geometric dimension and tolerancing (GD&T) symbols
- Identify safety factors
- Participate in concurrent engineering
- Demonstrate knowledge of print reading
BIL: Essential

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Competency: Build a machine to specifications

**Competency Builders:**
- Install hydraulic and pneumatic actuators
- Troubleshoot hydraulic and pneumatic actuators
- Install motors
- Troubleshoot motors
- Install sensors
- Troubleshoot sensors
- Install PLC's
- Troubleshoot PLC's
- Install industrial controls
- Troubleshoot industrial controls
- Install power distribution systems
- Troubleshoot power distribution systems
- Install brakes and clutches
- Troubleshoot brakes and clutches
- Install lubrication system
- Troubleshoot lubrication system
Unit: Electromechanical Technology

BIL: Essential

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Competency: Interpret electromechanical drawings

Competency Builders:
Identify types of drawings and their applications
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings
BIL: Essential

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Competency: Describe the operation of electronic sensors and transducers

Competency Builders:
- Explain temperature transducers operation
- Explain stress and strain transducers operation
- Explain magnetic transducers operation
- Explain liquid and fluid flow transducers operation
- Explain fiber optic system operation
- Explain pressure transducers operation
BIL: Essential

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Competency: Demonstrate knowledge of transducers (sensors) and instrumentation

Competency Builders:
- Describe characteristics associated with transducers and instrumentation
- Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
- Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
- Troubleshoot transducers
- Differentiate among thermocouple types
- Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
- Interpret specification of pressure sensors (e.g., strain gage, piezo electric/piezo resistive) to electrical circuits
- Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
- Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT))
- Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
- Interpret specifications of final control elements (e.g., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
- Describe application circuits
- Calculate specification of proximity sensors
- Calculate specifications of infrared and photo-sensors
- Explain use of proximity sensors
- Explain use of photo electric sensors
- Explain use of mechanically activated switches
- Troubleshoot switch failure

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Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits
BIL: Essential

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Competency: Demonstrate knowledge of power distribution systems

Competency Builders:
Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Demonstrate lock-out/tab-out procedures
Describe inner lock systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems
BIL: Essential


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Competency: Demonstrate proficiency in power distribution equipment

Competency Builders:
Describe power transformers
Interpret transformer name plate data
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe current transformer safety procedures
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Demonstrate lock-out/tag-out procedures
Describe inner lock systems
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot voltage transformers
Troubleshoot medium-voltage circuit breakers and fuses
**BIL:** Essential

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**Competency:** Demonstrate knowledge of motors and motor control

**Competency Builders:**
- Test solid state components with ohmmeter
- Test solid state DC motor control circuits
- Test solid state AC motor control circuits
- Calibrate or recalibrate equipment
- Identify SCR and TRIAC AC control circuits
- Explain how load is connected to 3-phase wye configured AC generator
- Identify wye connected and delta connected 3-phase motors
- Explain revolving fields in AC motors
- Describe common start/stop circuits
- Describe operation of common AC motors
- Explain motor starters/overloads
- Explain motor’s EFF
- Explain power factor affect on motors
- Describe operation of variable frequency AC drives
- Define advantages and disadvantages of common DC motors
- Explain how motor load affects speed regulation
- Describe operation of stepper motors
- Describe speed control of various types of motor drives using sensors
- Identify defective motors
- Describe regenerative dynamic breaking
- Describe operation of various feedback loops
- Interpret motor name plate data
**BIL:** Essential

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**Competency:** Apply quality control techniques

**Competency Builders:**
- Perform preventive maintenance
- Perform predictive maintenance
- Apply statistical process control (SPC)
- Recalibrate equipment
- Apply problem-solving tools and techniques
BIL: Essential

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Competency: Apply electromechanical maintenance management practices

Competency Builders:
Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Explain computer management maintenance systems (CMMS)
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making
Unit: Electromechanical Technology for IM

BIL: Essential

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Competency: Interpret electromechanical drawings

Competency Builders:
- Identify types of drawings and their applications
- Explain the use of auxiliary views, revolutions, and sectional views
- Describe dimensioning practices and techniques on drawings
- Interpret mechanical/electronic production and assembly drawings
BIL: Essential

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Competency: Describe the operation of electronic sensors and transducers

Competency Builders:
- Explain temperature transducers operation
- Explain stress and strain pressure transducers operation
- Explain magnetic transducers operation
- Explain liquid and fluid flow transducers operation
Competency: Demonstrate proficiency in transducers (sensors) and instrumentation

Competency Builders:
Describe characteristics associated with transducers and instrumentation
Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Troubleshoot transducers
Differentiate among thermocouple types
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
Interpret specification of pressure sensors (e.g., strain gage, piezoelectric/piezoresistive) to electrical circuits
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT))
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
Interpret specifications of final control elements (e.g., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
Describe application circuits
Calculate specification of proximity sensors
Calculate specifications of infrared and photo-sensors
Explain use of proximity sensors
Explain use of photo electric sensors
Explain use of mechanically activated switches
Troubleshoot switch failure
Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits
BIL: Recommended

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Competency: Demonstrate proficiency in power distribution systems

Competency Builders:
Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Demonstrate lock-out/tag-out procedures
Describe kirk key inner lock systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems
BIL: Recommended

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Competency: Demonstrate proficiency in power distribution equipment

Competency Builders:
- Describe power transformers
- Describe transformer name plate data
- Describe power capacitors
- Describe power oil switches and cutouts
- Describe application of NEMA or IEC controls
- Describe different types of enclosures for controls
- Describe current transformers
- Describe current transformer safety procedures
- Describe potential transformers
- Describe medium-voltage circuits breakers and fuses
- Use medium-voltage safety equipment
- Troubleshoot power transformers
- Demonstrate lock-out/tag-out procedures
- Describe kirk key inner lock systems
- Troubleshoot power capacitors
- Troubleshoot power oil switches and cutouts
- Troubleshoot current transformers
- Troubleshoot potential transformers
- Troubleshoot medium-voltage circuit breakers and fuses
BIL: Recommended

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Competency: Demonstrate proficiency in motors and motor control

Competency Builders:
- Test solid state components with ohmmeter
- Test solid state DC motor control circuits
- Test solid state AC motor control circuits
- Calibrate or recalibrate equipment
- Identify SCR and TRIAC AC control circuits
- Explain how load is connected to 3-phase wye configured AC generator
- Identify wye connected and delta connected 3-phase motors
- Explain revolving fields in AC motors
- Describe operation of common AC motors
- Explain power factor effect on motors
- Demonstrate two and three wire control concepts
- Explain motor starter/overloads
- Describe operation of variable frequency AC drives
- Define advantages and disadvantages of common DC motors
- Explain how motor load affects speed regulation
- Describe operation of stepper motors
- Describe speed control of various types of motor drives using sensors
- Identify defective motors
- Describe regenerative dynamic breaking
- Describe operation of various feedback loops
- Explain motor name plate data
BIL: Recommended

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Competency: Apply quality control techniques

Competency Builders:
Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques
BIL: Recommended

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Competency: Apply electromechanical maintenance management practices

Competency Builders:
Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Explain computer management maintenance systems (CMMS)
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making
Unit: Hydraulics and Pneumatics

BIL: Essential

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Competency: Describe fluid flow concepts

Competency Builders:
- Explain Pascal's Law
- Explain Boyle's Law
- Explain Bernoulli's Principle
- Describe flow velocity
- Explain how heat and pressure relate to power and transmission
- Describe physical and chemical properties of a fluid
- Describe fluids in motion in closed conductors
- Describe continuity of mass flow
- Identify types of fluids
- Identify properties of fluids
- Identify English and metric units of measurement for pressure, density, and viscosity
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**Competency:** Describe energy considerations

**Competency Builders:**
- Differentiate work and power
- Differentiate potential and kinetic energy
- Explain energy conservation concept
- Explain hydraulic horsepower
- Explain work of compression in compressible fluids
BIL: Essential

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Competency: Describe system losses

Competency Builders:
Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)
BIL: Essential

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Competency: Describe hydrostatics

Competency Builders:
- Explain pressure, density, and viscosity
- Explain buoyancy
- Explain equilibrium
**BIL:** Essential

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**Competency:** Calculate energy

**Competency Builders:**
- Apply Pascal's Law
- Apply Bernoulli's Principle
- Apply Boyle's Law
- Calculate work and power
- Calculate potential and kinetic energy
- Calculate hydraulic horsepower
- Calculate flow velocity and pressure
- Calculate pressure losses
- Calculate laminar flow
- Calculate pump capacity
- Calculate system requirements
BIL: Essential

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Competency: Design basic hydraulic/pneumatic system

Competency Builders:
Use common symbols
Create circuit diagrams (e.g., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system
BIL: Essential

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Competency: Describe component operation

Competency Builders:
- Identify functions and operation of hydraulic components
- Identify functions and operation of pneumatic components
- Explain application(s) of different materials (e.g., plastic, copper)
- Identify and interpret pressure ratings
BIL: Essential

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Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:
Identify common symbols
Sketch circuit diagrams (e.g., schematics)
Interpret circuit diagrams (e.g., schematics)
Analyze circuit
Diagram an air supply system
BIL: Essential

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Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:
Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits
BIL: Recommended

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Competency: Perform pump maintenance and repair

Competency Builders:
- Identify types and operating features of pumps
- Identify pump capacity and system requirements
- Explain packing and seal requirements
- Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
- Perform pump maintenance
- Disassemble a pump
- Reassemble a pump
- Test pump
BIL: Recommended

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Competency: Maintain piping and accessories for high and low pressure fluid power systems

**Competency Builders:**
- Identify components of a piping system
- Explain maintenance features of both metallic and non-metallic piping systems
- Explain types of valves and their operation and maintenance
- Explain use and maintenance of strainers, filters, and traps in piping systems
- Join common fittings
- Join metallic pipe
- Join plastic pipe
- Join copper and steel tubing
- Bend copper and steel tubing
- Cut copper and steel tubing
- Flare tubing
Competency: Maintain hydraulic system components

Competency Builders:
Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves
BIL: Essential

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Competency: Troubleshoot hydraulic systems

Competency Builders:
- Interpret hydraulic schematic
- Identify causes of failure modes
- Connect electrically controlled valves
- Explain hydraulic system troubleshooting techniques
- Repair or replace hydraulic valves
- Repair or replace hydraulic cylinders
- Repair or replace hydraulic pumps and motors
- Install hydraulic components
**BIL:** Essential

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**Competency:** Describe reciprocating and rotary air compressors

**Competency Builders:**
- Explain relationship of force, weight, mass, and density in pneumatic system
- Explain operation of reciprocating compressors
- Explain operation of rotary compressors
- Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
- Explain operation of compressor valves, cylinders, and motors
BIL: Recommended

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Competency: Maintain pneumatic systems

Competency Builders:
Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves
Safety precautions
BIL: Essential

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Competency: Troubleshoot pneumatic systems

Competency Builders:
Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers
**BIL:** Recommended

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**Competency:** Maintain vacuum systems

**Competency Builders:**
- Describe characteristics associated with vacuum systems and sub-atmospheric pressure
- Describe the principles and operation of vacuum gauges
- Demonstrate use of vacuum gauges
- Repair or replace vacuum gauges
- Describe the principles and operation of vacuum pumps
- Demonstrate use of vacuum pumps
- Repair or replace vacuum pumps
- Describe the principles and operation of vacuum controls
- Demonstrate use of vacuum controls
- Repair or replace vacuum controls
Unit: Hydraulics and Pneumatics for ET

BIL: Essential

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Competency: Describe fluid flow concepts

Competency Builders:
- Explain Pascal's Law
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- Describe flow velocity
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- Describe physical and chemical properties of a fluid
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- Identify types of fluids
- Identify properties of fluids
- Identify English and metric units of measurement for pressure, density, and viscosity
BIL: Essential

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Competency: Describe energy considerations

Competency Builders:
Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids
**BIL:** Recommended

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**Competency:** Describe component operation

**Competency Builders:**
- Identify functions and operation of hydraulic components
- Identify functions and operation of pneumatic components
BIL: Recommended

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Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:
Identify common symbols
Sketch circuit diagrams (e.g., schematics)
Interpret circuit diagrams (e.g., schematics)
Sketch circuit analysis
Diagram an air supply system
Unit: Computerized Numerical Control (CNC) for EM

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill Standards developed by the Metalworking Industry Skills Standards Board. Source: Duties and Standards for Machining Skills. Level II. Duties 2.22 and 2.23. January 1995.

BIL: Essential

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Competency: Demonstrate knowledge of CNC

Competency Builders:
- Define numerical control (NC) and computerized numerical control (CNC)
- Differentiate NC and CNC
- Describe closed loop, open loop, and adaptive controls
- Define point to point systems
- Identify tool movement of point to point systems
- Define continuous path systems
- Identify tool movements of continuous path systems
- Define canned cycles
- Differentiate hardware and software
- List advantages/disadvantages of CNC machining centers
- Explain direct numerical control (DNC)
BIL: Essential

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Competency: Perform preventive maintenance

Competency Builders:
Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Identify wear and alignment issues on CNC equipment
**BIL:**  Recommended

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**Competency:** Prepare CNC program

**Competency Builders:**
- Write a program manually in word address format
- Write a program off line
- Write a program manually in conversational program
- Generate a program using a CAD/CAM package
- Program machine using manual data input (MDI) process
Unit: Computerized Numerical Control (CNC) for IM

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill Standards developed by the Metalworking Industry Skills Standards Board. Source: Duties and Standards for Machining Skills. Level II. Duties 2.22 and 2.23. January 1995.

BIL: Recommended

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Competency: Demonstrate knowledge of CNC

Competency Builders:
Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Explain the purpose of the post-processor
Define canned cycles
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)
BIL:  Recommended

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Competency:  Perform preventive maintenance

Competency Builders:
Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment
Identify wear and alignment issues on CNC equipment
Competency: Apply CNC operations

Competency Builders:
- Identify parts of the machine
- Apply basic programming skills to a turning and a milling operation
- Select proper work holders
- Select proper cutting tools
- Set machine parts to drawing tolerances
- Use CAD/CAM for part program development
- Apply proper set-up procedures
BIL: Essential

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Competency: Prepare CNC program

Competency Builders:
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Write a program off line
Write a program manually in conversational program
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Program machine using manual data input (MDI) process
BIL: Essential

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Competency: Program CNC operations

Competency Builders:
Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates, and surface feet per minute limitations
Turn intersection points into segments (e.g., defined in terms of points, lines, and circles)
Debug program
Competency: Load machine

Competency Builders:
Load program from MDI and/or off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant
BIL: Essential

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Competency: Operate CNC machine

**Competency Builders:**
Perform dry run
Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Inspect part
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine
Unit: Precision Machining

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill developed by the Metalworking Industry Skills Standards Board. Source: Duties and Standards for Machining Skills. Level I. Duties 1 and 2. November 1994.

**BIL:** Essential

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**Competency:** Perform prerequisite machining skills

**Competency Builders:**
- Demonstrate maintenance of immediate work area, machinery, tools and gages
- Demonstrate proficiency in interpreting prints/drawings
- Demonstrate proficiency in planning work sequence/set up
- Follow safety rules and regulations for each machine
- Identify and use personal protective equipment for each machine
BIL: Essential

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Competency: Analyze machine shop jobs

Competency Builders:
Identify sequence of work on specified project(s)
Identify tolerances and finishes on specified project(s)
Identify variables that effect job efficiency (e.g., speeds, feeds)
Use machinery handbook
Identify causes of workpiece defects
**BIL:** Essential

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**Competency:** Achieve machine shop job standards

**Competency Builders:**
- Write machine shop job procedure
- Complete machine shop job status report(s)
- Analyze machine shop job evaluation data
**BIL:** Essential

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**Competency:** Perform bench operations

**Competency Builders:**
- Use measuring instruments and hand tools
- Deburr workpiece
- Lay out workpiece
- Drill hole
- Hand tap hole
- Cut threads with die
- Apply basic metallurgy knowledge
BIL: Essential

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Competency: Operate metal cutting saw

Competency Builders:
Identify types and uses
Transfer dimensions from blueprint
Clean metal cutting saw
Lubricate metal cutting saw
Install guides
Adjust guides
Select proper blades
Weld saw blade
Install saw blade
Select speeds and feeds
Cut metal
Deburr workpiece
Apply basic metallurgy knowledge
Identify proper cutting fluids
BIL: Essential

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Competency: Operate drill press

**Competency Builders:**
Clean drill press
Lubricate drill press
Identify proper cutting fluid
Mount part in holding device/fixture
Select proper bit, speed, and feed
Demonstrate proper bit sharpening techniques
Drill part
Countersink
Tap hole
Apply basic metallurgy knowledge
BIL: Essential

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Competency: Operate tool and cutter grinding machine

Competency Builders:
Identify parts of machine
Identify proper cutting fluids
Identify causes of workpiece defects
Select proper wheels and work holding devices (e.g., superabrasives)
Perform truing operations
Perform dressing operations
Perform forming operations
Select proper speeds and feeds
Sharpen end mill
Sharpen horizontal milling cutter
Sharpen drills and countersinks
Apply basic metallurgy knowledge
BIL: Essential

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Competency: Operate pedestal grinder

Competency Builders:
Clean pedestal grinder
Lubricate pedestal grinder
Identify proper wheel
Identify proper coolant
Check wheel for defects
Mount wheel
Position guard and rest
Dress wheel
Sharpen drill bit
Apply basic metallurgy knowledge
BIL: Essential

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Competency: Operate lathe

Competency Builders:
Clean and lubricate lathe
Deburr
Demonstrate use of a 4-jaw chuck
Identify proper cutting fluid
Identify proper tools and holders
Sharpen tools properly
Mount workpiece
Use dial indicator
Position guards
Select feed(s) and speed(s)
Face workpiece
Turn shaft
Turn taper
Knurl workpiece
Cut off workpiece
Center drill hole
Cut threads (inside and outside)
Turn inside bore
Demonstrate use of steady rest
Demonstrate use of centers
Apply basic metallurgy knowledge
BIL: Essential

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Competency: Operate milling machine

Competency Builders:
- Clean milling machine
- Lubricate milling machine
- Identify proper cutting fluid
- Select proper tool
- Select proper feeds and speeds
- Type of cut (e.g., climb, std.)
- Mount workpiece
- Mount tool
- Mill surface
- Mill keyway
- Drill workpiece
- Bore with milling machine
- Mill angle
- Apply basic metallurgy knowledge
### BIL: Essential

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**Competency:** Operate surface grinder

**Competency Builders:**
- Clean surface grinder
- Lubricate surface grinder
- Identify proper cutting fluid
- Select proper wheel
- Select proper speeds and feeds
- Check wheel for defects
- Mount wheel
- Position guard
- Dress wheel
- Identify proper mounting techniques
- Mount workpiece
- Set surface grinder
- Apply basic metallurgy knowledge
BIL: Essential

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Competency: Select materials

**Competency Builders:**
Interpret color codes, numbering systems, and classification systems of materials (e.g., ANSI, SAE)
Identify metals using spark test
Identify metals using variety of tests
Identify materials
Apply basic metallurgy knowledge
BIL: Essential

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Competency: **Perform heat treatment and testing of metals**

**Competency Builders:**
- Test hardness of metals
- Perform non-destructive testing
- Perform destructive testing
- Harden metals to job specifications
- Temper metals to job specifications
- Anneal metals to job specifications
- Normalize metals to job specifications
- Case harden metals to job specifications
BIL: Essential

EDU: 12 AD AC

Competency: Explain nontraditional machining processes

Competency Builders:
- Describe principles of chemical etching
- List applications of chemical etching
- List advantages/disadvantages of chemical etching
- Describe principles of photochemical etching
- List applications of photochemical etching
- List advantages/disadvantages of photochemical etching
- Describe electrical-discharge machining (EDM)
- List applications of Plunge EDM
- Differentiate between Plunge EDM and wire EDM
- List applications for wire EDM
- Describe principles of electrochemical machining
- List applications of electrochemical machining
- List advantages/disadvantages of electrochemical machining
- Describe principles of water jet cutting
- List applications of water jet cutting
- Describe principles of torch cutting
- List applications of torch cutting
- Describe principles of laser cutting
- List applications of laser cutting
- List advantages/disadvantages of laser cutting
- Describe shot peen
- Describe media finish
- Describe glass bead
- Describe principles of laser welding
**BIL:** Essential

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**Competency:** Perform precision layouts

**Competency Builders:**
- Identify appropriate tools for measuring
- Describe precision, accuracy, tolerance, reliability, and discrimination
- Distinguish between precision and semiprecision measuring
- Define standard stock dimensions and tolerances
- Demonstrate knowledge of different units of measure (metric, standard, inches)
- Describe common measurement errors and correction procedures
- Calibrate measuring machines and devices
- Demonstrate care of measuring instruments
- Demonstrate use of rule
- Demonstrate use of tape
- Demonstrate use of pi tape
- Demonstrate use of combination square
- Demonstrate use of calipers
- Demonstrate use of micrometers (inside and out)
- Demonstrate use of dial indicators
- Demonstrate use of sine bar
- Demonstrate use of gauges (e.g., dial bore, dial snaps)
- Demonstrate use of surface plate
- Demonstrate use of protractor
- Explain use of profilometer
- Demonstrate use of thermometer
- Demonstrate use of dividers
- Demonstrate basic use of gauge blocks
- Demonstrate use of threading specs
- Explain use of optical comparitor
- Explain use of digital instruments
- Explain use of electronic gauging equipment
- Explain use of data acquisition equipment
Explain operation of manual coordinate measuring machine (CMM)
Explain use and application of laser alignment/measurement
Unit: Metal Stamping Dies

BIL: Recommended

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Competency: Describe different types of dies

Competency Builders:
Describe crimping die
Describe parts assembly die
Describe CAM bending die
Describe blanking die
Describe pierce die
Describe forming die
Describe draw die
Describe progressive die
BIL: Recommended

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Competency: Describe fixtures

Competency Builders:
- Describe crimping fixture
- Describe locating fixture
- Describe press fitting fixture
- Describe riveting fixture
- Describe welding fixture
**Competency:** Design product

**Competency Builders:**
- Draw isometric view of product
- Construct model (e.g., clay, form, wood, plastic)
- Scan model
- Wire frame data
- Create computerized model
- Interface model with CAD/CAM
- Reproduce surface finish
- Identify materials for product
- Create prototype
- Validate product
- Standardize product
**BIL:** Recommended

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**Competency:** Troubleshoot design errors

**Competency Builders:**
- Isolate cause of die component breakage
- Isolate cause of failure of parts to be removed from die
- Isolate cause of incorrect punch clearance
- Isolate cause of incorrect die clearance
- Isolate cause of misfitting die components
BIL: Recommended

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Competency: Correct design errors

Competency Builders:
Correct cause of die component breakage
Correct cause of failure of parts to be removed from die
Correct cause of improper punch clearance
Correct cause of improper die clearance
Correct cause of misfitting die components
BIL: Recommended

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Competency: Explain die processing

Competency Builders:
Describe preplanning activities
Describe die layout
Identify die operations (e.g., number, purpose and sequence of die operations)
Describe feasibility study development
Describe sequence of operations from die construction
BIL: Recommended

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Competency: Explain pattern shop applications

Competency Builders:
Describe pattern shop activities
Describe die pattern materials (e.g., wood, styrofoam, ceramic)
Describe die pattern construction
Describe casting of dies
Describe casting of components
Describe model process steps
Describe model use
BIL: Recommended

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Competency: Explain die construction (e.g., production and operation techniques)

Competency Builders:
- Explain need for basic machining skills
- Explain need for sculptured machining skills
- Explain EDM functions
- Explain die material standards
- Describe tool and die welding
- Describe punch finishing
- Explain lifter/gauging systems
- Explain pressure systems
- Describe function of cams
BIL: Recommended

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**Competency:** Explain the die tryout process

**Competency Builders:**
- Explain need to use analytical problem solving for die tryout
- Describe process documentation
- Describe die modification techniques
- Describe blank modification techniques
- Describe die buy-off
- Describe die release
- Describe part release
- Describe die coatings
- Describe die treatments
BIL: Recommended

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Competency: Explain die maintenance

Competency Builders:
- Describe planned die maintenance
- Describe predictive die maintenance
- Describe preventive die maintenance
- Describe die maintenance troubleshooting techniques
- Describe die refurbishment techniques
Unit: Press Technology

BIL: Recommended

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Competency: Explain press operation

Competency Builders:
- Identify types of presses
- Describe functions of presses
- Identify capacity of presses
- Identify operator safety devices
BIL: Recommended

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Competency: Demonstrate knowledge of press accessories

Competency Builders:
Describe function of monitors, proximity switches and die protection
Describe function of loaders
Describe function of roller levelers
Describe function of decoilers
Describe function of feeders
Describe function of transfer mechanisms
Describe function of lubricators and coolants
Describe processing of coil steel
Describe use of SMED change
Describe press set-up
Unit: Sheet Metal Fabrication

BIL: Recommended

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Competency: Demonstrate knowledge of sheet metal fabrication

Competency Builders:
- Describe sheet metal fabricated products
- Describe press working process
- Describe process(es) of straightening metal
- Describe metal finishing and coating
- Explain bend allowances
- Identify materials used for sheet metal fabrication (e.g., hot roll, cold roll, aluminum, stainless)
- Explain process of determining metal thicknesses
- Explain process of layout
- Explain process of fastening
- Explain process of punch and die clearance and alignment
- Demonstrate the capability to finish (cleaning, painting, plating)
- Demonstrate CADD uses for layout
**BIL:** Recommended

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**Competency:** Describe types of metal fabrication manufacturing

**Competency Builders:**
- Describe shear
- Describe press brake
- Describe cut-to-length lines
- Describe roll forming
- Describe computer numerical control (CNC) turret presses
- Describe flexible manufacturing system (FMS) cells
**BIL:** Recommended

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**Competency:** Layout sheet metal

**Competency Builders:**
- Lay out 90° ells
- Lay out 95° and 30° ells
- Use radial line development to lay out
- Use development by triangulation to lay out

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**BIL:** Recommended

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**Competency:** Fabricate components

**Competency Builders:**
- Layout design
- Measure materials
- Create pattern and/or prototype
- Use hand tools
- Cut materials
- Form materials
- Use temporary and permanent fasteners
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**Competency:** Perform sheet metal fabrication

**Competency Builders:**
- Identify sheet metal fabrication jobs
- Identify tools needed (e.g., manual and hand powered)
- Fabricate round ells
- Fabricate tees
- Fabricate pyramids
- Fabricate cones
- Fabricate transitions
Unit: Basic Moldmaking

BIL: Recommended

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Competency: Explain processes for building molds

Competency Builders:
Describe process of making a mold
Describe machinery used in moldmaking
Describe types of metal used for molds
Identify types of components used in the forming process (e.g., gibs, core, cavity, slides, heaters)
Identify surface finishes for molds
Identify types of molding materials (e.g., glass, plastic, rubber, die cast, pressware)
Describe the fitting and assembly process
BIL: Recommended

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Competency: Describe the process of extrusion/pultrusion

Competency Builders:
- Explain extrusion method/pultrusion
- Identify machines and dies used in extrusion
- Identify applications for extrusion
- Identify auxiliary equipment needed
**BIL:** Recommended

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**Competency:** Describe compression molding

**Competency Builders:**
- Explain compression molding method
- Identify machines and molds used in compression molding
- Identify applications for compression
- Identify auxiliary equipment needed
**BIL:** Recommended

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**Competency:** Describe injection molding

**Competency Builders:**
- Explain injection molding method
- Identify machines and molds used in injection molding
- Identify applications for injection molding
- Identify auxiliary equipment needed
BIL: Recommended

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**Competency:** Describe blow molding

**Competency Builders:**
- Explain blow molding method
- Identify machines and molds used in blow molding
- Identify applications for blow molding
- Identify auxiliary equipment needed


**BIL:** Recommended

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**Competency:** Describe thermoforming

**Competency Builders:**
- Explain thermoforming method
- Identify machines and molds used in thermoforming
- Identify applications for thermoforming
- Identify auxiliary equipment needed
Competency: Describe rotational molding

Competency Builders:
- Explain rotational molding method
- Identify machines and molds used in rotational molding
- Identify applications for rotational molding
- Identify auxiliary equipment needed
BIL:  Recommended

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Competency: Describe calendering method

Competency Builders:
- Explain calendering method
- Identify machines and molds used in calendering
- Identify applications for calendering
- Identify auxiliary equipment needed
BIL: Recommended

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Competency: Describe foam processes

Competency Builders:
- Explain foam processes method
- Identify machines and materials used in foam processing
- Identify applications for foam processes
- Identify auxiliary equipment needed
BIL: Recommended

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Competency: Describe powder coating

Competency Builders:
- Explain powder coating method
- Identify machines and materials used in powder coating
- Identify applications for powder coating
- Identify auxiliary equipment needed
Unit: Material Joining Technology

BIL: Recommended

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Competency: Perform basic soldering of electrical components

Competency Builders:
Prepare surfaces to be soldered
Select appropriate solder
Select appropriate flux
Select appropriate soldering iron temperature
Select appropriate soldering iron tip shape
Select appropriate flux remover
Select appropriate surface sealant
Inspect solder joints under microscope
Identify good and bad solder joints
Measure solder joint resistance of good and bad joints
BIL: Recommended

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Competency: Operate wave soldering machine

**Competency Builders:**
- Inspect surfaces to be soldered
- Select appropriate solder
- Select appropriate flux
- Set all machine parameters (e.g., temperature, wave amplitude, transport velocity)
- Inspect solder joints of completed printed circuit boards
BIL: Recommended

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Competency: Solvent weld plastic joints

Competency Builders:
- Prepare surfaces to be joined
- Select appropriate cleaners
- Select appropriate adhesive
- Make and inspect joints
- Review and adhere to appropriate codes
**BIL:** Recommended

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**Competency:** Thermal weld plastic joints

**Competency Builders:**
- Prepare surfaces to be joined
- Select appropriate cleaners
- Select appropriate heat gun temperature
- Select appropriate inert gas and flow rate
- Select appropriate plastic rod if required
- Make and inspect joints
Unit: Welding Basics

BIL: Essential

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Competency: Perform basic gas welding, brazing, and cutting

Competency Builders:
Follow safety guidelines
Differentiate welding and brazing
Identify gas welding and cutting equipment and accessories
Use personal protective equipment required for welding and cutting
Explain capillary attraction as it applies to metal
Demonstrate proper lighting, adjusting, and shutting down of gas torch
Layout mild steel
Cut mild steel
Braze mild steel
Solder non-ferrous metals
Apply basic metallurgy technology
BIL: Essential

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Competency: Perform basic arc welding/cutting (e.g., stick)

Competency Builders:
Identify arc welding equipment and accessories
Explain process of resistance welding
Explain process of projection welding
Explain process of flash-butt welding
Explain process of laser welding
Explain process of friction welding
Explain process of spot welding
Explain process of shielded metal-arc welding (SMAW)
Explain process of gas metal-arc welding (GMAW)
Explain process of gas tungsten-arc welding (GTAW)
Explain process of plasma-arc cutting
Explain process of carbon arc gouging and cutting
Explain process of welding plastics
Explain welding rod alloys
Read welding rods
Explain mild steel welding rod
Explain low hydrogen welding electrode
Explain rationale for preheating and post-heating metal
Explain (GMAW) welding in flat, horizontal, vertical positions
Explain (GTAW) welding on mild steel, stainless steel, and aluminum
Explain process of build up and hard facing
Troubleshoot fusion of materials
Weld stainless steel using (SMAW) process
Weld steel requiring preheat
Weld cast iron
Weld aluminum
Apply basic metallurgy technology

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