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ABSTRACT

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)

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Engineering Technologies

State Competency Profile

May 7, 1998
Columbus, Ohio

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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:

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Engineering Technologies Futuring Panel
April 14, 1998
Columbus, Ohio

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Panel Facilitator

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**Engineering Technologies
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Engineering Technologies State Competency Profile Meeting

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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

	12	AD	AC
EDU	P	R	C

Competency: XXXXXXXX

Example:

BIL: Essential Recommended Delete

	12	AD	AC
EDU	P	R	C

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 **IM =** Industrial Manufacturing Technician

EM = Electromechanical Systems/Electrical Maintenance **CT =** CADD Technician

Technician

Small Type		UNIT						
Large Type		ET	EM	IM	CT			
1	1	X	X	X	X			
	16	X	X	X	X			
	27	X	X	X	X			
	36	X	X	X	X			
	41	X	X	X	X			
	45	X	X	X	R			
	50	X	X	X	X			
	53	X	X	X	X			
	57	X	X	X	X			
	69	X	X	X	X			
	97			X				
	126	X	X	X	X			
	148		R	R	R			
	152			X				
	155	X	X					
	173			X				
	181	X						
	183	X		R				
	193	X						
	196							
	209	X	X	X				
	217	X	X					

R = Recommended

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

Small Type	Large Type	UNIT	ET	EM	IM	CT
161	223	Electronic Noise	X	X		
164	226	Analog Circuits	X	X		
169	232	Digital Logic Circuits	X	X		
173	236	Microcomputer Electronics Technology	X			
178	244	Instrumentation Control Technology	R	X		
185	252	Electro-optic Technology	X	X		
190	259	Electronics Troubleshooting and Repair	X	X		
198	268	Electronics Troubleshooting and Repair for IM	X	X	X	
200	271	Electronic Product Servicing Technology	R			
207	281	Programmable Logic Controllers (PLCs)	R	X	R	
211	287	Communications Electronics Technology for ET	R			
220	298	Communications Electronics Technology for EM		X		
227	308	Industrial Electricity	X	X	X	
235	322	Wiring Methods		X		
246	334	Electrical Test and Measurement Equipment	X	X	X	
248	338	Electronic Assembly and Repair	X			
251	342	Equipment Installation		X	X	
256	348	Equipment Maintenance	R	X	X	
263	360	Industrial Engineering Basics			X	
267	367	Industrial Manufacturing Technology			X	
273	375	Basic Materials Science			X	R
285	394	Mechanical Power Transmission		X	X	
299	413	Fundamentals of Machine Anatomy		X	X	
301	416	Electromechanical Technology	R	X		

Unit: **Employability Skills**

BIL: Essential

EDU:	12	AD	AC
	P	R	C,S,M

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

BIL: Essential

EDU:	12	AD	AC
	P	R	C,S,M

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

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	P	R	C

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

BIL: Essential

EDU:	12	AD	AC
	P	R	C

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

BIL: Essential

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	P	R	C,S,M

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

EDU:	12	AD	AC
	P	R	C,S,M

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

EDU:	12	AD	AC
	P	R	C

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 work place/community

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

EDU:	12	AD	AC
	P	R	C,S,M

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

EDU:	12	AD	AC
	P	R	C,S,M

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

EDU:	12	AD	AC
	I	P	M,C

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

EDU:	12	AD	AC
	I	R	S,C,M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C,S,M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C,S,M

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

EDU:	12	AD	AC
	I	R	C

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

EDU:	12	AD	AC
	I	R	C,S,M

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C,S,M

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	P	R	C,S,M

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

EDU:	12	AD	AC
	I	P	C,S,M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	I	R	C

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

EDU:	12	AD	AC
	P	R	C,S,M

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

EDU:	12	AD	AC
	I	R	S

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	P	C,M,S

Competency: Implement projects *

Competency Builders:

Monitor project

Control project

Modify project

BIL: Essential

EDU:	12	AD	AC
	I	P	C,M,S

Competency: Evaluate projects *

Competency Builders:

Analyze performance

Perform critical review of project

Draw project management conclusions

BIL: Recommended

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	P	R	M,C,S

Competency: Appraise situations #

Competency Builders:

Identify concerns

Set priorities

Identify resolution process

Plan resolution

BIL: Recommended

EDU:	12	AD	AC
	I	P	M,C,S

Competency: Analyze problems #

Competency Builders:

Identify potential problems

Identify likely causes

Test for probable causes

Verify cause

Identify preventive actions

Identify contingent actions

BIL: Recommended

EDU:	12	AD	AC
	I	P	M,C,S

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

EDU:	12	AD	AC
	P	R	M,C,S

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

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	P	R	C,M

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	M,C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	P	M

Competency: Explain equipment depreciation *

Competency Builders:

- Explain straight line
- Explain sum of year's digits
- Explain declining balance
- Explain IRS strategies

BIL: Essential

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	R	M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	P	R	C,S

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

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	I	P	C

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

BIL: Essential

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	P	R	C

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

BIL: Essential

EDU:	12	AD	AC
	P	R	C

Competency: Explain operation of peripheral devices # *

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

EDU:	12	AD	AC
	P	R	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	P	R	C

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

BIL: Essential

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	P	R	S

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

EDU:	12	AD	AC
	P	R	M,C

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

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	M,C

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

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	R	M

Competency: Manipulate quality cost data

Competency Builders:

Develop quality cost data

Translate cost reports

Graph quality cost data (e.g., pareto)

BIL: Recommended

EDU:	12	AD	AC
	I	R	M,C

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

EDU:	12	AD	AC
	I	P	M,C

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

EDU:	12	AD	AC
	I	R	M,C

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

EDU:	12	AD	AC
	I	R	M

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability

Define empirical probability

Calculate probability for outcomes

BIL: Recommended

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	R	M

Competency: Construct X and R charts

Competency Builders:

Arrange data into statistical sub-groups

Explain importance of random sampling

Compute \bar{X} (e.g., average of values) and R (e.g., range of values in subgroup) within sample

Plot in \bar{X} and R on chart

Construct control chart with \bar{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

EDU:	12	AD	AC
	I	R	M,C

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

EDU:	12	AD	AC
	I	R	M

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: Recommended

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	R	M,C

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

EDU:	12	AD	AC
	I	R	M

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 = O (zero) acceptance plan
- Interpret instructions in a control plan

BIL: Recommended

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	P	

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

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
		P	

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use \bar{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

EDU:	12	AD	AC

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

EDU:	12	AD	AC

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

EDU:	12	AD	AC

Competency: Construct X and R charts

Competency Builders:

Arrange data into statistical sub-groups

Explain importance of random sampling

Compute \bar{X} (e.g., average of values) and R (e.g., range of values in subgroup) within sample

Plot \bar{X} and R on chart

Construct control chart with \bar{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

EDU:	12	AD	AC

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: Essential

EDU:	12	AD	AC
		P	

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

EDU:	12	AD	AC
		P	

Competency: Apply JIT

Comptency 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

EDU:	12	AD	AC
		P	

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

EDU:	12	AD	AC
		P	

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
- Interpret instructions in a control plan

BIL: Essential

EDU:	12	AD	AC
		P	

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

EDU:	12	AD	AC
	I	P	C,S,M

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

EDU:	12	AD	AC
	I	P	C,S,M

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

EDU:	12	AD	AC
	I	R	

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

BIL: Recommended

EDU:	12	AD	AC
	I	R	C

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

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

BIL: Essential

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	P	R	

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications

Prepare pictorial drawings

Prepare schematics

Interpret various drawings

BIL: Essential

EDU:	12	AD	AC
	P	R	

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

EDU:	12	AD	AC
	I	P	M

Competency: Interpret advanced prints

Competency Builders:

Interpret screw thread specifications

Identify structural steel shapes

Interpret special symbols

Interpret electrical, pneumatic/hydraulic drawings

Interpret schematics

BIL: Essential

EDU:	12	AD	AC
	I	P	

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, perpendicularity, 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 cylindricity

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

BIL: Essential

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	P	R	M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	M

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

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

BIL: Essential

EDU:	12	AD	AC
	I	P	M,C

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

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	R	M

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: Recommended

EDU:	12	AD	AC
	I	R	M

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

Unit: Visualization and Design for Function

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency: Deduce by examination function(s) of parts

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)

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

BIL: Essential

EDU:	12	AD	AC
	P	R	C

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

BIL: Essential

EDU:	12	AD	AC
	P	R	M,C

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

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	P	R	C

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles

Edit text styles

Select text styles

Apply notes

BIL: Essential

EDU:	12	AD	AC
	P	R	C,M

Competency: Dimension orthographic drawings

Competency Builders:

Apply dimensions per standards

Edit text

Control dimension variables/models

BIL: Essential

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	P	R	M

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

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	I	P	

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**

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing*. Version 2.1. April 1997, pp. 34-36.

BIL: Essential

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
		I	M

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

EDU:	12	AD	AC
		P	

Competency: Configure a CADD station

Competency Builders:

Install CADD software

Configure display drivers

Configure printer/plotter drivers

Configure input drivers

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
		I	

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

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	P	R	S,M,C

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

BIL: Essential

EDU:	12	AD	AC
	P	R	M,S,C

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

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 Thevenin'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

EDU:	12	AD	AC
	I	P	C,S,M

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

EDU:	12	AD	AC
	I	R	C,S,M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C,S,M

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 an 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

EDU:	12	AD	AC
	I	P	C

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C,M,S

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M,C,S

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C,S,M

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

EDU:	12	AD	AC
	I	P	M,C

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.

BIL: Essential

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	P	R	M

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	R	C

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

EDU:	12	AD	AC
	I	P	S,C,M

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)

BIL: Essential

EDU:	12	AD	AC
	I	P	C,S,M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency: Build control loops

Competency Builders:

Build flow loop

Build level control loop

Build pressure loop

Build temperature loop

BIL: Recommended

EDU:	12	AD	AC
	I	P	M,C,S

Competency: Perform calculations

Competency Builders:

Calculate orifice plate sizing

Calculate flow transmitter differential pressure

Calculate control valve sizing

BIL: Essential

EDU:	12	AD	AC
	P	R	M,C,S

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

EDU:	12	AD	AC
	I	P	M,C,S

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	S

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)

BIL: Essential

EDU:	12	AD	AC
	I	P	S

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

EDU:	12	AD	AC
	I	P	S

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

BIL: Recommended

EDU:	12	AD	AC
	I	R	S

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

EDU:	12	AD	AC
	I	R	S

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	C,M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	S

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
		P	

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: Electronic Product Servicing Technology

BIL: Recommended

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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)

BIL: Recommended

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	I	P	C,M,S

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

EDU:	12	AD	AC
	I	R	C,M

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

EDU:	12	AD	AC
	I	R	C,M,S

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

BIL: Recommended

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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 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

BIL: Recommended

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC

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

EDU:	12	AD	AC

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

EDU:	12	AD	AC

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

EDU:	12	AD	AC

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

EDU:	12	AD	AC

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 types of carrier systems

Describe principles and operation of various types of networks (e.g., ethernet, token ring)

Demonstrate operation of various types of networks

Describe proper techniques for cable termination (e.g., UTP, COAX, FIBER)

Demonstrate proper techniques for cable termination

BIL: Recommended

EDU:	12	AD	AC

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

EDU:	12	AD	AC

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

EDU:	12	AD	AC
	P	R	S,M,C

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

EDU:	12	AD	AC
	I	P	

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

BIL: Essential

EDU:	12	AD	AC
	I	P	S

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

EDU:	12	AD	AC
	P	R	S

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

EDU:	12	AD	AC
	P	R	S

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

EDU:	12	AD	AC
	P	R	C,M,S

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

EDU:	12	AD	AC
	I	P	C,S,M

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

Competency: Interpret schematics and diagrams

Competency Builders:

Identify circuit function

Interpret electrical symbols

Interpret block and ladder diagrams

Interpret schematics

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	P	R	

Competency: Use soldering tools

Competency Builders:

Select appropriate soldering tools and supplies for job

Perform soldering and desoldering techniques (e.g., micro-miniature, standard)

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	C,S,M

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

EDU:	12	AD	AC
	P	R	C,S,M

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

EDU:	12	AD	AC
	P	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	P	C

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)

BIL: Essential

EDU:	12	AD	AC
	I	P	M,C,S

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

EDU:	12	AD	AC
	I	P	M,C,S

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

EDU:	12	AD	AC
	I	P	M,C,S

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

EDU:	12	AD	AC
	I	P	M,C

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

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	P	R	M,C

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

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	P	R	C

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

EDU:	12	AD	AC
	I	P	C,M,S

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	

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

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards of the National Coalition for Advanced Manufacturing and the Metalworking Industry Skills Standards Board. Sources: *National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.* April 1997, pp. 36-39 and *Duties and Standards for Machining Skills. Level I. Duty 3.* November 1994.

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	C,M

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	P	M,C

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

EDU:	12	AD	AC
	I	P	S,M,C

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 powdered metallurgy

Explain secondary finishing operations (e.g., paint, anodizing)

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

Competency: Demonstrate basic knowledge of heat treatment

Competency Builders:

Describe process of heat treating

Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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 modulus)

List protective practices used after pouring

Describe concrete tools and applications (e.g., float, chairs)

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

BIL: Essential

EDU:	12	AD	AC
	I	P	S

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

BIL: Essential

EDU:	12	AD	AC
	I	P	

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	S,C,M

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	M,C,S

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	C,M,S

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, piezzo electric/piezzo 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

Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

BIL: Essential

EDU:	12	AD	AC
	I	P	C,M,S

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

EDU:	12	AD	AC
	I	P	C,S,M

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 circuit 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

EDU:	12	AD	AC
	I	P	M,S,C

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 braking
- Describe operation of various feedback loops
- Interpret motor name plate data

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

BIL: Recommended

EDU:	12	AD	AC
	I	R	C,M,S

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, piezzo electric/piezzo 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

Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

BIL: Recommended

EDU:	12	AD	AC
	I	R	M,S,C

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

EDU:	12	AD	AC
	I	R	M,C,S

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 circuit 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

EDU:	12	AD	AC
	I	R	M,S,C

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 braking
- Describe operation of various feedback loops
- Explain motor name plate data

BIL: Recommended

EDU:	12	AD	AC
	I	R	M,S,C

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

EDU:	12	AD	AC
	I	R	M,S,C

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

EDU:	12	AD	AC
	I	P	S,M,C

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

BIL: Essential

EDU:	12	AD	AC
	P	R	S,C

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

EDU:	12	AD	AC
	I	P	S,C

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

EDU:	12	AD	AC
	P	R	S,C

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity

Explain buoyancy

Explain equilibrium

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M

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

EDU:	12	AD	AC
	I	P	S

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

EDU:	12	AD	AC
	I	P	S,C

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

EDU:	12	AD	AC
	I	P	S

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

EDU:	12	AD	AC
	I	P	S

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits

Troubleshoot hydraulic circuits

Analyze pneumatic circuits

Troubleshoot pneumatic circuits

BIL: Recommended

EDU:	12	AD	AC
	I	P	S,C

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

EDU:	12	AD	AC
	I	P	S,C

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M,C,S

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

EDU:	12	AD	AC
	I	P	C,S

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

EDU:	12	AD	AC
	I	P	S,C

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

EDU:	12	AD	AC
	I	P	C,S

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

EDU:	12	AD	AC
	I	P	C,S

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

EDU:	12	AD	AC
	I	P	C,S

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

EDU:	12	AD	AC
	I	P	S,M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M

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

EDU:	12	AD	AC
	I	R	S,M

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components

Identify functions and operation of pneumatic components

BIL: Recommended

EDU:	12	AD	AC
	I	R	M,S

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

EDU:	12	AD	AC
		P	

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

EDU:	12	AD	AC
		P	

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

EDU:	12	AD	AC

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

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	R	

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

BIL: Essential

EDU:	12	AD	AC
	I	P	C

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

EDU:	12	AD	AC
	I	P	

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M

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

BIL: Essential

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	I	P	M

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

EDU:	12	AD	AC
	P	R	C,M

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

EDU:	12	AD	AC
	P	R	M,C

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

EDU:	12	AD	AC
	P	R	M,C

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

EDU:	12	AD	AC
	P	R	M,S

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

EDU:	12	AD	AC
	P	R	M,S,C

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

EDU:	12	AD	AC
	P	R	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S,C

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	S,C,M

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

EDU:	12	AD	AC
	I	P	S,M

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
	I	P	C,S,M

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

EDU:	12	AD	AC
	I	P	S,M,C

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

EDU:	12	AD	AC
	I	R	C

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

EDU:	12	AD	AC
	I	R	C

Competency: Describe fixtures

Competency Builders:

Describe crimping fixture

Describe locating fixture

Describe press fitting fixture

Describe riveting fixture

Describe welding fixture

BIL: Recommended

EDU:	12	AD	AC
	I	R	M,S,C

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

EDU:	12	AD	AC
	I	R	S,M,C

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

EDU:	12	AD	AC
	I	R	M,C

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

EDU:	12	AD	AC
	I	R	C,M,S

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

EDU:	12	AD	AC
	I	R	C,M,S

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

EDU:	12	AD	AC
	I	R	M,S,C

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

EDU:	12	AD	AC
	I	R	M,C

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

EDU:	12	AD	AC
	I	R	C

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

EDU:	12	AD	AC
	I	R	

Competency: Explain press operation

Competency Builders:

Identify types of presses

Describe functions of presses

Identify capacity of presses

Identify operator safety devices

BIL: Recommended

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	M,C,S

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

EDU:	12	AD	AC
	I	R	C,M

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

EDU:	12	AD	AC
	I	R	M

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

BIL: Recommended

EDU:	12	AD	AC
	I	R	M

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

BIL: Recommended

EDU:	12	AD	AC
	I	R	M

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

EDU:	12	AD	AC
	I	R	C

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

EDU:	12	AD	AC
	I	R	S,C

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

EDU:	12	AD	AC
	I	R	S,C

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

EDU:	12	AD	AC
	I	R	S,C

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

EDU:	12	AD	AC
	I	R	C,S

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

EDU:	12	AD	AC
	I	R	C,S

Competency: Describe thermoforming

Competency Builders:

Explain thermoforming method

Identify machines and molds used in thermoforming

Identify applications for thermoforming

Identify auxiliary equipment needed

BIL: Recommended

EDU:	12	AD	AC
	I	R	S,C

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

EDU:	12	AD	AC
	I	R	S,C

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

EDU:	12	AD	AC
	I	R	C,S

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

EDU:	12	AD	AC
	I	R	C,S

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

EDU:	12	AD	AC
	I	R	M,C

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	R	

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

EDU:	12	AD	AC
	I	P	M,S

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

EDU:	12	AD	AC
	I	P	

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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