Plastics Technical Competency Profile.

Ohio State Univ., Columbus. Center on Education and Training for Employment.

Ohio Board of Regents, Columbus.; Ohio State Dept. of Development, Columbus.; Ohio State Dept. of Education, Columbus.

96

233p.; Product of the Ohio Tech Prep Initiative.

Center on Education and Training for Employment, College of Education, The Ohio State University, 1900 Kenny Road, Columbus, OH 43210.

Guides - Classroom Use - Teaching Guides (For Teacher) (052)

MF01/PC10 Plus Postage.

Basic Skills; Behavioral Objectives; Competence; *Competency Based Education; *Employment Qualifications; High Schools; Job Skills; *Plastics; Postsecondary Education; *Statewide Planning; *Technical Occupations; *Tech Prep

Ohio

This document, which is intended to assist individuals responsible for developing tech prep programs, lists the occupational, academic, and employability competencies that representatives from education, business/industry, and labor throughout Ohio have identified as being necessary for employment in technician-level positions involving the manufacture and/or use of plastics. Included in the introductory section are the following: overview of the technical competency profile (TCP) process used to identify the technical competencies; lists of TCP team members; plastics job definitions; and plastics technical competency profile matrix. The plastics technical competencies identified by the TCP team are listed by the following categories: communications literacy; mathematics literacy; science literacy; technological literacy; employability skills; professionalism; teamwork; technical recording and reporting; problem analysis; project management; computer literacy; basic economics; workplace safety; industrial electricity; electric test and measurement equipment; drafting technology; print reading; computer-aided design fundamentals; equipment maintenance; electromechanical technology; basic machining; hydraulics and pneumatics; industrial manufacturing technology; programmable logic controllers; welding basics; supervision; quality assurance; plastics press technology; sheet metal fabrication; mold making; polymer technology; plastics troubleshooting; plastics product design; color matching; instrumental methods; rheology; and plastics manufacturing. Concluding the document are a sample glossary and plastics TCP Index.

(MN)
Plastics Technical Competency Profile

A Collaborative Project of the:

Ohio Department of Development

Ohio Tech Prep Initiative
(co-sponsored by the Ohio Department of Education and Ohio Board of Regents)

Polymer Processors Association (PPA)

Printed and distributed by:

CENTER ON EDUCATION AND TRAINING FOR EMPLOYMENT
COLLEGE OF EDUCATION
THE OHIO STATE UNIVERSITY

BEST COPY AVAILABLE
Plastics Technical Competency Profile

Printed and distributed by:
Center on Education and Training for Employment
College of Education
The Ohio State University
1900 Kenny Road
Columbus, Ohio 43210
"The plastics industry has played a major role in Ohio's resurgence as an economic leader. Ohio accounts for approximately 10% of the national plastics industry workforce, employing more than 100,000 people, and is responsible for the manufacture and shipment of products valued at more than $15 billion..."

—Ohio Governor George V. Voinovich
A Collaborative Plastics Curriculum

More than a year ago, members of the Polymer Processors Association (PPA), Society of Plastics Engineers (SPE), and the plastics industry at-large sought the assistance of the Ohio Department of Development and the Ohio Tech Prep Initiative to develop a statewide core curriculum. This curriculum would provide career paths for students at the end of a high school vocational program, adult education program, 8,000 hour apprenticeship program, Tech Prep (2 + 2) program, applied associate degree program, and/or baccalaureate program.

As the plastics project curriculum facilitator, Cathy Scruggs, Ohio Tech-Prep Curriculum Specialist, would like to thank the following individuals for their help and support with this collaborative effort.

—Special Thanks—

For their extra networking efforts and driving force behind the project:
Per Flem, CEO, Performance Plastics, Inc.
Bill Palmer, President, Thermoplastics Division, Goshen Rubber Companies, Inc.
Bob Rajkovich, Gem City Plastic Machinery, Inc.

For their extra committee work:
Nancy Clem, Director, Akron Polymer Training Center
Mickey Brandon, President & CEO, Marco Molding
Les Crowell, Change Agent, Master Industries

For their assistance with facilitation of groups during the TCP Process:
Jan Eley, Director, Akron Area Tech Prep Consortium
Ed Harper, Director, Workforce Development Council
Mike Hockman, Supervisor Great Oaks Institute of Technology & Career Dev.
Sara Mazak, Program Associate, Center on Ed. & Training for Employment
Wendell Melton, Tech Prep Coordinator, Miami Valley Career & Tech.Center
Virginia Ramey, Director, Ohio South Tech Prep Consortium
Jerry Wickman, Director, Plastics Research Center, Ball State University

For their "behind the scenes" support:
Steve Chambers, Librarian, Center on Education & Training for Employment
Lowell "Chris" Chrisman, Executive Director, Polymer Processors Association
Sara Mazak, Program Associate, Center on Ed. & Training for Employment
Linda O'Connor, Manager, OITP, Ohio Department of Development
Tan Ray, Word Processor, Center on Education & Training for Employment
Shannon Vanderpool, OITP Secretary, Ohio Department of Development
# Table of Contents

The TCP Process ................................................................. vii


Education and Community Participants-1996 Plastics Technologies Curriculum Team............... xi

Plastics Job Definitions .......................................................... xix

Plastics Technical Competency Profile Matrix ...................................................... xxi

TCP Leveling Codes........................................................................ 1

- Communications Literacy—3
- Mathematics Literacy—19
- Science Literacy—29
- Technology Literacy—48
- Employability Skills—50
- Professionalism—56
- Teamwork—61
- Technical Recording & Reporting—64
- Problem Analysis—65
- Project Management—67
- Computer Literacy—69
- Basic Economics—71
- Workplace Safety—73
- Industrial Electricity—78
- Electrical Test & Measurement Equipment—85
- Drafting Technology—86
- Print Reading—92
- CAD Fundamentals—94
- Equipment Maintenance—97
- Electromechanical Technology—101
- Basic Machining—103
- Hydraulics & Pneumatics—111
- Industrial Manufacturing Technology—118
- Programmable Logic Controllers (PLCs)—123
- Welding Basics—126
- Supervision—129
- Quality Assurance—131
- Plastics Press Technology—142
- Sheet Metal Fabrication—146
- Moldmaking—149
- Polymer Technology—152
- Plastics Troubleshooting—163
- Plastics Product Design—165
- Color Matching—169
- Instrumental Methods—172
- Rheology—175
- Plastics Manufacturing—180
- Sample Glossary—196

Plastics Technical Competency Profile Index ...................................................... 201
The "Technical Competency Profile (TCP) Process" produces a list of occupational, academic, and employability competencies that need to be obtained in preparation for technician level positions in business, industry, and labor. The "TCP Process" allows individuals from both secondary and postsecondary education and business, industry, and labor to deal with change in a positive manner by being active decision makers in the development of curriculum. Prior to the first official TCP meeting, labor market need has been determined and occupations identified for the targeted curriculum cluster. Then the following three "panel sessions" occur.

Part I of the TCP Process:

Business, industry, and labor representatives from a labor market area are convened to identify the occupational, academic, and employability competencies needed by one or more technician-level positions.

• First, a brainstorming session is conducted to identify the critical skills needed by the technician(s) positions being targeted (e.g., Process Technician, or a cluster of occupations within the plastics industry).
• Second, a draft competency list that has been compiled in accordance with definitions of the individual or group of technician-level position(s) identified as the labor market need is offered for consideration. Then, business, industry, and labor representatives eagerly (1) add to, (2) delete from, and (3) alter the wording of the draft competency list until it reflects the needs in the consortium's labor market area. It is critical that business, industry, and labor representatives alter the draft to fit the needs of their area, because it will be the catalyst for systemic curriculum reform in their schools and colleges—ultimately altering the type of employee pool available.
• Then the business, industry, and labor representatives are provided with state required competencies in academic courses such as mathematics, language arts (communications), and science. They are asked to circle the code beside each competency that could be taught in the context of the technologies being addressed by the TCP. This is done by silent, written votes so that the educational levels of committee members will not sway the results. After tabulating the responses, the corresponding competencies are identified with an asterisk (*) and used during Parts II and III of the TCP Process.

© 1996. The Ohio State University, Center on Education and Training for Employment.
Part II of the TCP Process:

Both the academic and vocational-technical faculty members who will be delivering the competencies in the consortium's participating secondary schools and postsecondary colleges meet to assign grade levels and mastery levels to each competency on the list.

- "Leveling" codes are used to indicate two-year increments (by the end of grade 10, grade 12, AD-an associate degree, BD-a baccalaureate degree) during which competencies will be introduced (I) and/or reinforced (R); when students will expected to be competent (C), or proficient (P), or as having mastered (M) the competency; provided at a worksite (WS); or are lifelong learning (LL) skills due to technological change. Competencies may carry one code (e.g., M12) or multiple codes such as I-10, P-12, R-AD, M-BD, WS, LL. Faculty members are also asked to list obstacles to delivering the competencies as stated (e.g., wording, equipment, training needs). These issues are recorded and addressed during TCP Part III.
- Faculty members are also given the list of academic competencies that business, industry, and labor representatives identified during Part I as appropriate to be taught in the context of those technologies (indicated by an asterisk*) and asked to verify the validity of those choices. They are also asked to identify (using #) any additional competencies that need to be taught in the context of those technologies (Note—this is necessary due to educational terms not being understood by industry representatives.) In this way faculty begins to discuss ways to apply academic content to the various technologies and ways to collaborate across disciplines to accomplish that task.

Part III of the TCP Process:

Both groups, from TCP Parts I and II, meet together to address perceived obstacles to accomplishing the competencies and how they, as a team, can best work together to facilitate delivery of the curriculum by removing or addressing each of the obstacles identified in Parts II and III. This is the "magic" of the TCP Process. With all the individual "players" at the same table, planning for true systemic change can take place—especially if the focus is improving the education and training of students who will be their future employees and community members.

© 1996. The Ohio State University, Center on Education and Training for Employment.
Post-TCP Steps:

- Following the three “panel sessions” of the TCP Process, committees are formed to complete the leveling of the competency builders and to create “pathways” that aid parents, teachers, and counselors in guiding students toward career choices.

Sample Section of TCP Accountability Chart

<table>
<thead>
<tr>
<th>Unit: Computer Literacy</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency: Operate computer hardware</td>
<td>I</td>
<td>R</td>
<td>M</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Competency Builders:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)</td>
<td>M</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify hardware and its use</td>
<td>I</td>
<td>M</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Use hardware (e.g., mouse, drives, modems, cables, printers, digitizers, scanners, protection devices)</td>
<td>I</td>
<td>R</td>
<td>M</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Keyboard efficiently</td>
<td>M</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Demonstrate basic care of hardware</td>
<td>I</td>
<td>M</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

- The TCP chart is then used to extrapolate competencies into Competency Documentation Sheets that outline the content of each course/worksite experience on the curriculum pathway and verify that all the competencies in the TCP are covered.

Sample Competency Documentation Sheet

| Futures County High School, Plastics Technologies Program |
| Integrated Math I covers the following competencies: |
| NR2 Estimate answers, compute, and solve problems involving real numbers |
| M1 Estimate and use measurements |
| M8 Establish ratios with and without common units |
| M13 Compute total sales from a variety of items |
| M18 Identify area and volume |
| D1 Organize data into tables, charts, and graphs |
| D7 Use tables, charts, and graphs to identify trends, draw conclusions, and make predictions |
| A13 Set up and solve linear equations |
| A21 Graph linear equations |
| A36 Translate verbal statements into symbolic language |
| G1 Create and interpret drawings of three-dimensional objects |
| G2 Represent problem situations with geometric models and apply properties of figures |
| G4 Demonstrate knowledge of angles, parallel, and perpendicular lines |
| (the list would continue...) |

- To complete the TCP Process, committees often use both the “pathways” and the TCP chart to assist in the development of actual projects, lessons, modules, courses of study, and eventually curriculum resource guides for the various components of the program at each grade level.

© 1996. The Ohio State University, Center on Education and Training for Employment.
<table>
<thead>
<tr>
<th>Business, Industry, and Labor Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996 Plastics Technologies Curriculum Team</td>
</tr>
</tbody>
</table>

Mickey Brandon, President & CEO  
Marco Molding, Dayton

Lowell "Chris" Chrisman, Executive Director  
Polymer Processors Association, Akron

Les Crowell, Change Agent  
Master Industries, Ansonia

Wayne Decamp, Vice President-Manufacturing  
Landmark Plastic Corporation, Akron

Bill Deimling, President  
Deimling/jeliho, Amelia

Per Flem, CEO  
Performance Plastics, Inc., Cincinnati

Kurt Hamblin, Maintenance Superintendent  
Cardinal Packaging, Inc., Streetsboro

George Howard, Molding Superintendent  
Akro-Mils/a Myers Industries Company, Akron

Donald Keyes, Principal Engineer & Manager  
U. S. Precision Lens, Inc., Cincinnati

Ken Lazo, Director of Human Resources  
PREMIX, North Kingsville

Ken Lewis, Department Manager  
RECTO MOLDEP Products, Cincinnati

Mike Lilja, Engineering Manager  
Itew Industries, Ashtabula

Bill Loskofsky, Sr. Development Engineer  
The Goodyear Tire & Rubber Company, Akron
Business, Industry, and Labor Participants
1996 Plastics Technologies Curriculum Team

Brent Martin, Manager, Blow Molding Engineering Center
Owens-Brockway Plastics & Closures, Toledo

Joe Pallota, Plant Manager
Akro-Mils/a Myers Industries Company, Akron

Bill Palmer, President Thermoplastics Division
Goshen Rubber Companies, Inc., Englewood

Dennis Palmer
Palmer Plastic Machinery Services, Inc., Columbus

Bob Rajkovich
Gem City Plastic Machinery, Inc., Dayton

Ron Riffe, Diversified Industrial Training Coordinator
Ashtabula County JVS, Jefferson

Jim Schweller, Plant Manager
All Service Plastic Molding, Inc., Dayton

Donald Sherry, President
D. E. Sherry Company, Rocky River

John Silvey, Vice President
International Business Alliance, Ltd., Huber Heights

Willy Tychesen, Plastics Coordinator
Ohio Valley Regional Development Commission, Portsmouth

Paul Vieltorf, Territory Manager
Advanced Elastomer Systems, L. P., Akron
Education and Community Participants
1996 Plastics Technologies Curriculum Team

Shep Anderson, Chairperson, Manufacturing Education
Sinclair Community College, Dayton

Allen Arthur, Associate Dean, Applied Sciences
University of Cincinnati, Cincinnati

Mary Banton, Applied Communications Teacher
Tri-County Vocational School, Nelsonville

Richard M. Beldyk, Instructor, Mechanical Engineering Technology
Washington State Community College, Marietta

Dick Bickerstaff, Chairperson, Manufacturing Technologies
Columbus State Community College, Columbus

Karen Blocher, Tech Prep Coordinator
Greater Cincinnati Consortium, Batavia

Dale Bodey, Education Committee
Cleveland Society of Plastics Engineers, Strongsville

Jerry Brockway, Superintendent
Ashtabula County & Vocational School District, Jefferson

Scott Brohard, Instructor
Pike County Vocational School, Piketon

Martha Brosz, Program Director, Scientific Laboratory Technology
Cincinnati State Technical & Community College, Cincinnati

David Brown, Coordinator, Industrial Finishing
Lima Technical College, Lima

Bill Burson, Director
Vanguard-Sentinel Technical Center, Fremont

Andre Camarata, Supervisor of Curriculum & Instruction
Ashtabula County Schools, Jefferson
Education and Community Participants
1996 Plastics Technologies Curriculum Team

Tony Carter, Electricity Instructor
Pike County Vocational School, Piketon

Stephen J. Clarson, Assistant Dean, College of Engineering
University of Cincinnati, Cincinnati

Nancy Clem, Director
Akron Polymer Training Center, The University of Akron, Akron

Gary N. Conley, President
Institute of Advanced Manufacturing, Cincinnati

Bill Deffenbaugh, Director, Economic & Workforce Development
Owens Community College, Toledo

Michael J. DiMuzio, Technical Foundations Instructor
Great Oaks Institute of Technology & Career Dev., Cincinnati

Elaine Edgar, Tech Prep Administrator
Ohio Board of Regents, Columbus

Jan Eley, Tech Prep Director
Akron Area Tech Prep Consortium, Akron

L. Maxine Ewig, Project EMPOWER
Edison Industrial Systems Center, Toledo

Leonard Fitzwater, Trades &Industry Supervisor
Miami Valley Career Technology Center, Clayton

James Fraiser, Director
Great Oaks Institute of Technology & Career Dev., Cincinnati

Ted Gabry, Materials Instructor
Hocking College, Nelsonville

Darrell Gastin, Electronics Instructor
Tri-County Vocational School, Nelsonville
Education and Community Participants
1996 Plastics Technologies Curriculum Team

John P. Hardy, Engineering Technologies Instructor
Collins Career Center, Chesapeake

Edmund C. Harper, Director
Workforce Development Council, Fremont

Sandy Hartley, Applied Communications Teacher
Miami Valley Career Technology Center, Clayton

Daniel P. Hochgreve, Program Manager, Quality and Supplier Dev.
Lake Erie Manufacturing Extension Partnership, Toledo

Mike Hockman, Quality Support Team
Great Oaks Institute of Technology & Career Dev., Cincinnati

Jan Hoeweler, Mathematics Instructor
Cincinnati State Technical & Community College, Cincinnati

Lindell Holtzmeier, Materials Instructor
Hocking College, Nelsonville

Linda Howard, Tech Prep Director
Southeast Tech Prep Consortium, Nelsonville

Janet Hyden, Technical Communication Teacher
Scarlet Oaks Career Dev. Center, Cincinnati

Stan Jennings, Tech Prep Coordinator
Scioto County Vocational School District, Lucasville

Nicholas Johnson, Electrical Instructor
Scioto County Vocational School, Lucasville

Bruce Jones, Mathematics Instructor
Hocking College, Nelsonville

Dr. Daniel H. Jones, Polymer Technology Teacher
East High School, Akron
Education and Community Participants
1996 Plastics Technologies Curriculum Team

Dan Keehan, Plastics Instructor
Lorain County Community College, Elyria

Peter W. Klein, Assistant Professor, Dept. of Industrial Technology
College of Engineering and Technology, Ohio University, Athens

Jim Kronberg, Economic & Workforce Development
Owens Community College, Toledo

John Kunkler, Principal
Stow High School, Stow

Howard Lawson, Director of Career Education
Akron Public Schools, Akron

Vicki Lear, Teacher, Applied Mathematics
Miami Valley Career Technology Center, Clayton

Jack Lenz, Tech Prep Supervisor
Div. of Vocational & Adult Ed., Ohio Dept. of Education, Columbus

G. Rick Limber, Job Placement & Career Education
Four County Vocational School District, Archbold

Gretchen Lisi, Manager Technology Dev., Division of Training
U. S. Precision Lens, Inc., Cincinnati

Steve Martin, Tech Prep Coordinator
Pike County Vocational School District, Piketon

William Maston, Plastics Instructor
Miami Valley Career Technology Center, Clayton

Mike McGill, Vocational Instructor
Wadsworth High School, Wadsworth

Kim McKinley, Adult Director
Tri-County Vocational School, Nelsonville
Education and Community Participants
1996 Plastics Technologies Curriculum Team

Scott McMillen, Chemistry Teacher
Wadsworth High School, Wadsworth

William Meeker, Trade & Industrial Education Supervisor
Div. of Vocational & Adult Ed., Ohio Dept. of Education, Columbus

Wendell Melton, Tech-Prep Coordinator
Miami Valley Career Technology Center, Clayton

Steve Mercer, Director
Ashtabula County Vocational School District, Jefferson

Otto Meyer, Tech Prep Coordinator
West Central Ohio Consortium, Lima

Eric Miller, Applied Science Teacher
Tri-County Vocational School, Athens

Mike Miller, Instructional Supervisor
Ohio Hi-Point Career Center, Bellefontaine

Russ Miller, Mathematics Teacher
Ohio Hi-Point Career Center, Bellefontaine

Susan E. Mongiardo, Interim Coordinator, Polymer Technology
University of Akron, Akron

James D. Mumaw, Teaching & Learning Chair, Tech. & Sciences Div.
Terra Community College, Fremont

Becky Nicewarner, Human Resources Manager
Landmark Plastic Corporation, Akron

Judy Norris, Adult Director
Tri-Rivers Career Center, Marion

Leslie North, Mathematics Teacher
Wadsworth High School, Wadsworth
Education and Community Participants
1996 Plastics Technologies Curriculum Team

Linda O'Connor, Manager, Ohio Industrial Training Program
Economic Development Div., Ohio Dept. of Development, Columbus

G. James Pinchak, Associate Director, Planning & Admin. Services
Div. of Vocational & Adult Ed., Ohio Dept. of Education, Columbus

Sally Porter, Vocational Director
Wadsworth School District, Wadsworth

Virginia Ramey, Tech Prep Director
Ohio South Tech Prep Consortium, Portsmouth

Sue Ramlo, Physics Instructor, Engineering & Science Tech. Div.
University of Akron, Akron

Larry Reuss, Manufacturing Engineering Technology Instructor
Cincinnati State Technical & Community College, Cincinnati

Joyce M. Rimlinger, Composition & Literature Department Chair
Cincinnati State Technical & Community College, Cincinnati

Tom Robinson, Instructor
Great Oaks Institute of Technology & Career Dev., Cincinnati

Roger C. Scherer, Associate Professor, Eng. Technologies/Plastics
Shawnee State University, Portsmouth

Mike Schmeltzer, Chemistry Instructor
Wadsworth High School, Wadsworth

Doug Scott, Adult Education
Toledo Public Schools, Toledo

George H. Sehi, Dean, Engineering and Industrial Technology
Sinclair Community College, Dayton

Brian Sneider, Tech Prep Teacher
Vanguard/Sentinel Technical Center, Fremont
Education and Community Participants
1996 Plastics Technologies Curriculum Team

Steve Spriggs, Tech Prep Instructor
EHOVE Career Center, Milan

Jack Steinicke, Coordinator
Lakeland Tech Prep Consortium, Kirtland

Melanie R. Stewart, Polymer Science & Testing
Stow High School, Stow

Beth Stilwell, Mathematics Teacher
Tri-County Vocational School, Athens

Linda R. Taggart, English Teacher
Wadsworth High School, Wadsworth

Don Thompson, Science Instructor
Vanguard/Sentinel Technical Center, Fremont

Dr. Emin G. Turker, Dean, Engineering Technologies
Lakeland Community College, Kirtland

James Wallace, Instructor, Communications/General Studies
Hocking College, Nelsonville

Pat Walsh, Director, Engineering Technology
Hocking Technical College, Nelsonville

Linda Watkins, Superintendent
Four County Vocational School District, Archbold

Steven E. Wendel, Asst. Professor, Drafting & Design Technology
Sinclair Community College, Dayton

Steve Wheeler, Applied Science Teacher
Tri-County Vocational School, Nelsonville

Dr. Jerry L. Wickman, Director, Plastics Research and Ed. Center
Ball State University, Muncie, Indiana
Education and Community Participants
1996 Plastics Technologies Curriculum Team

Jennifer Williams, Supervisor
Tri-Rivers Career Center, Marion

Charles Winkle, Board Member
Great Oaks Institute of Technology & Career Dev., Cincinnati

Jeffery M. Woodson, Asst. Professor, Mechanical Engineering Tech.
Columbus State Community College, Columbus
Plastics Job Definitions

Production Associate—An operator of plastics processing equipment. Technical skills should include, but not be limited to:
- safety issues in plastic processing
- trimming/finishing operation
- visual inspection for appearance/defects
- performs basic quality procedures (e.g., use of go/no go gauges, calipers, scales)
- document process information (e.g., production reports, traceability, SPC charts)

Preferred Minimum Education Level: High School Graduation or GED equivalent

Set-Up Person—An individual who set-ups plastics processing equipment utilizing set-up specifications and prints. Technical skills should include, but not be limited to:
- has above plus
- enhanced safety training
- can read and understand set-up sheets, follow written instruction, keep records
- set-up tooling and auxiliary equipment
- can startup and run initial samples
- basic tooling and equipment maintenance
- material handling capabilities

Preferred Minimum Education Level: High School Graduation or GED equivalent

Maintenance Person—An individual who maintains, troubleshoots, and repairs equipment. Technical skills should include, but not be limited to:
- work experience of set-up/production associate
- advanced safety requirements
- understanding of electrical, hydraulic, pneumatic and mechanical systems on processing and related equipment
- reading schematic diagrams
- basic machining capabilities
- basic welding
- document changes

Preferred Minimum Education Level: High School Graduation or GED equivalent
Plastics Job Definitions

Quality Assurance Person—An individual who monitors and documents products conformance to specifications. Technical skills should include, but not be limited to:
• work experience of set-up/production associate
• reads prints
• maintain calibration program
• generate first piece inspection
• can apply SPC technologies
• handling the responsibility of being in an unpopular position
• capability of team problem solving

Preferred Minimum Education Level: High School Graduation or GED equivalent

Process Technician—An individual who troubleshoots and corrects processing problems. Would also be used to improves processes. Technical skills should include, but not be limited to:
• has above plus
• abilities of quality assurance
• knowledge of material properties
• capability of team problem solving

Preferred Minimum Education Level: Two-year Applied Associate Degree and/or Postsecondary Apprenticeship Certificate

Journeyman—An individual who possesses the technical skills of the molder, set-up, maintenance, quality assurance, and processing technician.

Preferred Minimum Education Level: Completion of an 8,000 hour Apprenticeship Program or a Two-year Applied Associate Degree and several years of experience

Baccalaureate Degree—An individual who has obtained a four-year degree in either (1) Plastics Manufacturing/Processing or Materials Science; (2) Industrial Technology with an emphasis in plastics; or (3) an area of Engineering Technologies with a capstone in plastics.
# Plastics Technical Competency Profile Matrix
(March 1996)

A = Production Associate  
B = Set-Up Person  
C = Maintenance Person  
D = Quality Assurance Person  
E = Process Technician  
F = Journeyman  
G = Baccalaureate Degree

<table>
<thead>
<tr>
<th>PG</th>
<th>UNITS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>*Communications Literacy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>19</td>
<td>*Mathematics Literacy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>29</td>
<td>*Science Literacy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>48</td>
<td>*Technology Literacy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>50</td>
<td>Employability Skills</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>56</td>
<td>Professionalism</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>61</td>
<td>Teamwork</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>64</td>
<td>Technical Recording &amp; Reporting</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>65</td>
<td>Problem Analysis</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>67</td>
<td>Project Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>69</td>
<td>Computer Literacy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>71</td>
<td>Basic Economics</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>73</td>
<td>Workplace Safety (Level 1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>77</td>
<td>Workplace Safety (Level 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>78</td>
<td>Industrial Electricity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>85</td>
<td>Electrical Test &amp; Measurement Equipment</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>86</td>
<td>Drafting Technology</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>92</td>
<td>Print Reading</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>94</td>
<td>CAD Fundamentals</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>97</td>
<td>Equipment Maintenance</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>101</td>
<td>Electromechanical Technology</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>103</td>
<td>Basic Machining</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>111</td>
<td>Hydraulics &amp; Pneumatics</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>118</td>
<td>Industrial Manufacturing Technology (Level 1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>122</td>
<td>Industrial Manufacturing Technology (Level 2)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Plastics Technical Competency Profile
Matrix
(continued)

A = Production Associate
B = Set-Up Person
C = Maintenance Person
D = Quality Assurance Person
E = Process Technician
F = Journeyman
G = Baccalaureate Degree

<table>
<thead>
<tr>
<th>PG</th>
<th>UNITS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>Programmable Logic Controllers (PLCs)</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>126</td>
<td>Welding Basics</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>129</td>
<td>Supervision</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>131</td>
<td>Quality Assurance (Level 1)</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>134</td>
<td>Quality Assurance (Level 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>Quality Assurance (Level 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>142</td>
<td>Plastics Press Technology (Level 1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>143</td>
<td>Plastics Press Technology (Level 2)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>146</td>
<td>Sheet Metal Fabrication</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>149</td>
<td>Moldmaking (Level 1)</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>151</td>
<td>Moldmaking (Level 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>152</td>
<td>Polymer Technology (Level 1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>161</td>
<td>Polymer Technology (Level 2)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>163</td>
<td>Plastics Troubleshooting (Level 1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>164</td>
<td>Plastics Troubleshooting (Level 2)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>165</td>
<td>Plastics Product Design</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>169</td>
<td>Color Matching (Level 1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>171</td>
<td>Color Matching (Level 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>172</td>
<td>Instrumental Methods (Level 1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>174</td>
<td>Instrumental Methods (Level 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>175</td>
<td>Rheology</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>180</td>
<td>Plastics Manufacturing (Level 1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>185</td>
<td>Plastics Manufacturing (Level 2)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

196 Sample Glossary
TCP LEVELING CODES

10 = by end of grade 10
12 = by end of grade 12
AD= by end of the Associate Degree
BD= by end of the Baccalaureate Degree
LL = lifelong learning necessary due to technological change
WS = on-job-training that occurs at an actual worksite
I = introduce (applies to at least 3 competency builders)
R = reinforce or add depth (after introducing or mastery)
M or C or P = master, competent, or proficient (achievement of the competency and all its competency builders)

Example: M12, RAD
Example: I-10, R12, PAD, LL
Example: R10, C12, WS
Example: I-12, RAD, MBD

Special Academic Codes used only for Communications Literacy, Mathematics Literacy, Science Literacy, and Technology Literacy.

* = Industry identified this competency to be taught using applied methods in context of technology
# = Teachers identified this competency to be taught using applied methods in context of technology

Note: All academic competencies not identified by * or # are to be taught using regular or applied teaching methods.
| Subunit: Reading—Structure | RS1 | RS2 | RS3 | RS4 | RS5 | RS6 | RS7 | RS8 | RS9 | RS10 | RS11 | RS12 | RS13 | RS14 | RS15 | RS16 |
|---------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|
| Exhibit knowledge of language structure | C | P | R | R | | | | | | | | | | | | |
| Recognize that there may be more than one interpretation of reading selections | R | C | P | R | | | | | | | | | | | | |
| Recognize various literary devices | R | C | P | R | | | | | | | | | | | | |
| Recognize and discuss literary elements | R | C | P | R | | | | | | | | | | | | |
| Develop and use an increasingly sophisticated vocabulary gained through context | R | C | R | R | | | | | | | | | | | | |
| Apply knowledge of language structure to reading | C | P | R | R | | | | | | | | | | | | |
| Explain why there may be more than one interpretation of reading selections | I | R | C | P | | | | | | | | | | | | |
| Recognize effect of literacy devices on meaning | I | R | R | C | | | | | | | | | | | | |
| Analyze author's use of literary elements | | | | | | | | | | | | | | | | |
| Recognize relationship of structure to meaning | I | C | P | R | | | | | | | | | | | | |
| Describe various interpretations of reading selections | I | R | C | P | | | | | | | | | | | | |
| Characterize author's use of literary devices | | | | | | | | | | | | | | | | |
| Characterize use of literary techniques | | | | | | | | | | | | | | | | |
| Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization | R | C | R | R | | | | | | | | | | | | |
| Apply an expanding vocabulary gained through reading | R | C | R | R | | | | | | | | | | | | |
| Explain various interpretations selections and meaning levels in reading | I | R | C | P | | | | | | | | | | | | |
## Unit: Communications Literacy

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.

### Subunit: Reading—Structure (continued)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS17</td>
<td>Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>RS18</td>
<td>Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>RS19</td>
<td>Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

### Subunit: Reading—Meaning Construction

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM1</td>
<td>Demonstrate ability to recognize appropriate pre-reading strategies</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>*RM2</td>
<td>Describe effectiveness of a reading selection</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>*RM3</td>
<td>Read to clarify personal thinking and knowledge</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>*RM4</td>
<td>Support interpretation of text by locating and citing specific information</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM5</td>
<td>Develop and support personal response to a variety of literary works</td>
<td></td>
<td></td>
<td>I</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>RM6</td>
<td>Recognize diverse literary interpretations</td>
<td></td>
<td></td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
</tr>
<tr>
<td>*RM7</td>
<td>Engage in self-selected reading activities</td>
<td></td>
<td></td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*RM8</td>
<td>Confirm and extend meaning in reading by researching new concepts and facts</td>
<td></td>
<td></td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>*RM9</td>
<td>Self-monitor and apply corrective strategies when communication has been interrupted or lost</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM10</td>
<td>Use features of literary genres to extend meaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

---

4 27
### Unit: Communications Literacy

<table>
<thead>
<tr>
<th>Subunit: Reading—Meaning Construction (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM11 Assess effectiveness of a selection read</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM12 Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM13 Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM14 Predict, recognize, interpret, and analyze themes based on familiarity with author's work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>RM15 Compare and contrast literary genres</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM16 Assess validity and quality of selection read</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM17 Clarify meaning when reading</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM18 Compare personal reaction to critical assessment of a literary selection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>RM19 Assess validity of diverse literary interpretations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>RM20 Use reference books to find, evaluate, and synthesize information</td>
<td></td>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
</tr>
<tr>
<td>RM21 Identify tone of a literary work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>RM22 Critique validity of diverse literary interpretations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>RM23 Integrate personal reaction to and critical assessment of a literary selection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

### Subunit: Reading—Application

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*RA1 Select and read material for personal enjoyment and information</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RA2 Read a variety of complete, unabridged works</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.
<table>
<thead>
<tr>
<th>Subunit: Reading—Application (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* RA3 Employ various reading strategies according to purpose</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>RA4 Participate in selection of books, materials, and topics for literature study groups</td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>RA5 Develop and apply knowledge of the interrelationship of concepts</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>RA6 Read selections from a variety of styles and formats, recognizing that style and format influence meaning</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* RA7 Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>RA8 Read extensively from a particular author's work and explain elements of author's style</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Reading—Multidisciplinary</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* RM1 Connect themes and ideas across disciplines through literature</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>P</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* RM2 Read to facilitate learning across curriculum</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* RM3 Read to develop awareness of human rights and freedom</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>RM4 Participate actively in a community of learners</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RM5 Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
### Unit: Communications Literacy

Industry identified these to be taught using applied methods

Teachers identified these to also be taught using applied methods

Note: The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Reading—Multidisciplinary (cont.)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM6 Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>RM7 Value thinking and language of others</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>RM8 Relate literature to historical period about which or in which it was written</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>RM9 Read to facilitate content learning</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Writing—Structure</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS1 Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WS2 Clarify word choice according to audience, topic, and purpose</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WS3 Locate and correct errors in usage, spelling, and mechanics using a variety of resources</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WS4 Recognize information gained from primary and secondary sources</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WS5 Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WS6 Use information from a variety of sources to develop an integrated piece of writing</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WS7 Evaluate and revise writing to focus on such things as audience, tone, and purpose</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
**Unit: Communications Literacy**

* = Industry identified these to be taught using applied methods  
# = Teachers identified these to also be taught using applied methods  
**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Writing—Structure (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* WS8 Recognize differences between documentation and reference list styles</td>
<td></td>
<td></td>
<td>I</td>
<td>C</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>WS9 Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>WS10 Select from a repertoire of organization strategies a pattern appropriate to a topic</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>* WS11 Synthesize information from a variety of sources</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>* WS12 Refine word choice and tone according to audience, situation, and purpose</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>* WS13 Appropriately cite information gained from primary and secondary sources</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>* WS14 Use style manuals or software to prepare documentation and reference lists</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>* WS15 Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>* WS16 Identify organization patterns appropriate to writing topic</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>* WS17 Respond to others' suggested revisions to a writing piece</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

31
## Unit: Communications Literacy

* = Industry identified these to be taught using applied methods  
# = Teachers identified these to also be taught using applied methods  
Note: The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Writing—Meaning Construction</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>WM1 Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM2 Develop criteria for writing evaluation using scoring guides and peer/teacher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td>√</td>
</tr>
<tr>
<td>WM3 Respond to others' suggested revisions to a piece of writing</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* WM4 Use word processing, graphics, and publishing aids to construct meaning in writing</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM5 Engage in self-initiated writing activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* WM6 Incorporate personal criteria with generally accepted standards for writing evaluation</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* WM7 Evaluate, analyze, and synthesize information for writing</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM8 Evaluate own writing using personal and established scoring criteria</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM9 Assess personal/peer revisions to a writing piece</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM10 Recognize and refine personal writing styles</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Writing—Application</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* WA1 Apply appropriate writing techniques suitable for varied writing tasks</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* WA2 Use sentence-combining techniques to improve syntactic fluency and maturity</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
### Unit: Communications Literacy

**Notes:** Industry identified these to be taught using applied methods. Teachers identified these to also be taught using applied methods. The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Writing—Application (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WA3</strong> Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA4</strong> Develop personal voice in writing</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA5</strong> Consider audience and purpose for writing</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA6</strong> Develop criteria for selection and potential development of topic</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA7</strong> Write in a journal or learning log to clarify personal thinking and knowledge</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA8</strong> Apply an expanding vocabulary gained through writing</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA9</strong> Make judicious use of reference sources (e.g., dictionary, thesaurus, online data base, encyclopedia)</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA10</strong> Demonstrate an appreciation for aesthetically pleasing language through word choice and style</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA11</strong> Apply revising and editing strategies needed for writing task</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA12</strong> Vary sentence lengths and patterns</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA13</strong> Refine personal voice in writing</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA14</strong> Vary styles and formats for intended purpose and audience</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA15</strong> Apply criteria for selection and development of topic</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA16</strong> Participate in peer review of writing in progress</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>WA17</strong> Use transitions between sentences, ideas, and paragraphs in writing</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
### Unit: Communications Literacy

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Writing—Application (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>WA18 Revise and edit papers extensively in preparation for presentation/publication</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WA19 Develop a variety of genres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WA20 Focus writing and tone on such elements as audience, situation, and purpose</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* WA21 Develop topic fully and appropriately</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* WA22 Use writing process to clarify personal thinking and knowledge</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WA23 Apply appropriate recursive writing process as suggested by writing task and writer's process</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WA24 Develop an extended piece of writing</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WA25 Revise writing and tone to assure focus on such elements as audience, situation, and purpose</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WA26 Use writing process to write reflectively</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

### Subunit: Writing—Multidisciplinary

| WM1 Use writing process for learning across curriculum | R  | R  | R  | R  | √  |
| * WM2 Use writing process to demonstrate knowledge of need for human rights and freedom | R  | R  | R  | R  | √  |
| WM3 Value and apply collaborative skills in writing process | R  | R  | R  | R  | √  |
| * WM4 Write in response to reading, speaking, viewing, and listening | R  | R  | R  | R  | √  |
| * WM5 Use multidisciplinary resources in writing projects | R  | R  | R  | R  | √  |
| WM6 Use writing process to facilitate learning across curriculum | I  |    |    |    | √  |
### Unit: Communications Literacy

#### Subunit: Writing—Multidisciplinary (continued)

<table>
<thead>
<tr>
<th>Competency</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>WM7 Recognize value of and engage in collaboration in writing process</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM8 Use communication processes to develop a published writing piece in collaboration with others</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM9 Record experiences and observations related to content learning</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM10 Apply collaborative skills in writing process</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>WM11 Write collaboratively with peers</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WM12 Use cross-disciplinary resources in writing projects</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

#### Subunit: Listening/Visual Literacy—Structure

<table>
<thead>
<tr>
<th>Competency</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS1 Listen to and view a wide variety of genres</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>LS2 Become aware of an author's style through listening and viewing a variety of works</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>LS3 Recognize correct and appropriate grammar, diction, and syntax</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>LS4 Expand vocabulary through listening to and viewing varied media</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>LS5 Recognize beauty of language</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LS6 Enhance recognition of an author's style through listening and viewing a variety of works</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>LS7 Recognize use and misuse of language in media</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>LS8 Refine knowledge of style through listening and viewing multiple works by the same author</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.
# Unit: Communications Literacy

* = Industry identified these to be taught using applied methods  
# = Teachers identified these to also be taught using applied methods  
Note: The remaining competencies are to be taught using regular or applied methods.

## Subunit: Listening/Visual Literacy—Structure (continued)

<table>
<thead>
<tr>
<th>*</th>
<th>LS9</th>
<th>Expand and refine grammar, diction, and syntax through listening</th>
<th>R</th>
<th>R</th>
<th>R</th>
<th>R</th>
<th>√</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS10</td>
<td>Compare authors' styles through viewing and listening to their works</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>LS11</td>
<td>Expand knowledge of complex grammar, diction, and syntax issues</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

## Subunit: Listening/Visual Literacy—Meaning Construction

| * | LM1 | Develop critical thinking skills necessary to evaluate media and assess oral presentations | I | C | P | R | √ |
| LM2 | Compare new oral texts to past experiences and knowledge in order to enhance comprehension | I | C | R | P | √ |
| LM3 | Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature | P | R | R | R | √ |
| LM4 | Focus listening and viewing on themes and/or plots | P | R | R | R | √ |
| * | LM5 | Gather information from listening and viewing experiences to enhance research | C | P | R | R | √ |
| * | LM6 | Use critical thinking skills to evaluate media and oral presentations | C | P | R | R | √ | √ |
| LM7 | Use prior knowledge and experiences to facilitate comprehension of new oral texts | I | R | R | R | √ |
| LM8 | Identify rhythmic and time patterns in speech and literature | P | R | R | R | √ |
| LM9 | Identify and analyze themes and/or plots when listening and viewing | P | R | R | R | √ |
| LM10 | Use information gathered from listening and viewing experiences to expand research | C | P | R | R | √ |
**Unit:** Communications Literacy

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Listening/Visual Literacy—Meaning Construction (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM11 Enhance use of critical thinking skills to evaluate media and oral presentations</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>LM13 Appreciate rhythmic and time patterns of speech and literature</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>LM14 Select viewing and listening materials to support written text</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>*LM15 Evaluate media and oral presentations analytically and critically</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>LM16 Organize prior knowledge and experiences to comprehend new texts</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>LM17 Organize and use viewing and listening materials to support written text</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Listening/Visual Literacy—Application</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>*LA1 Listen attentively during oral reading</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>*LA2 Use media as stimuli for learning and thinking</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>LA3 Develop knowledge of structure through art, music, and literature</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>LA4 Use electronic media to enhance and highlight language learning</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>LA5 Listen and view for entertainment and enjoyment</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>*LA6 Use technology and other media as means of expressing ideas</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Unit: Communications Literacy</td>
<td>* = Industry identified these to be taught using applied methods # = Teachers identified these to also be taught using applied methods Note: The remaining competencies are to be taught using regular or applied methods.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Listening/Visual Literacy—Multidisciplinary</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM1 Facilitate learning across curriculum through critical listening and viewing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td>√</td>
</tr>
<tr>
<td>* LM2 Engage in individual, small-group, and whole-group listening and viewing activities</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>LM3 Develop language arts (e.g., viewing, listening) projects collaboratively</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>LM4 Investigate language and cultural differences through listening and viewing activities</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM5 Participate in a community of learners through productive listening</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Oral Communication—Structure</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* OS1 Refine oral communication skills</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* OS2 Demonstrate knowledge of grammar, usage, and syntax when presenting</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* OS3 Select topics and vocabulary suitable to audience</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* OS4 Organize notes and ideas for speaking</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS5 Use language imaginatively</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS6 Modulate voice to meaning when interpreting literature orally</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* OS7 Organize notes and ideas for formal, semiformal and informal presentations of information</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* OS8 Refine speaking techniques for formal, semiformal, and informal settings</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Unit: Communications Literacy**

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Oral Communication—Structure (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS9 Develop repertoire of organizational strategies for presenting information orally</td>
<td></td>
<td></td>
<td>C</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OS10 Expand vocabulary to fit topic</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OS11 Select topics suitable to audience, situation, and purpose</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OS12 Select appropriate strategies when organizing notes and ideas for speaking</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Oral Communication—Meaning Construction</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* OM1 Make connections between prior knowledge and new information for oral presentations</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM2 Participate in informal speaking activities</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM3 Use interviewing techniques to gather information</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM4 Communicate orally to entertain and to inform</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM5 Participate in group communication activities</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM6 Take and organize notes when preparing speech/presentation</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>OM7 Interpret texts orally to illustrate meaning</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM8 Respond to needs of various audiences</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM9 Gather and assess information for speaking</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM10 Communicate orally to inform and persuade</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>* OM11 Prepare and deliver formal speech/presentation</td>
<td>I</td>
<td>C</td>
<td>R</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>OM12 Participate in a variety of oral interpretations</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
Unit: Communications Literacy

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Oral Communication—Meaning Construction (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
</table>
* OM13 Assess needs of audience and adjust language and presentation according to their knowledge | C  | P  | R  | R  |    | √  |
OM14 Analyze and synthesize information for speaking | I  | C  | P  | R  | √  |    |
OM15 Describe effectiveness of literary selection | C  | R  | R  | P  | √  |    |
* OM16 Describe topic or idea in order to clarify personal/audience thinking | R  | C  | P  | R  | √  | √  |
* OM17 Analyze and synthesize information gathered from a variety of sources for speaking | I  | C  | P  | R  | √  |    |
OM18 Describe validity and/or quality of a literary selection and justify selection | I  |    |    |    |    |    |
OM19 Interpret orally a variety of literature | I  | R  | R  | C  | √  |    |
* OM20 Describe topic or idea to clarify meaning for others | R  | C  | P  | R  |    |    |

Subunit: Oral Communication—Application

* OA1 Become proficient at using interviewing techniques | I  | C  | R  | √  |    |    |
OA2 Give an oral interpretation for a specific audience | I  | C  | P  | R  | √  |    |
* OA3 Develop and apply oral communication skills for cooperative/collaborative learning | R  | C  | R  | P  | √  |    |
* OA4 Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales) | R  | R  | R  | R  | R  | √  |
* OA5 Develop and apply decision-making strategies | I  | C  | P  | R  | √  |    |
OA6 Practice interviewing techniques | R  | R  | R  | R  | R  | √  |

17
# Unit: Communications Literacy

* = Industry identified these to be taught using applied methods  
# = Teachers identified these to also be taught using applied methods  
Note: The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Oral Communication—Application (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* OA7 Apply interviewing techniques to purposeful interviews</td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>OA8 Focus oral interpretation on a specific audience</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Oral Communications—Multidisciplinary</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* OM1 Value thinking and language of others</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>OM2 Develop oral projects collaboratively</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>OM3 Be involved in individual, small-group, and whole-group language activities</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>OM4 Participate actively in a community of learners</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>OM5 Investigate language and cultural differences through oral language activities</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
**Unit: Mathematics Literacy**

*Industry identified these to be taught using applied methods*

# Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Numbers and Number Relations</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>NR1</em> Compare, order, and determine equivalence of real numbers</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>NR2</em> Estimate answers, compute, and solve problems involving real numbers</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>NR3</em> Compare and contrast real number system, rational number system, and whole number system</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>NR4</em> Extend knowledge to complex number system and develop facility with its operation</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subunit: Measurement**

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M1</em> Estimate and use measurements</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>M</td>
<td>✓</td>
</tr>
<tr>
<td><em>M2</em> Understand need for measurement and probability that any measurement is accurate to some designated specification</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
</tr>
<tr>
<td><em>M3</em> Understand and apply measurements related to power and work</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
</tr>
<tr>
<td><em>M4</em> Understand and apply measurement concepts of distance-rate-time problems and acceleration problems</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
</tr>
<tr>
<td><em>M5</em> Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
</tr>
<tr>
<td><em>M6</em> Use real-world problem situations involving mass and weight</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><em>M7</em> Use real-world problem situations involving simple harmonic motion</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><em>M8</em> Establish ratios with and without common units</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td><em>M9</em> Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Subunit: Measurement (continued)</td>
<td>M10</td>
<td>M11</td>
<td>M12</td>
<td>M13</td>
<td>M14</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>* Understand and solve rate-change problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Graph and interpret ordered pairs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Compute total sales from a variety of items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Comprehend and compute rates of growth or decay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Comprehend, compute, and interpret real problems involving annuities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Develop techniques to identify real problems and provide possible solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Identify and apply different types of measurement scales</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Identify area and volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Estimation and Mental Computation</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Use estimation to eliminate choices in multiple-choice tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Use estimation to determine reasonableness of problem situations in a wide variety of applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Estimate shape of graphs of various functions and algebraic expressions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Use mental computation when computer/calculator are inappropriate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.
<table>
<thead>
<tr>
<th>Subunit: Data Analysis and Probability</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* D1 Organize data into tables, charts, and graphs</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>* D2 Understand and apply measures of central tendency, variability, and correlation</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>* D3 Use curve fitting to predict from data</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* D5 Use computer simulations and random number generators to estimate probabilities</td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* D6 Test hypotheses using appropriate statistics</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* D8 Identify probabilities of events involving unbiased objects</td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* D9 Use sampling and recognize its role in statistical claims</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>* D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* D11 Describe normal curve in general terms and use its properties</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* D12 Create and interpret discrete probability distributions</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* D13 Understand concept of random variable</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.
Unit: Mathematics Literacy

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Data Analysis and Probability (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
</table>
* D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square | I C P √ √ |

<table>
<thead>
<tr>
<th>Subunit: Algebra</th>
</tr>
</thead>
</table>
* A1 Describe problem situations by using and relating numerical, symbolic, and graphical representations | C R P R |
* A2 Use language and notation of functions in symbolic and graphing settings | I C P R |
* A3 Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations | I C P |
* A4 Describe and use logic of equivalence (≤,≥,=) in working with equations, inequalities, and functions | I C P |
* A5 Develop graphical techniques of solution for problem situations involving functions | I C R P |
* A6 Explore and describe characterizing features of functions | I C R P |
* A7 Make arguments in algebraic settings (solve literal equations) | I R C |
* A8 Factor difference of two squares | I P R R |
* A9 Identify slope, midpoint, and distance | I C P R |
A10 Explore and combine rational functions | I C R P |
* A11 Explore factoring techniques | I C P R |
* A12 Solve quadratic equations by factoring and formula | I C P R |
* A13 Set up and solve linear equations | C R P R |
* A14 Solve systems of linear equations with two variables | I C P R |
<table>
<thead>
<tr>
<th>Subunit: Algebra (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* A15 Describe geometric situations and phenomena using variables, equations, and functions</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A16 Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A17 Represent inequalities on number line and in coordinate plane</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A18 Use coordinate arguments in making geometric proofs</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A19 Symbolize transformations of figures and graphs</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A20 Explore geometric basis for functions of trigonometry</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A21 Graph linear functions</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A22 Develop and use vectors to represent direction and magnitude including operations</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A23 Use polar and parametric equations to describe, graph, and solve problem situations</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A24 Represent sequences and series as functions both algebraically and graphically</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A25 Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A26 Describe and solve algebraic situations with matrices</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A27 Describe and use inverse relationship between functions including exponential and logarithmic</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A28 Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subunit: Algebra (continued)</td>
<td>10</td>
<td>12</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>* A29 Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A30 Explore relationships between complex numbers and vectors</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A31 Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A32 Represent transformations in plane with matrices</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A33 Contrast and compare the algebras of rational, real, and complex numbers with characteristics of a matrix algebra system</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A34 Construct polynomial approximations of a function over specified intervals of convergence</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A35 Examine complex numbers as zeros of functions</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># A36 Translate verbal statements into symbolic language</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A37 Simplify algebraic expressions</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A38 Use laws of exponents (including scientific notation)</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A39 Expand and extend idea of vectors and linear algebra to higher dimensional situations</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A40 Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A41 Develop and communicate arguments about limit situations</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A42 Use matrices to describe and apply transformations</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Unit: Mathematics**

**Literacy**

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Algebra (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A43 Develop and use polar and parametric equations to represent problem situations</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A44 Explore proofs by mathematical induction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Geometry</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* G1 Create and interpret drawings of three-dimensional objects</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* G2 Represent problem situations with geometric models and apply properties of figures</td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* G3 Apply Pythagorean theorem</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* G4 Demonstrate knowledge of angles and parallel and perpendicular lines</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* G5 Explore inductive and deductive reasoning through applications to various subject areas</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G6 Translate between synthetic and coordinate representations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>* G7 Identify congruent and similar figures using transformation with computer programs</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G8 Deduce properties of figures using transformations and coordinates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>* G9 Use deductive reasoning</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* G10 Explore compass and straightedge constructions in context of geometric theorems</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G11 Demonstrate knowledge of and ability to use proof</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12 Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>G13 Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Unit: Mathematics Literacy

#### Subunit: Geometry (continued)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>G14</strong></td>
<td>Explore different proof strategies</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G15</strong></td>
<td>Investigate different proofs of theorems</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G16</strong></td>
<td>Develop knowledge of an axiomatic system</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G17</strong></td>
<td>Apply transformations and coordinates in problem solving</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G18</strong></td>
<td>Represent problem situations with geometric models and apply properties of figures</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G19</strong></td>
<td>Deduce properties of figures using vectors</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G20</strong></td>
<td>Analyze properties of Euclidean transformations and relate translations to vectors</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G21</strong></td>
<td>Apply vectors in problem solving</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G22</strong></td>
<td>Develop further knowledge of axiomatic systems by investigating and comparing various geometry’s</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Subunit: Patterns, Relations, and Functions

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P1</strong></td>
<td>Model real-world phenomena with polynomial and exponential functions</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P2</strong></td>
<td>Explore relationship between zeros and intercepts of functions</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong></td>
<td>Translate among tables, algebraic expressions, and graphs of functions</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P4</strong></td>
<td>Use graphing calculator or computer to generate graph of a function</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P5</strong></td>
<td>Explore relationship between a linear function and its inverse</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P6</strong></td>
<td>Describe and use characteristics of polynomial functions in problem-solving situations</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.
<table>
<thead>
<tr>
<th>Subunit: Patterns, Relations, and Functions (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>P7 Explore conic sections and graph using graphing calculator or computer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* P8 Apply trigonometric functions to problem situations involving triangles</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P9 Discover relationships between algebraic description, kind, and properties of conic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P10 Explore periodic real-world phenomena using sine and cosine functions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P11 Analyze effects of parameter changes on graphs</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P12 Use graphing calculator or computer to graph functions</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P13 Develop a knowledge of rational and transcendental functions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P14 Understand connections between trigonometric and circular functions</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P15 Use circular functions to model periodic real-world functions</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P16 Solve trigonometric equations and verify trigonometric identities</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P17 Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># P18 Model real-world phenomena with a variety of functions</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P19 Graph using polar coordinates</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* P20 Explore graphs in three dimensions</td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods
Note: The remaining competencies are to be taught using regular or applied methods.
**Unit: Mathematics Literacy**

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Patterns, Relations, and Functions (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>P21 Explore functions of several variables</td>
<td></td>
<td></td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P22 Explore recursive functions using spreadsheets and/or programming languages</td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# = Teachers identified these to also be taught using applied methods

<table>
<thead>
<tr>
<th>Subunit: Scientific Inquiry</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* Q2 Use ratios, proportions, and percentages in appropriate problem situations</td>
<td>R</td>
<td>P</td>
<td>M</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)</td>
<td>R</td>
<td>P</td>
<td>M</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* Q4 Derive algebraic formulas and create new ones in appropriate problem-solving situations</td>
<td>I</td>
<td>P</td>
<td>M</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* Q7 Identify, compare, and contrast different modes of inquiry</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Subunit: Scientific Inquiry (continued)</td>
<td>10</td>
<td>12</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td><strong>Q11</strong> Use appropriate units for counts and measures</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q12</strong> Create and use databases (electronic and other) to collect, organize, and verify data and observations</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q13</strong> Design and conduct investigations with multiple variables</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q14</strong> Communicate the results of investigations clearly in a variety of situations</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q15</strong> Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q16</strong> Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q17</strong> Select, invent, and use tools, (including analog and digital instruments) to make and record direct measurements</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q18</strong> Observe and document events and characteristics of complex systems</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q19</strong> Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Q20</strong> Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
### Unit: Science Literacy

<table>
<thead>
<tr>
<th>Subunit: Scientific Inquiry (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q21 Generate testable hypotheses for observations of complex systems and interactions</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas</td>
<td>R</td>
<td>C</td>
<td>M</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q24 Construct and test models of physical, biological, social, and geological systems</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., Discover, Omni, Popular Mechanics)</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q26 Explore discrepant events and develop and test explanations of what was observed</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q27 Conduct theory-based research using surveys, observational instruments, and other methods</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q29 Analyze error and develop explanations in various domains</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.

Q21 Generate testable hypotheses for observations of complex systems and interactions
Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues
Q24 Construct and test models of physical, biological, social, and geological systems
Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., Discover, Omni, Popular Mechanics)
<table>
<thead>
<tr>
<th>Unit: Science Literacy</th>
<th>* = Industry identified these to be taught using applied methods # = Teachers identified these to also be taught using applied methods Note: The remaining competencies are to be taught using regular or applied methods.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subunit: Scientific Inquiry (continued)</strong></td>
<td><strong>10</strong></td>
</tr>
<tr>
<td># Q31</td>
<td>Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)</td>
</tr>
<tr>
<td>* Q32</td>
<td>Account for discrepancies between theories and observations</td>
</tr>
<tr>
<td>* Q33</td>
<td>Analyze the changes within a system when inputs, outputs, and interactions are altered</td>
</tr>
<tr>
<td>* Q34</td>
<td>Create, standardize, and document procedures</td>
</tr>
<tr>
<td>* Q35</td>
<td>Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities</td>
</tr>
<tr>
<td># Q36</td>
<td>Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, ...</td>
</tr>
<tr>
<td># Q37</td>
<td>Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors</td>
</tr>
<tr>
<td>* Q38</td>
<td>Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)</td>
</tr>
<tr>
<td>* Q39</td>
<td>Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing (resource materials; intuitive)</td>
</tr>
<tr>
<td>Unit: Science Literacy</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>* = Industry identified these to be taught using applied methods</td>
<td># = Teachers identified these to also be taught using applied methods</td>
</tr>
<tr>
<td>Note: The remaining competencies are to be taught using regular or applied methods.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Scientific Inquiry (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td># Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td># Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subunit: Scientific Knowledge</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td># K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subunit: Scientific Knowledge (continued)</td>
<td>T10</td>
<td>T12</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td># K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>K5 Investigate degrees of kinship among organisms and groups of organisms</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K7 Investigate estimates and measurements of a wide range of distances and rates of change</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>K11 Investigate conservation principles associated with physical, chemical, and nuclear changes</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>
### Unit: Science Literacy

<table>
<thead>
<tr>
<th>Subunit: Scientific Knowledge (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K12</strong> Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K13</strong> Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K14</strong> Formulate explanations for the influences of objects and organisms on each other over time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K15</strong> Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K16</strong> Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K17</strong> Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K18</strong> Formulate understandings of geologic time (e.g., millennia, periods, epochs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K19</strong> Formulate an understanding of the historical development of the model of the universe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

Note: The remaining competencies are to be taught using regular or applied methods.
### Unit: Science Literacy

<table>
<thead>
<tr>
<th>Subunit: Scientific Knowledge (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K20</strong> Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>K21</strong> Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>K22</strong> Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>K23a</strong> Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>K23b</strong> Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K24</strong> Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors)</td>
<td>I</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.
### Unit: Science Literacy

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Scientific Knowledge (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyletic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>
## Unit: Science Literacy

### Subunit: Scientific Knowledge (continued)

<table>
<thead>
<tr>
<th>K30</th>
<th>Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>K31</td>
<td>Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)</td>
<td>10</td>
<td>12</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
<tr>
<td>K32</td>
<td>Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)</td>
<td>10</td>
<td>12</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
<tr>
<td>K33</td>
<td>Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)</td>
<td>10</td>
<td>12</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
<tr>
<td>K34</td>
<td>Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)</td>
<td>10</td>
<td>12</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
<tr>
<td>K35</td>
<td>Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems</td>
<td>10</td>
<td>12</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
</tbody>
</table>

### Subunit: Conditions for Learning Science

| C1 | Participate actively in dialogue about and resolution of community issues | 10 | 12 | AD | BD | WS | LL |
### Unit: Science Literacy

<table>
<thead>
<tr>
<th>Subunit: Conditions for Learning Science (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2 Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3 Analyze the scientific ideas presented in science fiction stories and films</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* C4 Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* C5 Present the results of investigations in a variety of forums</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* C6 Contribute to the decisions regarding topics for investigation</td>
<td>C</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* C7 Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* C8 Consider the scientific thinking and language of others</td>
<td>C</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* C9 Individually and collaboratively produce clearly written representations of investigative results</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* C10 Fulfill responsibilities as part of a research group</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* C11 Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>C12 Present persuasive argument based on the scientific aspects of controversial issues</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

Note: The remaining competencies are to be taught using regular or applied methods.
**Unit: Science Literacy**

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Conditions for Learning Science (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C13</strong> Collect, store, retrieve, and manipulate information with available technologies alleges that may range from hand processes up through computer applications</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>C14</strong> Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td><strong>C15</strong> Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>C16</strong> Examine the intellect, perspectives, and ethics of notable scientists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td><strong>C17</strong> Collect and analyze observations made over extended periods of time and compare these to scientific theories</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>C18</strong> Create presentations of scientific understandings using diverse modes of expressions</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>C19</strong> Conduct formal scientific debates in the classroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td><strong>C20</strong> Wonder about the likelihood of events that may occur by chance or coincidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td><strong>C21</strong> Plan and conduct field trips and experiences for small and large groups</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C22</strong> Analyze the historical context which leads to and has lead to scientific theories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td><strong>C23</strong> Seek information on topics of personal scientific interest from a variety of sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>
### Subunit: Conditions for Learning Science (continued)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Details</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C24</td>
<td>Conduct learner-developed investigations independently and collaboratively over periods of week and months</td>
<td></td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C25</td>
<td>Listen attentively and critically to presentations of scientific information made by others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C26</td>
<td>Conduct analyses of propaganda related to scientific issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C27</td>
<td>Perform investigations that require observations over varying periods of time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C28</td>
<td>Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C29</td>
<td>Access appropriate technology to perform complicated, time-consuming tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C30</td>
<td>Relate historical accounts of science to the cultural context in which they were written</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C31</td>
<td>Work as a contributing member of a collaborative research group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C32</td>
<td>Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C33</td>
<td>Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C34</td>
<td>Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Unit: Science Literacy

Subunit: Conditions for Learning Science (continued)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C35</td>
<td>Lead groups of learners of various ages in designing, planning, and conducting science activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>* C36</td>
<td>Respect the scientific thinking of others and self</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C37</td>
<td>Recognize and contrast different epistemologies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>C38</td>
<td>Develop possible courses of action in response to scientific issues of local and global concern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
<td></td>
</tr>
<tr>
<td># C39</td>
<td>Determine the validity of research conclusions in relation to the design, performance, and results</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C40</td>
<td>Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>C41</td>
<td>Produce interesting and scientifically correct stories and present them using various modes of expression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>C42</td>
<td>Reflect on the ideas and content found in their own journal records</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>C43</td>
<td>Examine ambiguous results and formulate explanations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>C44</td>
<td>Recognize and synthesize the contributions to scientific thought of individuals from many cultures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>C45</td>
<td>Construct models and simulations of the component structures and functions of living and non-living entities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>C46</td>
<td>Lead multi-age groups in the examination of and planned resolution for scientific issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

Note: The remaining competencies are to be taught using regular or applied methods.
## Unit: Science Literacy

### Subunit: Conditions for Learning Science (continued)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C47</td>
<td>Recognize and choose members of research teams based upon the merit of their ideas and skills</td>
</tr>
<tr>
<td>C48</td>
<td>* Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences</td>
</tr>
<tr>
<td>C49</td>
<td>Synthesize scientific information from a variety of sources</td>
</tr>
<tr>
<td>C50</td>
<td>Evaluate and prioritize scientific issues based upon risk-benefit analyses</td>
</tr>
<tr>
<td>C51</td>
<td>Refining scientific skills from a variety of experiences</td>
</tr>
</tbody>
</table>

### Subunit: Applications for Science Learning

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these databases</td>
</tr>
<tr>
<td>A2</td>
<td>Make personal behavior decisions by interpreting information that has a scientific basis</td>
</tr>
<tr>
<td>A3</td>
<td>Propose courses of action that will validate and demonstrate personal understandings of scientific principles</td>
</tr>
<tr>
<td>A4</td>
<td>Guide other learners in their understanding of the interactions of technologies and society at various periods in time</td>
</tr>
<tr>
<td>A5</td>
<td>Promote and carry out practices that contribute to a sustainable environment</td>
</tr>
<tr>
<td>A6</td>
<td>Study and propose improvements in public services and systems in their community</td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

Note: The remaining competencies are to be taught using regular or applied methods.
### Unit: Science Literacy

<table>
<thead>
<tr>
<th>Subunit: Applications for Science Learning (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* A7 Choose consumer materials utilizing personal and environmental risk and benefit information</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* A8 Make inferences and draw conclusions using databases, spreadsheets, and other technologies</td>
<td>I</td>
<td>P</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* A9 Do simple troubleshooting on common electrical and mechanical systems, identifying and eliminating possible causes of malfunctions</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* A10 Construct devices that perform simple, repetitive actions</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>* A11 Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)</td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>A12 Make decisions regarding personal and public health</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A13 Evaluate the social and ecological risks and benefits resulting from the use of various consumer products</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A14 Analyze the contributions of advances in technology through history to his/her everyday life</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A15 Identify and reduce risks and threats to a sustainable environment</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A16 Extend the limits of human capabilities using technological enhancements</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A17 Use and recognize various propaganda techniques</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

Note: The remaining competencies are to be taught using regular or applied methods.
<table>
<thead>
<tr>
<th>Subunit: Applications for Science Learning (continued)</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td># A18 Solve unique problems using the results of systematic analyses</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>A19 Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* A20 Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>* A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>
### Unit: Science Literacy

**Note:** The remaining competencies are to be taught using regular or applied methods.

<table>
<thead>
<tr>
<th>Subunit: Applications for Science Learning</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A27</strong> Research and write environmental impact statements of his/her own design</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>A28</strong> Compare school-based science perspectives with those gained through cutting-edge technological applications</td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td><strong>A29</strong> Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A30</strong> Refine personal career interests</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td><strong>A31</strong> Promote public awareness of the interaction of technology with social issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A32</strong> Advocate and propose courses of action for local and global scientific issues using global networks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td><strong>A33</strong> Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text</td>
<td></td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A34</strong> Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td><strong>A35</strong> Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td><strong>A36</strong> Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Subunit: Applications for Science Learning (continued)</td>
<td>I0</td>
<td>I2</td>
<td>AD</td>
<td>BD</td>
<td>WS</td>
<td>LL</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>A37 Develop and write environmental impact and safety and hygiene management plans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A39 Design, construct, and market inventions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>
Unit: Technology Literacy

Note: Over 600 Ohio business, industry, and labor representatives examined, altered, and then verified the content extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans. This unit stresses the impact of technology on both teaching and learning.

<table>
<thead>
<tr>
<th>Competencies</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>* T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* T2 Assess the career, family, and personal development implications of technological change</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* T3 Demonstrate continuous learning via technology</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* T5 Apply historical perspective on technology to the development and use of new technologies</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* T7 Apply legal principles and ethical conduct to the use of technology</td>
<td>I</td>
<td>P</td>
<td>C</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems</td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>* T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

Note: The remaining competencies are to be taught using regular or applied methods.
### Unit: Technology Literacy

<table>
<thead>
<tr>
<th>Competencies</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T10</strong> Use a variety of tools, materials, and equipment in solving problems and extending human capabilities</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>T11</strong> Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>T12</strong> Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems</td>
<td>I</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

* = Industry identified these to be taught using applied methods
# = Teachers identified these to also be taught using applied methods

**Note:** The remaining competencies are to be taught using regular or applied methods.
Unit: Employability Skills

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

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
- Evaluate personal strengths and weaknesses
Competency: Prepare for employment

Competency Builders:
Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
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
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
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects)
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

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 alternatives 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 (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication
Competency: Demonstrate knowledge of work ethic

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

Competency: Exhibit appropriate work ethic

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

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

---

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
Competency: Exhibit characteristics for job advancement

Competency Builders:
Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in workplace/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds 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**

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
</table>

**Competency: Project professional image**

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

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
</table>

**Competency: Achieve individual and professional goals**

**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
Competency: Manage 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 discriminatory vs. non-discriminatory expenditures

---

Competency: Support community well-being

**Competency Builders:**
- Identify environmental, educational, and social issues
- Participate in social and/or community activities

---

Competency: Achieve organizational goals

**Competency Builders:**
- Evaluate personal goals in relation to organizational goals
- Monitor progress by evaluating feedback
- List responsibilities in relation to organization 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
Competency: Demonstrate positive relations in the workplace

Competency Builders:
- Identify personality types of self and other
- Identify various management styles
- Support employer expectations
- Support employer decisions
- Accept constructive criticism
- Give constructive feedback
- Adapt to changes in workplace
- List factors to consider before resigning
- Write letter of resignation

Competency: Manage stressful situations

Competency Builders:
- Learn how to 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
- Implement strategies to manage stress
- Create strategies for developing and maintaining support systems
Competency: Analyze effects of family on work and work on family

**Competency Builders:**
- Identify how family values, goals, and priorities are reflected in workplace
- 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

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>C</th>
<th>R</th>
<th>√</th>
<th>√</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Competency: Demonstrate knowledge of teamwork

**Competency Builders:**
- Define empowerment
- Differentiate work groups and teams
- Identify conditions essential to teamwork (e.g., brainstorming)
- 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 a valuable team member
- 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
Competency: Demonstrate teamwork

**Competency Builders:**
- Identify purpose of team and intended goal (include time frames)
- Structure team around purpose
- Define responsibilities of team members
- 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
- Stress continuous improvement
- Accept failure as part of learning

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Competency: Use teamwork to solve problems

**Competency Builders:**
- Identify appropriate situations for using teams
- Use problem-solving process in a team setting
- Identify quality management processes/techniques
- Identify quality assurance processes/techniques
- Prepare presentation
Competency: Conduct team meetings

Competency Builders:
Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group’s agenda
### Unit: Technical Recording and Reporting

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
</table>

**Competency: Demonstrate technical recording skills**

**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 identified parameters

- 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
- Draft preventive maintenance and calibration procedures

---

87

64
Unit: Problem Analysis

Competency: Appraise situations

Competency Builders:
- Identify concerns
- Classify concerns
- Set priorities
- Identify resolution process
- Plan resolution

Competency: Analyze potential problems

Competency Builders:
- Identify potential problems
- Identify likely causes
- Identify preventive actions
- Identify contingent actions

Competency: Analyze actual problems

Competency Builders:
- Identify deviation
- Identify problem and possible causes
- Test for probable causes
- Verify cause
<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>R</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Competency: Analyze decision(s)**

**Competency Builders:**
- Identify objective(s)
- Classify objective(s)
- Identify alternatives
- Evaluate alternatives
- Assess risks
- Make final choice
- Verify effectiveness of decision(s)
Unit: Project Management

Competency: Explain project management

Competency Builders:
Identify project purpose/goal
Identify project objectives
Identify work breakdown structure (WBS)
Identify resource requirements

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
Apply software programs

Competency: Implement projects

Competency Builders:
Monitor project
Control project
Modify project
<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Competency: Evaluate projects**

**Competency Builders:**
- Analyze performance
- Close-out project evaluation
- Draw project management conclusions
Unit: Computer Literacy

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 techniques
- Identify types of memory

Competency: Explain information processing cycle

**Competency Builders:**
- Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
- Describe computer languages and their use
- Describe difference between data files and program files
- Explain PC layout
- Explain network layout
- Differentiate between hardware and software
- Differentiate open from proprietary architecture
<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

**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., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
- Keyboard efficiently
- Demonstrate basic care of hardware
- Explain need for and application of security levels/procedures
- Perform basic hardware troubleshooting
- Explain hardware addressing techniques

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>R</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

**Competency: Use software**

**Competency Builders:**
- Define software types and functions
- Describe basic disk operations and care
- Perform functions necessary to operate software
- List advantages and disadvantages of integrated and dedicated software
- Operate system software
- Operate diagnostic software
- Demonstrate basic proficiency in spreadsheet use
- Demonstrate basic proficiency in word processing
- Demonstrate basic proficiency in database use
- Demonstrate basic proficiency in network use
- Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
- Demonstrate basic proficiency in report writing
- Demonstrate system commands
- Differentiate ethical use/misuse of software
- Describe bulletin boards/electronic mail
- Apply security levels/procedures while handling sensitive data
- Explain data compression
- Explain use and deletion of passwords
Unit: Basic Economics

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency: Explain basic economic concepts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency Builders:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differentiate between needs and wants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain concept of supply and demand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain concept of price</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain how supply, demand, and price are related</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain concept of private enterprise and business ownership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain concept of cost, profit, and cash flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain concept of risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain concept of competition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain relationship among risk, competition, and profit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compare types of economic systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe the free enterprise system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency: Identify cost and profit influences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competency Builders:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify importance of maximizing quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify importance of maximizing productivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differentiate between specialized training and cross training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differentiate between labor and management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differentiate between government and business</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Competency: Explain basic business concepts

Competency Builders:
Identify functions of business
Explain role of management
Explain role of labor
Explain role of R&D (i.e., research and development)
Explain role of administration
Explain role of sales and marketing
Explain role of operations
Explain role of advertising
Identify role of company objectives
Identify role of mission statement
Identify importance of ethical business practices
Explain role of teams in business
Explain concept of service as a product
Identify types of ownership
Identify components of a business plan
Explain laws relating to working conditions, wages and hours, civil rights, social security, disability, and unemployment insurance
Unit: Workplace Safety (Level 1)

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
</table>

Competency: Describe general workplace safety and hazards and understand both personal and company responsibility

Competency Builders:
- Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards, toxicity)
- Identify safety materials/equipment (e.g., absorbent socks, oil dry, air-moving equipment, sonic-absorption panels, fire extinguishers)
- Explain purpose(s) of OSHA, NIOSH, and NFPA
- Identify purpose of emergency evacuation/relocation routes, master switch, lockout/tagout locations, safety color coding systems, and basic machine guarding
- Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
- Describe methods of evaluating potential hazards (e.g., visual analysis)
- Describe methods of correcting potential hazards
- Describe corrective procedures for unsafe conditions
- Explain precautions required when using toxic (e.g., ingested, contact, inhaled) or flammable materials
- Describe various types of toxicity (e.g., chronic, immediate)
- Define confined space and related requirements
- Explain how international directives relate to safety
- Recognize personal responsibility for acts (e.g., running, shouting, horseplay, practical jokes, drug use/abuse, arguing, not paying attention, personal distractions)
- Locate Material Safety Data Sheets (MSDS)
Competency: Apply general workplace safety precautions/procedures

Competency Builders:
Identify local, state, and federal rules and regulations (e.g., worker's compensation)
Identify personal protective wear and equipment (e.g., safety glasses, helmet, respirator)
Identify visual controls (e.g., monitors, read outs)
Identify visual and audible alarms
Define and explain hazardous materials notices on containers (e.g., flammable, combustible, ignitable, inflammable, non-flammable)
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures (e.g., do not wear dangling clothing/jewelry, inappropriate footwear, restrain hair)
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic, and pneumatic safety rules and procedures
Apply fire safety rules and procedures
Apply hazardous waste rules and procedures, including disposal
Define and explain Material Safety Data Sheets (MSDS)
Perform lockout and tagout
Recycle materials
Use preventive maintenance checklists
Competency: Perform first aid

**Competency Builders:**
Acquire state approved first aid certification
Acquire blood-borne pathogen training (e.g., hepatitis, AIDS)
Assist with first aid for wounds or fractures
Administer first aid to control bleeding
Administer first aid for shock
Administer first aid for electrical shock (e.g., chemical, electrical, heat-related)
Identify chemical, electrical, and heat-related burns
Administer first aid for burn patient
Assist with first aid for poisoned patient
Assist with choking patient
Assist with patient having seizure
Assist with unconscious patient
Perform head to toe assessment
Describe signs and symptoms of emergency situations
Identify and locate basic emergency procedures and equipment
Contact local emergency assistance
Demonstrate first responder procedures

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Competency: Explain purpose of industrial pollution control systems

**Competency Builders:**
Describe types of air, water, ground, groundwater, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>R</td>
<td>C</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Competency: Maintain environmental health and safety regulations

**Competency Builders:**
Comply with current environmental health and safety laws
Demonstrate the ability to perform safety inspections
Participate in safety audits
Participate in safety, health, and environmental training (at home and work)
Use safety monitoring equipment
Organize and store chemicals and equipment properly (e.g., label chemicals, materials, tools, and equipment with appropriate safety, health, and environmental details)
Keep workspace clean and orderly
Report unsafe or potentially unsafe conditions and acts
Demonstrate safe handling of materials

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Explain basic ergonomics in the workplace

**Competency Builders:**
Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
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

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>
Unit: Workplace Safety (Level 2)

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td>P</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Maintain cardiopulmonary resuscitation (CPR) certification

Competency Builders:
- Acquire CPR certification
- Update CPR certification
- Administer CPR to infants and children
- Administer CPR to adults
- Administer care for obstructed airways for infants, children, and adults
Unit: Industrial Electricity

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>P</td>
<td>R</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

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 photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify sources of potential electricity (e.g., static)
Describe differences between AC/DC
Describe differences between single and 3-phase
Describe effects varying degrees of electricity have on the human body

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Use the National Electrical Code (NEC)

Competency Builders:
Use NEC to identify correct materials
Use NEC to identify correct applications

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>C</td>
<td>R</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Explain operation of electrical distribution systems

Competency Builders:
Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution
Describe interfacing control circuits to a microprocessor
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
- Repair/replace electrical control devices

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Read and apply electrical/electronic drawings

**Competency Builders:**
- Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
- 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 prints, schematics, and assembly drawings

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>
### Competency: Demonstrate proficiency in direct current (DC) circuits

**Competency Builders:**

- Describe voltage, current, resistance, power, and energy
- 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 Kirchoff's law
- Interpret color codes and symbols to identify electrical components and values
- 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 and operate power supplies for DC circuits
- Analyze frequency spectrums
- Apply Thevenin's and Norton's theorems
Competency: Demonstrate proficiency in alternating current (AC) circuits

Competency Builders:
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 characteristics 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
Demonstrate the operation of RLC circuits (i.e., 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)
## Competency: Demonstrate proficiency in power distribution systems

**Competency Builders:**
- Describe power distribution systems
- Describe 3-phase distribution systems
- Describe single-phase distribution systems
- Describe AC distribution systems
- Describe delta distribution systems
- Describe wye distribution systems
- Describe medium-voltage distribution systems (less than 600v)
- Troubleshoot 3-phase distribution systems
- Troubleshoot single-phase distribution systems
- Troubleshoot AC distribution systems
- Troubleshoot delta distribution systems
- Troubleshoot wye distribution systems
- Troubleshoot medium-voltage distribution systems (less than 600v)

## Competency: Demonstrate proficiency in power distribution equipment

**Competency Builders:**
- Describe power transformers
- 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 potential transformers
- Describe medium-voltage circuits breakers and fuses
- Use medium-voltage safety equipment
- Troubleshoot power transformers
- Troubleshoot power capacitors
- Troubleshoot power oil switches and cutouts
- Troubleshoot current transformers
- Troubleshoot potential transformers
- Troubleshoot medium-voltage circuit breakers and fuses
Competency: Demonstrate proficiency in motors and motor control

Competency Builders:
Describe integrated circuits
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
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops
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 preventive maintenance
Explain predictive maintenance
Perform preventive and predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
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: Electrical Test and Measurement Equipment

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

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 (1 million value)
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

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

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 amp probe
Describe function and operation of oscilloscopes
Describe function and operation of operation of infrared heat sensor
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: Drafting Technology

Competency: Apply basic drafting skills

Competency Builders:
Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials
Identify line styles and 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
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
Competency: Apply advanced drafting skills

Competency Builders:
Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Create a bill of materials
Dimension drawings using ANSI standards
Describe purpose of auxiliary and sectional views
Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, pattern shop, trim dies)
Interpret mold prints

<table>
<thead>
<tr>
<th>Levels of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>R</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 tool drawings
- Prepare molding diagrams
- Prepare stamping drawings
- Prepare numerical control drawings/instructions
- Prepare assembly and installation drawings
- Prepare purchase part drawings
- Prepare plant layout drawings
- Prepare approval drawings
- Resolve problems by descriptive geometry and revolutions
- Use precision dimensioning to include geometric characters
- Use precision measuring instruments
Competency: Explain geometric dimensioning and tolerancing

Competency Builders:
Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define 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

Competency: Convert dimensions and tolerances

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

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

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

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
</table>

Competency: Interpret drawings/prints/schematics

**Competency Builders:**
- Interpret machine drawings/prints/schematics
- Interpret basic hydraulic and pneumatic drawings/prints/schematics
- Interpret instrument drawings/prints/schematics
- Interpret electrical drawings/prints schematics
- Interpret process flow drawings
- Interpret P & ID (piping and instrument) diagrams that are commonly used in process facilities
- Identify the types of information found on floor plans, elevation plans, flow diagrams, piping and instrumentation diagrams, and electrical diagrams
- Identify commonly used symbols and abbreviations
- Explain how to trace diagrams
- Explain how to use diagrams to locate actual components
- Visualize object from drawing
- Interpret orthographic projections
- Interpret isometric views
- Interpret sectional views
- Interpret detail and assembly drawings
- Interpret dimensions
- Interpret tolerances
- Interpret GD&T characteristic symbols
- Interpret GD&T supplementary symbols
- Interpret mold prints
Competency: Interpret structural drawings

Competency Builders:
Define terms related to structural drafting
Define structural drawing
List types of structures
Identify types of materials used for structures
Describe types of steel members
Identify structural steel shapes
Explain drawing practices for steel members
Describe the placement of gage lines for steel members
Describe fastener sizes and spacings
Explain dimensioning procedures for steel structures
Label a structural steel callout
Explain structural steel marking
Describe anchor bolts
Differentiate among types of concrete
Identify types of concrete reinforcement
Identify standard prestressed concrete units
Describe foundation parts
Describe types of structural drawings for concrete
Create chart of symbols and abbreviations for concrete placing drawings
Identify standard practices for documentation of rebar
Identify typical details of concrete structures
Describe wood construction
Identify types of wood connectors
Identify types of framing connectors
Describe components of wood construction
Explain heavy timber construction
Unit: CAD Fundamentals

Competency: Demonstrate basic understanding of computer operating system

Competency Builders:
Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands
Competency: Operate a CAD system

Competency Builders:
Execute CAD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer
Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities by other methods (e.g., last, previous, type, all)
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, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, trim, 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
Create text styles
Edit text styles
Select text styles
Apply notes
Create dimensions
Competency Builders: (continued from previous page)
Edit text
Control dimension variables/models
Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views
Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties)
Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:
- Dispose of trash and recyclable waste
- Clean work area
- Store hand tools, cutters, fixtures, jigs, and attachments
- Follow tool crib procedures
- Inspect machine guards
- Replace or adjust machine guards
- Report problems to supervisor

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
- Maintain historical files
- Explain reasons for maintenance scheduling
- Prepare new/replacement equipment recommendations
- Track processing anomalies with unassigned causes
- Chart maintenance expenses
- Define and explain "machine capability study"
Competency: Inspect machine systems

**Competency Builders:**
- Coordinate preventative maintenance services with production in advance
- Inspect safety systems
- Analyze system failure
- Explain planned maintenance
- Explain predictive maintenance measures
- Explain preventive maintenance measures (e.g., lubrication)
- Log machine histories
- Log machine events (in hours)
- Explain machine system(s) calibration
- Inspect linkages and lever mechanisms
- Inspect drive couplings
- Inspect clutches
- Inspect roller ball bearings/bushings/shoes

Competency: Perform machine maintenance

**Competency Builders:**
- Coordinate preventative maintenance services with production in advance
- Apply lockout/tagout procedure
- Use operator's and manufacturer's manuals
- Operate individual machines
- Diagnose malfunctions
- Disassemble defective section
- Clean equipment
- Lubricate equipment
- Check equipment for wear and alignment
- Repair or replace defective parts
- Test machine for proper operation and follow-up for performance
- Make minor adjustments to equipment
- Prepare and coordinate planned maintenance schedules
- Explain breakdown maintenance
Competency: Maintain hand tools

**Competency Builders:**
- Demonstrate use and care of common hand tools
- 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 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, taps, dies, and reamers)
- Demonstrate use and care of pipe cleaning equipment

Competency: Maintain portable power tools

**Competency Builders:**
- Demonstrate use and care of light-duty and heavy-duty drills
- Demonstrate use and care of power screwdrivers and impact wrenches
- Demonstrate use and care of linear motion saws
- Demonstrate use and care of belt, pad and disc sanders
- Demonstrate use and care of grinders and shears
Competency: Maintain stationary equipment

**Competency Builders:**
- Demonstrate care of mechanical presses
- Demonstrate care of hydraulic presses
- Demonstrate care of drill presses
- Demonstrate care of bench grinders
- Demonstrate care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
- Demonstrate care of band saws
- Demonstrate care of pipe threaders
Unit: Electromechanical Technology

### Competency: Interpret electromechanical drawings

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

### Competency: Describe and 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)
- Describe the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
- Troubleshoot transducers
- Differentiate among thermocouple types
- Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
- Interpret specification of pressure sensors (e.g., strain gage, piezoelectric/piezoresistive) to electrical circuits
- Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters, ultrasonic)
- 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)
Competency Builders: (continued from previous page)
Interpret specifications of final control elements (i.e., silicon controlled rectifiers [SCR], power controllers, motor drives, actuators/robots)
Describe application circuits
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
Unit:  Basic Machining

<table>
<thead>
<tr>
<th>Competency: Perform prerequisite machining skills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competency Builders:</strong></td>
</tr>
<tr>
<td>Demonstrate maintenance of immediate work area, machinery, tools and gages</td>
</tr>
<tr>
<td>Demonstrate proficiency in interpreting prints/drawings</td>
</tr>
<tr>
<td>Demonstrate proficiency in planning work sequence/set up</td>
</tr>
<tr>
<td>Follow safety rules and regulations for each machine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competency: Analyze machine shop jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competency Builders:</strong></td>
</tr>
<tr>
<td>Identify sequence of work on specified project(s)</td>
</tr>
<tr>
<td>Identify tolerances and finishes on specified project(s)</td>
</tr>
<tr>
<td>Identify variables that effect job efficiency (e.g., speeds, feeds)</td>
</tr>
<tr>
<td>Use Machinery Handbook</td>
</tr>
<tr>
<td>Identify causes of workpiece defects</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competency: Explain basic machining operations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competency Builders:</strong></td>
</tr>
<tr>
<td>Identify the parts of basic toolroom lathe</td>
</tr>
<tr>
<td>Identify the parts of basic milling machines</td>
</tr>
<tr>
<td>Identify the parts of basic drilling machines</td>
</tr>
<tr>
<td>Identify the parts of horizontal and vertical saws</td>
</tr>
<tr>
<td>Identify the parts of basic surface grinders</td>
</tr>
<tr>
<td>Describe the types of grinding operations: lapping, honing, drum, and blasting</td>
</tr>
<tr>
<td>Describe operations which the following machines can perform: sand blasting, lathes, shapers, mills, drills, saws, grinders, hones, EDM, and welders</td>
</tr>
</tbody>
</table>
Competency: Perform bench operations

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

Competency: Operate metal cutting saw

**Competency Builders:**
- Identify types and uses
- Identify proper cutting fluids
- 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
Competency: Operate drill press

Competency Builders:
Clean drill press
Lubricate drill press
Identify proper cutting fluid
Mount part
Select proper bit, speed, and feed
Demonstrate proper bit sharpening techniques
Drill part
Countersink
Tap hole
Apply basic metallurgy knowledge

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
Competency: Operate pedestal grinder

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

Competency: Operate lathe

Competency Builders:
Clean and lubricate lathe
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
Cut off workpiece
Deburr
Demonstrate use of a 4-jaw chuck
Center drill hole
Cut threads (inside and outside)
Turn inside bore
Demonstrate use of steady rest
Competency Builders:
Demonstrate use of centers
Apply basic metallurgy knowledge

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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
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 and balance
Position guard
Dress wheel
Grind chuck
Identify proper mounting techniques
Mount workpiece
Apply surface grinder techniques
Apply basic metallurgy knowledge

Competency: Select materials for job

Competency Builders:
Interpret color codes, numbering systems, and classification systems of materials (i.e., ANSI, SAE)
Identify materials (e.g., hazardous materials)
Apply basic metallurgy knowledge
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 EDM
Differentiate between 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
Competency: Demonstrate use of precision layout devices

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 (e.g., metric, English)
Describe common measurement errors and correction procedures
Calibrate measuring machines and devices
Demonstrate care of measuring instruments
Demonstrate use of rule
Demonstrate use of shrink 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 and pyrometer
Demonstrate use of dividers
Demonstrate basic use of gage blocks and gage pins
Demonstrate use of threading specs
Explain use of optical comparator
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: Hydraulics and Pneumatics

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

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
Competency: Describe system losses

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

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>P</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Competency: Describe hydrostatics

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

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Competency: Design basic hydraulic/pneumatic system

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

### Competency: Interpret hydraulic and pneumatic schematics

#### Competency Builders:
- Identify common symbols
- Sketch circuit diagrams (i.e., schematics)
- Interpret circuit diagrams (i.e., schematics)
- Sketch circuit analysis
- Diagram an air supply system

### Competency: Perform hydraulic system maintenance and repair

#### Competency Builders:
- Identify standard fittings for hose, pipe, and tube
- 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
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 pipe schedule and their application
- Explain use and maintenance of strainers, filters, and traps in piping systems
- Join common fittings
- Join metallic pipe
- Join plastic pipe for water cooling systems
- Join copper and steel tubing
- Bend copper and steel tubing
- Cut copper and steel tubing
- Flare tubing

Competency: Maintain hydraulic system components

Competency Builders:
- Install an oil filtration system
- Maintain an oil filtration system
- Explain maintenance of fouled heat exchangers
- Explain operation and use of heat exchanges
- Explain fouling and its effect
- Identify reservoir requirements
- Identify leaking heat exchangers
- Compute hose requirements
- Install hydraulic lines
- Select control valves and servo-type valves
- Install control valves and servo-type valves
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
- Analyze hydraulic circuits
- Troubleshoot hydraulic circuits

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
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
- Analyze pneumatic circuits
- Troubleshoot pneumatic circuits
- 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
Competency: Maintain vacuum systems

**Competency Builders:**
- Describe characteristics associated with vacuum systems and sub atmospheric pressure
- Describe different units of vacuum
- 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

---

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
Unit: Industrial Manufacturing Technology (Level 1)

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Competency: Describe industrial manufacturing process

**Competency Builders:**
- Explain techniques of measuring motion, forces, distance, time, and temperature
- Explain mechanical and chemical properties of various plastics, metals, ceramics, fillers, and additives
- Explain industrial manufacturing process
- Explain industrial use of non-metallic liquids, gases, and solids (e.g., ceramics, polymers)
- Develop flow chart and process sheets

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Competency: Describe materials requirements planning

**Competency Builders:**
- Define materials requirements planning
- Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
- Define 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
Competency: Describe role of supply materials

**Competency Builders:**
- Describe role of purchase requisitions
- Describe role of material specifications
- Describe role of quality parameters
- Define supplier certification rating methods
- Describe role of source inspector
- Describe role of receiving

Competency: Describe 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

Competency: Describe material flow

**Competency Builders:**
- Describe importance of flexibility
- Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
- Describe advantages and disadvantages of each pattern
Competency: Maintain quality control 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

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>I</th>
<th>C</th>
<th>P</th>
<th>✓</th>
<th>✓</th>
</tr>
</thead>
</table>

Competency: Describe post-production control

**Competency Builders:**
Explain importance of product protection, packaging, 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)
Competency: Analyze a manufacturing project

Competency Builders:
- 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: Industrial Manufacturing Technology (Level 2)

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)

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
Unit: Programmable Logic Controllers (PLCs)

Competency: Differentiate among process controls

**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

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
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 GPP (i.e., Graphic Programmable Panel)
- 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
- Use specific manufacturer of PLCs (e.g., Allen Bradley, Siemens, Texas Instruments)
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: Welding Basics

<table>
<thead>
<tr>
<th>Competency</th>
<th>Process Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain welding/cutting processes</td>
<td></td>
</tr>
<tr>
<td>Competency Builders:</td>
<td></td>
</tr>
<tr>
<td>Explain process of resistance welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of projection welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of flash-butt welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of laser welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of friction welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of spot welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of shielded metal-arc welding (SMAW)</td>
<td></td>
</tr>
<tr>
<td>Explain process of gas metal-arc welding (GMAW)</td>
<td></td>
</tr>
<tr>
<td>Explain process of gas tungsten-arc welding (GTAW)</td>
<td></td>
</tr>
<tr>
<td>Explain process of carbon arc gouging and cutting</td>
<td></td>
</tr>
<tr>
<td>Explain process of welding plastics</td>
<td></td>
</tr>
<tr>
<td>Explain welding rod alloys</td>
<td></td>
</tr>
<tr>
<td>Explain mild steel welding rod</td>
<td></td>
</tr>
<tr>
<td>Explain low hydrogen welding electrode</td>
<td></td>
</tr>
<tr>
<td>Explain rationale for preheating and post-heating metal</td>
<td></td>
</tr>
<tr>
<td>Explain (GMAW) welding in flat, horizontal, vertical positions</td>
<td></td>
</tr>
<tr>
<td>Explain (GTAW) welding on mild steel, stainless steel, and aluminum</td>
<td></td>
</tr>
<tr>
<td>Explain process of build up and hard facing</td>
<td></td>
</tr>
<tr>
<td>Explain process of submerged arc welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of plasma arc welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of oxy-hydrogen welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of stud welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of oxy-acetylene welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of percussion welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of upset welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of resistance spot welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of pressure gas welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of furnace brazing</td>
<td></td>
</tr>
<tr>
<td>Explain process of torch brazing</td>
<td></td>
</tr>
<tr>
<td>Explain process of resistance brazing</td>
<td></td>
</tr>
<tr>
<td>Explain process of induction brazing</td>
<td></td>
</tr>
<tr>
<td>Explain process of infra-red brazing</td>
<td></td>
</tr>
<tr>
<td>Explain process of cold welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of diffusion welding</td>
<td></td>
</tr>
<tr>
<td>Explain process of explosion welding</td>
<td></td>
</tr>
</tbody>
</table>
Competency Builders: (continued from previous page)

Explain process of forge welding
Explain process of ultrasonic welding
Explain process of electron beam welding
Explain process of electro-slag welding

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Leveling of this competency...

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

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Leveling of this competency...

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

Competency Builders:
Identify arc welding equipment and accessories
Read welding rods
Apply basic metallurgy technology
Weld stainless steel using (SMAW) process
Weld steel requiring preheat
Weld cast iron
Weld aluminum

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>R</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Competency: Evaluate welds

Competency Builders:
Evaluate the quality of welds by using the fracture test, tensile test, bend test, metallographic test, visual inspection, magnetic particle inspection, liquid penetrant tests, ultrasonic tests, and/or radiographic test
Identify the following types of weld defects: cracks, porosity, cold shut, inclusions, lack of fusion, and undercut
Unit: Supervision

<table>
<thead>
<tr>
<th>Competency: Perform supervisory functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competency Builders:</strong></td>
</tr>
<tr>
<td>Define supervision</td>
</tr>
<tr>
<td>Conduct task analysis</td>
</tr>
<tr>
<td>Create organizational and/or departmental charts</td>
</tr>
<tr>
<td>Apply company policies and procedures</td>
</tr>
<tr>
<td>Maintain workplace procedures manuals</td>
</tr>
<tr>
<td>Prepare budgets</td>
</tr>
<tr>
<td>Monitor budgets</td>
</tr>
<tr>
<td>Prepare managerial reports</td>
</tr>
<tr>
<td>Analyze daily production reports</td>
</tr>
<tr>
<td>Maintain appropriate work environment</td>
</tr>
<tr>
<td>Conduct tours</td>
</tr>
<tr>
<td>Facilitate assignments</td>
</tr>
<tr>
<td>Assign work</td>
</tr>
<tr>
<td>Delegate job tasks</td>
</tr>
<tr>
<td>Monitor progress</td>
</tr>
<tr>
<td>Prepare productivity reports</td>
</tr>
<tr>
<td>Provide training for new policies</td>
</tr>
<tr>
<td>Troubleshoot workplace problems</td>
</tr>
<tr>
<td>Coordinate workplace activities</td>
</tr>
<tr>
<td>Appraise performance and coach for improve</td>
</tr>
<tr>
<td>Document personnel issues</td>
</tr>
<tr>
<td>Coordinate administrative duties</td>
</tr>
<tr>
<td>Competency: Coordinate training</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td><strong>Competency Builders:</strong></td>
</tr>
<tr>
<td>Assess training needs</td>
</tr>
<tr>
<td>Secure training resources, materials and equipment</td>
</tr>
<tr>
<td>Train employees</td>
</tr>
<tr>
<td>Evaluate progress of trainee</td>
</tr>
<tr>
<td>Provide feedback</td>
</tr>
<tr>
<td>Solicit feedback</td>
</tr>
<tr>
<td>Receive feedback</td>
</tr>
<tr>
<td>Assess feedback</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td>C</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Unit: Quality Assurance (Level 1)

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>P</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

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 rework, salvage, and scrap
- Define safety terms of product
- Identify safety responsibility within the organization
- Explain customer approval process
- 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)
- 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
Competency: Demonstrate knowledge of quality assurance

Competency Builders:
Explain the ISO 9000 and QS 9000 process
Explain continuing improvement
Define quality terms
Define quality functions
Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Describe control devices used in functional areas (e.g., SPC, equipment)
Use checksheets to organize and record inspection results
Conduct in-process inspection
Conduct incoming materials inspection using sampling plan criteria
Identify safe and unsafe equipment
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of control charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)
Identify features of quality planning
Explain the relationship among organizational structures, policies, procedures, and quality assurance
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
- Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:
- Describe data collection methods
- Collect data
- Check chart for out-of-control conditions
- Define mean, median, and mode
- Explain significance of standard deviation
- Explain normal distribution

Competency: Demonstrate knowledge of precontrol

Competency Builders:
- Explain uses of precontrol
- Explain significance of the limits
- Plot values on a precontrol chart
- Explain "out-of-control" situation
- Make decisions on green, yellow and red conditions
### Quality Assurance (Level 2)

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

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

**Competency Builders:**
- Define manufacturability
- Define reliability factors (e.g., cost, human, producibility)
- Define failure
- Describe predictive maintenance

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

**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
- Identify critical in-process characteristics from specification(s) or drawing(s)
Competency: Use testing equipment

**Competency Builders:**
- Identify safe and unsafe testing equipment
- Demonstrate tensile-compression testing
- Demonstrate bending testing
- Demonstrate impact testing
- Demonstrate fatigue testing
- Demonstrate shear testing
- Demonstrate hardness testing
- Demonstrate liquid-penetrant testing
- Demonstrate radiographic testing
- Demonstrate ultrasonic testing
- Demonstrate electrical-analysis testing
- Demonstrate ability to clean, adjust, calibrate, and set up testing equipment and measuring devices
- Select proper tools and equipment for testing materials and products

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
- Explain advantages and limitations of penetrant inspection
- Explain choice of most suitable nondestructive test method
Competency: Demonstrate knowledge of basic statistics

**Competency Builders:**
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data

Competency: Demonstrate knowledge of precontrol

**Competency Builders:**
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability) and traceability
Calibrate to national standards
Apply geometric tolerancing
Explain C = 0 (zero) acceptance plan
Interpret instructions in a control plan

Competency: Construct $\bar{X}$ and R charts

**Competency Builders:**
Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in 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 $\bar{X}$-chart
Calculate upper and lower control limits for R-chart
### Competency: Interpret $\bar{X}$ 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 $\bar{X}$ 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

### 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
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
- Construct an NP (number defective) chart with control limits and data

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Competency: Demonstrate knowledge of process capability

**Competency Builders:**
- Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
- Calculate precontrol 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
- 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
Competency: Demonstrate knowledge of quality/cost implications

**Competency Builders:**
- Identify cost/quality objectives
- Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
- Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
- Define product liability

---

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Competency: Manipulate quality cost data

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

---

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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)
Unit: Quality Assurance (Level 3)

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>R</td>
<td>P</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

Leveling of this competency...

Competency: Demonstrate knowledge of engineering a quality product

Competency Builders:
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
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 (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe FMEA (Failure Mode Effects Analysis)

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>C</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Leveling of this competency...

Competency: Demonstrate knowledge of probability theory

Competency Builders:
Define classical probability
Define empirical probability
Calculate probability for outcomes
Competency: Conduct process improvement studies

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

Competency: Explain importance of interdepartmental relationships to quality assurance

Competency Builders:
Explain project selection
Explain project implementation
Explain project evaluation
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: Demonstrate knowledge of quality/cost implications

Competency Builders:
Explain consumerism and liability prevention
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim(s)
Unit: Plastics Press Technology (Level 1)

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Explain press operation

Competency Builders:
- Identify types of presses (e.g., injection, compression, blow, extrusion, etc.)
- Describe functions of each type of press
- Identify capacity of presses (e.g., tonnage, materials, shot size, etc.)
- Describe shutheight
- Identify and explain function of press operator safety devices
- Explain how mold dimension can affect the size of press
- Define terms used in plastics press operations
- Explain the sequence of operation of each type of machine
- Describe function of monitors, proximity switches, and die protection

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Demonstrate knowledge of auxiliary press accessories

Competency Builders:
- Describe function of barrel heaters
- Describe function of loaders and vacuum loaders
- Describe function of chillers, mold heaters, and hot runners
- Describe function of blenders and dryers
- Describe function of feeders and conveyors
- Describe function of part grinders
- Describe use of quick die change
- Describe function of bridge crane and fork lift
- Describe function of part weight scale
Unit: Plastics Press Technology (Level 2)

Competency: Explain various controls

Competency Builders:
Define relay controls
Define solid state controls
Define numerical control (NC) and computerized numerical control (CNC)
Differentiate between types of NC and CNC
Describe open loop and closed loop controls
Identify data input mediums
Identify computer memory types
Identify information stored relative to computer memory types

Competency: Perform preventive maintenance of control systems

Competency Builders:
Follow proper safety procedures
Describe care of various control systems
Calibrate NC and CNC control systems

Competency: Prepare setup sheet

Competency Builders:
Prepare basic setup sheet for press with relay controls
Prepare basic setup sheet for press with solid state controls
Prepare basic setup sheet for press with NC controls
Prepare basic setup sheet for press with CNC controls
Adapt to various control system setup sheets
### Competency: Describe Basic Press Operations

**Competency Builders:**
- Define manual mode
- Define semiautomatic mode
- Define full automatic mode
- Define dry cycle mode
- Explain core pull operation according to SPI and EUROMAP standards
- Describe different types of ejection (e.g., air, hydraulic, mechanical)
- Describe purpose of purging and its sequence

### Competency: Describe Relay Control Operations

**Competency Builders:**
- Identify parts of the press
- Identify various molding parameters
- Apply basic setup skills to setup press
- Set press molding parameters using setup sheet or create a new setup sheet if needed

### Competency: Describe Solid State Control Operations

**Competency Builders:**
- Identify various types of solid state controls
- Identify parts of the press
- Identify various molding parameters
- Apply basic setup skills to setup press
- Set press molding parameters to setup sheet or create new setup sheet if needed
Competency: Describe NC and CNC control operations

Competency Builders:
- Differentiate between NC and CNC (e.g., open loop control, closed loop control)
- Define total closed loop control and partial closed loop control
- Identify parts of the press
- Identify various molding parameters
- Apply basic setup skills to setup press
- Load mold parameters from storage media
- Load molding parameters from setup sheet or printout
- Write setup sheet for new molds or make printout of molding parameters or load to storage media
Unit: Sheet Metal Fabrication

<table>
<thead>
<tr>
<th>Competency: Describe sheet metal fabrication</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency Builders:
- Demonstrate safety handling of sheet metal and tools
- 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
- Demonstrate the capability to finish (e.g., cleaning, painting, plating)

<table>
<thead>
<tr>
<th>Competency: Describe types of metal fabrication manufacturing</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

Competency Builders:
- Describe shear
- Describe press brake
- Describe cut-to-length lines
- Describe roll forming
Competency: Explain machining fabrication processes

Competency Builders:
Explain the processes necessary to accomplish the following fabrication requirements: cutting, shaping, forming, turning, drilling, finishing, pressing, drawing, bending, shearing, slitting, rolling, forging, swaging, hobbing, coining, surfacing, extruding, braking, notching, nibbling, piercing, blanking, trimming, perforating, trueing, shaving
Identify the measuring tools, hand tools, machines, and materials necessary to perform each of the fabrication processes listed above

Competency: Layout sheet metal

Competency Builders:
Lay out 90° ells
Lay out 45° and 30° ells
Use radial line development to lay out
Use development by triangulation to lay out

Competency: Fabricate components

Competency Builders:
Layout design
Measure materials
Create pattern and/or prototype
Use hand tools
Cut materials
Form materials
Use fasteners
Spot weld
Competency: Perform sheet metal fabrication

Competency Builders:
Identify sheet metal fabrication jobs
Identify tools (e.g., manual and hand powered) needed
Fabricate round ells
Fabricate tees
Fabricate pyramids
Fabricate cones
Fabricate square to round transitions
Unit: Moldmaking (Level 1)

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

Competency: Explain basics of building molds

Competency Builders:
Describe types of molds and their components
Describe process of making a mold
Describe machinery used in moldmaking
Describe types of metal castings used for molds
Identify types of components used in the building process (e.g., gibs, core, cavity, slides, heaters)
Identify surface finishes for molds
Identify specialty mold materials (e.g., beryllium copper, lead-zinc alloys, epoxy resins)
Describe the fitting and assembly process
Describe hardness testing (e.g., Brinell, Rockwell)
Explain how draft and shrinkage must be allowed for in a mold
Describe how core and cavity blocks are mounted
Describe ejectors and their applications
Describe slide/side actions and their use
Identify hardware used in components of molds/tooling used in plastics (e.g., screws, taps and drills, dowel pins, leader pins, bushing)
Describe types and purposes of venting
Competency: Explain heating and cooling of molds

**Competency Builders:**
- Identify types of heating/cooling used with molds
- Describe flow patterns
- Describe baffles
- Describe using O-rings
- Describe bubbler
- Describe cooling zone
- Describe diverting plugs
- Describe high volume cooling
- Describe "heat pipes" and their applications
- Describe steam channels
- Describe application of oil heaters, water heaters, and electric heaters

---

Competency: Explain injection mold runners and gates

**Competency Builders:**
- Describe purpose of runners
- Describe size and shape of runners
- Describe purpose of gates
- Describe types, dimensions, and functions of gates
- Describe hot/cold/insulated runner molds
- Describe acceptable and unacceptable shapes of runners
- Explain purpose of cold slug wells
- Describe hot bushings
- Describe sprue pullers
- Describe sizing and types of sprues
Unit: Moldmaking (Level 2)

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>C</td>
<td>P</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Explain heating and cooling of molds

Competency Builders:
Describe the pattern and placement of heating/cooling lines

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>C</td>
<td>P</td>
<td>M</td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Competency: Describe the machining and/or manufacturing of plastics tooling

Competency Builders:
Describe applications for manufacturing of dies for extruders, forms for thermoforming, and related tooling to blow molding and roto molding, etc. by using mills (i.e., vertical, horizontal [boring]), lathes, grinders (surface, I.D. [jig], O.D.), EDM, wire EDM, saws, drills and hones
Explained how NC and CNC apply to applicable machines above
Explained heat treat
Competency: Demonstrate knowledge of plastics

Competency Builders:
- Explain the history, organization, importance, and potential of the plastics industry.
- Explain the various plastics standards (e.g., ASTM) that are essential for consistent manufacturing and testing.
- Describe the inter-relationship between materials and processing.
- Identify the primary plastics trade and professional organizations.
- List the advantages and disadvantages of plastics.
- Define terminology used in the plastics industry.
- Identify sources of raw materials.
- Identify and define the families and applications of thermoplastics, thermosets, elastomers, rubbers, and Liquid Crystal Polymers (LCP).
- Define polymers.
- Classify polymers by physical and chemical properties.
- Classify polymers by reactions.
- Identify processing methods (typical materials processed).
- Identify various uses of plastics in relation to the environment.
- Identify types and uses of additives and modifiers in plastics production.
- Explain composition of color.
- 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, blow, stretch-blow, molding, compression molding, and injection compression molding, etc.
- 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.
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)

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>P</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Competency: Define plastics materials

Competency Builders:
- Define olefins (polyolefins)
- Define styrenics
- Define PPO/PPE
- Define thermoplastic polyesters (PBT & PET)
- Define nylon (polyamides)
- Define acetals
- Define acrylics, polyarylate, polymethypentene
- Define polycarbonate
- Define polysulfone (and sulfone based polymers)
- Define fluoropolymers
- Define ketone polymers
- Define high heat specialty plastics
- Define vinyl and additives
- Define cellulose
- Define silicone
- Define commercial blends
- Define thermoplastic elastomers
- Define natural rubber, EPDM
- Define SBR & latex, polybutadiene

<table>
<thead>
<tr>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>✓</td>
</tr>
</tbody>
</table>

153

[ERIC]
Competency Builders: Define isoprene, butyl rubbers
Define fluorocarbon elastomers
Define nitrite, polyacrylic rubbers
Define polyurethanes
Define ureas
Define polyesters
Define epoxies
Define polyimides and polyamides
Define high heat thermoset plastics

Competency: Describe additives

Competency Builders:
Define additives and their benefits/effects
Define impact modifiers
Define colorants (e.g., dyes and pigments)
Define flame retardants
Define antimicrobials, antioxidants, and antistats
Define lubricants
Define release agents (internal & external)
Define glass fibers, carbon fibers, and metal fibers
Define glass microspheres
Define mineral fillers, glass fillers
Define plasticizers and processing aids (rubber)
Define vulcanizing agents
Define antidegradents
Define UV stabilizers and their effects
Define thermal stabilizers and their effects
Define compatibilizers and their effects
Define filler and reinforcements (rubber)
Define accelerators and activators
Competency: Demonstrate knowledge of polymer chemistry

**Competency Builders:**
- Explain the structure of polymers (e.g., amorphous, crystalizing, and LCP)
- Describe how to make polymers from corresponding monomers
- Explain the polymerization of polyethylene, addition and condensation polymers, and blends and alloys
- Explain degradation (e.g., heat, light, oxygen)
- Describe the characteristics of polymeric materials
- Describe feedstock materials
- Differentiate between organic and inorganic compounds
- List four (4) major classes of hydrocarbons and explain how they are structurally different
- Describe trends in physical and chemical properties of alkanes and cycloalkanes, alkenes, alkynes, aromatics, alcohols, phenols, ethers
- Describe the structures of carbon double and triple bonds
- Describe the structure and importance of addition polymers
- List reasons for the toxicity of most simple alcohols
- Explain the mechanism by which soap cleans dirt and nonpolar substances
- Predict the hydrolysis products of esters
- Describe the basicity of amines

Competency: Describe basic polymer processing

**Competency Builders:**
- Explain melt flow and rheology
- Explain physical and chemical properties of blends
- Explain compatibilizers
- Explain reinforcement with filler and fiber additives
- Explain reactive polymer processing
- Explain recycling for post consumption
- Explain morphology
Competency: Prepare polymer blends and alloys

Competency Builders:
Define blends
Define alloys
Prepare resin-blends
Prepare recipes and reaction batches
Prepare samples for ASTM testing procedures

Competency: Demonstrate knowledge of polymeric testing

Competency Builders:
List reasons to test polymers
Explain purpose of standards
Identify factors affecting test results
Identify principles of sample conditioning
Prepare samples for ASTM, DIN, and ISO testing procedures
Competency: Perform analytical testing of polymeric materials

Competency Builders:
- Analyze products by functional requirements
- Describe plastics by appearance (e.g., color, gloss)
- Identify plastics by reaction to solvents
- Dissect products
- Flame test plastics
- Identify the burning rates of plastics
- Identify the softening point of plastics
- Test deformation plastics
- Identify specific gravity determinations
- Identify specific gravity using density gradient
- Use Melt Index
- Identify ash content of filled plastics
- Identify principles of hardness testing
- Use shore A & D Durometers
- Test with Clark hardness tester
- Define the Law of Conservation of Energy
- Use Chapy/Izod Impact tester
- Perform permeation testing
- Identify principles of falling dart impacting
- Use Film Dart Impact tester
- Perform creep and creep-rupture testing
- Explain use of abrasion and friction testing
Competency: Describe effects of weathering and aging on polymeric materials

**Competency Builders:**
- Explain the purpose of weathering/aging tests
- Explain the theory of accelerated testing
- Perform water absorption tests
- Explain water absorption properties of plastics
- Explain thermal expansion of plastics
- Compare test results performed under different laboratory conditions (e.g., UV, salt-water, and accelerated weathering testing)

Competency: Tensile test polymeric materials

**Competency Builders:**
- Explain polymer stress and strain
- Use tensiometer
- Identify modulus of elasticity
- Use tear tester
- Test for stiffness and resilience of polymeric materials
- Describe tensile tests
- Describe flexural properties
- Describe compressive properties
- Describe creep properties
- Describe stress relaxation
- Describe impact properties
- Describe shear strength
- Describe abrasion
- Describe fatigue resistance
- Describe hardness tests
- Describe tests for elevated temperature performance
- Describe thermal conductivity
- Describe expansion
- Describe brittleness temperature
Competency: Identify electrical and weathering properties

Competency Builders:
Describe dielectric strength
Describe dielectric constant and dissipation factor
Describe electrical resistance tests
Describe arc resistance
Describe accelerated weathering tests
Describe outdoor weathering of plastics
Describe miscellaneous resistance to organic attacks tests

Competency: Identify optical properties and material characterization tests

Competency Builders:
Describe refractive index
Describe luminous transmittance and haze
Describe color
Describe specular gloss
Describe melt index test
Describe capillary rheometer test
Describe dynamic mechanical testing
Describe viscosity tests
Describe gel permeation chromatography
Describe thermal analysis techniques
Describe material characterization tests for thermosets
Leveling of this competency...  

Competency: Identify flammability, chemical properties, and analytical tests

**Competency Builders:**
- Describe UL testing (e.g., flame/temperature)
- Describe chemical resistance tests
- Describe specific gravity
- Describe density by density gradient technique
- Describe bulk (apparent) density test
- Describe water absorption
- Describe moisture analysis
- Describe sieve analysis (particle size) test

Leveling of this competency...

Competency: Identify tests and identification analysis of polymers

**Competency Builders:**
- Describe torque rheometer test
- Describe burst strength test
- Describe crush test
- Describe chemical and thermal analysis for identification of polymers
- Describe flame test

Leveling of this competency...

Competency: Identify testing of foam plastics and nondestructives

**Competency Builders:**
- Describe rigid foam test methods
- Describe flexible foam test methods
- Describe types of failure
- Describe FMEA (Failure Mode Effects Analysis)
- Describe nondestructive tests
Unit: Polymer Technology (Level 2)

Competency: Demonstrate knowledge of polymer chemistry

Competency Builders:
- Plot and explain the development of atomic theory
- Explain the Bohr atomic model
- Construct models of atoms, molecules, and macromolecules
- Explain carbon-carbon bonding
- Explain theory of electron probability
- Describe the behavior of electrons in various atoms
- Identify atoms and characteristics of the families from the periodic chart
- Demonstrate knowledge of molecular weight definitions
- Describe intermolecular bonds
- Describe various types of primary bonds
- Use Lewis Dot structures to represent primary bonding
- Describe various types of secondary bonds
- Draw structural formulas for alkanes and alkyl halides
- Define structural isomers and geometric isomers
- Draw the structures of simple alcohols, phenols, and ethers
- Identify primary, secondary, and tertiary alcohols and differences in their properties
- Contrast the physical properties of aldehydes and ketones and compare them to other organic compounds
- Identify carbonyl compounds that are natural fragrances
- Write equations that show the acidic properties of organic acids
- Describe the trends in the physical properties of carboxylic acids, esters, amines and amides
Competency: Apply instrumental methods of analysis

Competency Builders:
- Explain linear regression and its uses
- Explain purposes of instrumental analysis
- Explain precision and error analysis
- Explain atomic absorption
- Use spectroscopic methods
- Use thermal analysis methods
- Use chromatographic methods
- Use microscopy
- Use non-destructive testing methods (e.g., acoustic, strain gauges)
Unit: Plastics Troubleshooting (Level 1)

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>P</td>
<td>R</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Competency: Identify abnormal conditions

**Competency Builders:**
- Describe color streaking
- Describe short shots
- Describe sink marks
- Describe flash
- Describe weak weld
- Describe brittleness
- Describe poor surface finish
- Describe blush at gate
- Describe jetting
- Describe weld burns
- Describe lamination
- Describe warpage
- Describe wave marks
- Describe poor dimensional stability
- Describe sticking in cavity
- Describe sprue sticking
- Describe voids (bubbles)
- Describe knit-lines (weld lines)
Unit: Plastics Troubleshooting (Level 2)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Correct abnormal conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency Builders:</td>
<td>Increase injection pressure</td>
</tr>
<tr>
<td></td>
<td>Decrease injection pressure</td>
</tr>
<tr>
<td></td>
<td>Increase cycle time</td>
</tr>
<tr>
<td></td>
<td>Increase injection hold-time</td>
</tr>
<tr>
<td></td>
<td>Decrease injection hold-time</td>
</tr>
<tr>
<td></td>
<td>Use larger opening in nozzle</td>
</tr>
<tr>
<td></td>
<td>Adjust feed</td>
</tr>
<tr>
<td></td>
<td>Increase clamp pressure</td>
</tr>
<tr>
<td></td>
<td>Increase stock temperature</td>
</tr>
<tr>
<td></td>
<td>Decrease stock temperature</td>
</tr>
<tr>
<td></td>
<td>Increase mold temperature</td>
</tr>
<tr>
<td></td>
<td>Decrease mold temperature</td>
</tr>
<tr>
<td></td>
<td>Change flow path of cooling media</td>
</tr>
<tr>
<td></td>
<td>Pre-dry material</td>
</tr>
<tr>
<td></td>
<td>Polish surface of mold</td>
</tr>
<tr>
<td></td>
<td>Increase injection speed</td>
</tr>
<tr>
<td></td>
<td>Decrease injection speed</td>
</tr>
<tr>
<td></td>
<td>Re-seat nozzle (machine)</td>
</tr>
<tr>
<td></td>
<td>Check nozzle heating band</td>
</tr>
<tr>
<td></td>
<td>Check material for contamination</td>
</tr>
<tr>
<td></td>
<td>Polish sprue bushing</td>
</tr>
<tr>
<td></td>
<td>Decrease screw RPM</td>
</tr>
<tr>
<td></td>
<td>Increase back pressure</td>
</tr>
<tr>
<td></td>
<td>Decrease back pressure</td>
</tr>
<tr>
<td></td>
<td>Adjust mold protection</td>
</tr>
<tr>
<td></td>
<td>Clamp sequence and adjusting clamp velocities</td>
</tr>
<tr>
<td></td>
<td>Set ejector strokes</td>
</tr>
<tr>
<td></td>
<td>Increase sprue runner or gate size</td>
</tr>
<tr>
<td></td>
<td>Decrease gate land length</td>
</tr>
<tr>
<td></td>
<td>Re-match mold parting line</td>
</tr>
<tr>
<td></td>
<td>Add more gas vents</td>
</tr>
<tr>
<td></td>
<td>Change location of gate</td>
</tr>
</tbody>
</table>
Competency: Define product requirements

Competency Builders:
Define customer requirement(s) for mechanical and thermal loads
Define customer requirement(s) for features required
Define customer requirement(s) for product life expectancy
Explain customer requirement(s) for product/material recycling and coding (e.g., 1, 2-7)
Identify customer requirement(s) for agency/regulatory issues
Identify customer requirement(s) for environmental resistance
Competency: Describe plastic product design concepts

Competency Builders:
Describe nominal wall/uniform wall/draft
Describe projections
Describe depressions (e.g., sink marks)
Describe plating concerns
Describe part quality
Describe print format
Describe tolerance guidelines
Describe gating/ejection/texturing parting lines, radii, and location of each
Describe the value of concurrent engineering program
Describe post mold handling (e.g., robot arm, sprue picker)
Describe packaging requirements
Describe possible quality concerns, sink, bow, out-of-roundness, cosmetic issues, and shrinkage
Describe FMEA (Failure Mode Effects Analysis)
Competency: Select process based on criteria

**Competency Builders:**
- Define injection molding criteria
- Define thermoset and thermoplastic molding criteria
- Define extrusion criteria
- Define blow molding criteria
- Define thermoforming criteria
- Define composites criteria
- Define compression/transfer criteria
- Define pultrusion criteria
- Define injection compression criteria
- Define gas-assist criteria
- Define co-injection criteria
- Define RIM/RRIM criteria
- Define co-extrusion criteria
- Define coining criteria
- Define injection blow molding criteria
- Define tubular film blowing criteria
- Define sheet extrusion criteria
- Define gas counter pressure molding criteria
- Define foam extrusion criteria
- Define microwave cure criteria
- Define rotational molding criteria
Competency: Describe advanced part/tool design concepts

Competency Builders:
Identify prototyping systems (e.g., machining, molding, stereolithography)
Explain analysis of part designs
Explain effect of part design changes on tooling/mold flow
Identify need for 3-plate, sprue gate, hot runner
Contrast plastic part design-to-cost analysis
Perform product analysis (including Computer Modeling)
Perform process analysis (including Computer Modeling)
Explain in-mold degating
Explain integrated tool/part handling devices
Explain gating options
Explain in-mold decorating
Explain insert molding
Unit: Color Matching (Level 1)

| Leveling of this competency... | 1 | R | C | P | ✓ | ✓ |

Competency: Explain how color is perceived

Competency Builders:
Describe physical factors influencing the perception of color
Describe models for seeing color

| Leveling of this competency... | 1 | C | P | ✓ | ✓ |

Competency: Explain color measurement principles

Competency Builders:
Describe sample collection and visual assessment
Describe spectrophotometer use
Perform color difference calculations (e.g., tristimulus values, chromiticity, coordinates CIE lab color space, lab diagrams, LCH diagrams, tolerencing, CMC)

| Leveling of this competency... | 1 | C | P | ✓ | ✓ |

Competency: Analyze colorants

Competency Builders:
Describe color pigment or dye characteristics and users
Identify and describe organic and inorganic pigments
Identify families of dyes
Describe properties of specific classes of colorants
Explain evaluating performance
Identify sources of colorant information
Define colorant selection criteria
Describe dispersion
Define metamerism
Competency: Formulate colored plastic compounds

**Competency Builders:**
- Prepare mass-tone and letdown samples of a colorant
- Perform spectrophotometer
- Use colorant file for computer color math evaluation
- Perform batch correction capabilities of the spectrophotometer
- Explain dispersion aids
Unit: Color Matching (Level 2)

Competency: Interpret spectral curves

- Competency Builders:
  - Describe how spectral curves are developed
  - Describe characteristics of spectral curves
  - Identify components of a color mixture

Competency: Explain industry coloring materials

- Competency Builders:
  - Identify additives for plastics
  - Explain color mixing laws
  - Explain color matching types
  - Explain colorant replacement
  - Explain colorant strength
  - Explain pigment selection for typical plastics
Unit: Instrumental Methods (Level 1)

Competency: Explain principles of instrumental analysis

Competency Builders:
- Explain linear regression
- Explain Precision of Measurements Theory
- Explain purpose of instrumental analysis

Competency: Explain microscopy methods

Competency Builders:
- Explain optical
- Explain SEM
- Explain TEM

Competency: Explain non-destructive testing methods

Competency Builders:
- Explain acoustic emission
- Explain strain gauges
- Explain x-rays
- Explain birefringence
- Explain index of refraction
- Explain specific gravity
Competency: Perform instrumental analysis

Competency Builders:
Determine the specific gravity of a plastic material
Run melt index determinations to characterize flow properties
Run stress-strain analysis (e.g., tensile, compression)
Run dynamic mechanical properties (e.g., ASTM, QS, ISO)
Run tear tests
Use heat shrinkage tests to determine internal stress levels due to processing
Run heat aging tests to study long term environmental effects on material properties
Run hardness tests
Run heat and light stability tests
Run falling ball (ASTM)
Run low temperature brittleness and stiffness tests
Run falling dart test
Run Izod impact test
Run charpy impact test

Explain the reason for differences in test results on machine direction and transverse direction samples
Identify unknown plastic materials through the use of observations of physical appearance, burning characteristics, specific gravity, and stress-strain properties
Identify the various safety hazards associated with the testing of plastic material, and take appropriate precautions to avoid injury to both personnel and equipment
Unit: Instrumental Methods (Level 2)

| Leveling of this competency... | I | C |

Competency: Explain spectroscopic methods

Competency Builders:
- Explain infrared, near infrared, ultrasound, and microwave
- Explain mass spectroscopy
- Explain atomic absorption
- Explain NMR and other advanced techniques
- Explain light scattering

| Leveling of this competency... | C | P |

Competency: Explain thermal analysis methods

Competency Builders:
- Explain DSC
- Explain TGA
- Explain TMA
- Explain DMA

| Leveling of this competency... | C | R | √ | √ |

Competency: Explain chromatographic methods

Competency Builders:
- Explain GPC
- Explain liquid chromatography
Unit: Rheology

<table>
<thead>
<tr>
<th>Competency: Describe the effects of heat on polymers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency Builders:</td>
</tr>
<tr>
<td>Describe the effects of heat softening</td>
</tr>
<tr>
<td>Describe the effects of volume increase</td>
</tr>
<tr>
<td>Describe the effects of melting crystals</td>
</tr>
<tr>
<td>Describe the effects of no melting temperature for amorphous polymers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competency: Describe types of polymer flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency Builders:</td>
</tr>
<tr>
<td>Describe laminar flow</td>
</tr>
<tr>
<td>Describe velocity profile</td>
</tr>
<tr>
<td>Describe turbulent flow</td>
</tr>
<tr>
<td>Describe plug flow</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competency: Describe the effects of polymer flow on molded parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency Builders:</td>
</tr>
<tr>
<td>Describe areas of flow profile with greater orientation</td>
</tr>
<tr>
<td>Describe finished part properties exhibit anisotropy</td>
</tr>
</tbody>
</table>
Competency: Describe the influence of orientation in thermosets

Competency Builders:
Explain how lower flow rates are used to minimize orientation
Explain how 3D network reduces anisotropy
Explain why there is lower orientation in thermosets than thermoplastics

Competency: Describe the concepts of shear rheology

Competency Builders:
Describe the origin of shear viscosity
Describe concept and measurement of shear rate
Convert from Pa-s to mPa-s to Poise to cp to lb-sec/in^2
Describe and cite examples of Newtonian/non-Newtonian flow
Describe shear thinning behavior
Cite advantages of non-Newtonian flow
Explain how non-Newtonian flow fills thin wall cavities easier
Explain how non-Newtonian flow has less pressure loss at higher flow rates
Cite disadvantages of non-Newtonian flow
Explain why non-Newtonian is more difficult to control
Describe orientation variations in non-Newtonian flow
Cite examples of viscosity changes
Explain how acrylics can reduce viscosity by a factor of 100
Explain how polyethylenes can reduce viscosity by a factor of 30
Explain why polycarbonates exhibit minimal non-Newtonian behavior
Explain why polycarbonates, polysulfones, polyphenylene oxides, and polyphenylene sulfides show few orientation effects
Competency: Describe the effects of orientation in injection molded parts

Competency Builders:
- Explain the layer of oriented polymer near surfaces
- Explain the unoriented layer near center
- Explain how layering determines structural properties of a part

Competency: Describe the effects of orientation in compression molded parts

Competency Builders:
- Explain how flow affects orientation
- Explain how 3D network in thermosets determines structural properties

Competency: Describe the effects of orientation in transfer molded parts

Competency Builders:
- Explain why some orientation is seen in the direction of flow
- Explain how 3D network in thermosets determines structural properties

Competency: Describe the effects of orientation in extruded parts

Competency Builders:
- Explain why orientation is dependent upon shear rate in the die
- Explain why orientation is dependent upon post processing (draw rates)
Competency: Describe processes which induce little orientation

Competency Builders:
- Explain why foamed parts (any process) induces little orientation
- Explain why rotational molding induces little orientation
- Explain why casting induces little orientation
- Explain why RIM induces little orientation

Competency: Describe the effects of orientation in reinforced molded parts

Competency Builders:
- Explain why the fibers will orient in the direction of flow
- Explain why fibers account for most of the strength
<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

**Competency:** Describe viscoelasticity using dynamic mechanical rheology and methods

**Competency Builders:**
- Describe viscoelasticity and cite examples
- Describe time dependent behavior
- Describe viscous liquid response (long time)
- Describe elastic solid response (short time)
- Explain linear and non linear regions
- Describe processes that require a predominantly viscous response (e.g., extrusion, injection molding, and compression molding)
- Describe processes that require a predominantly elastic response (e.g., fiber spinning, injection blow molding, and tubular film blowing)
- Relate the viscous response to imaginary numbers
- Explain the tangent delta ratio
- Cite modes and examples used for dynamic mechanical testing
- Describe tensile (Autovibron)
- Describe shear (Rheometrics, DMA)
- Describe the relationships between $E'$, $E''$, and $E^*$
- Describe the relationships between $G'$, $G''$, and $G^*$
Unit: Plastics Manufacturing (Level 1)

Competency: Identify plastic forms

Competency Builders:
- Describe molding compounds (e.g., powders, pellets, flakes)
- Describe adhesives (e.g., co-extrusion)
- Describe profiles
- Describe films
- Describe fibers
- Describe liquids
- Describe cellular
- Describe reinforced

Competency: Identify property enhancers

Competency Builders:
- Describe filler (e.g., calcium, wood, mineral)
- Describe reinforcements (e.g., fiberglass, carbonfibers)
- Describe solvents
- Describe lubricants
- Describe plasticizers
- Describe stabilizers
- Describe antioxidants
- Describe antiozonants
- Describe antistatics
- Describe flame-retardants
- Describe catalysts
- Describe colorants
- Describe coatings
- Describe UV protectors
- Describe EMI/RFI shielding
- Describe conductivity enhancers
- Describe blowing agents

180
Competency: Identify plastics processing methods

**Competency Builders:**
- Describe injection molding
- Describe extrusion
- Describe blow molding
- Describe stretch-blow molding
- Describe thermoforming
- Describe rotational molding
- Describe (RIM reaction injection molding)
- Describe calendering
- Describe compression molding
- Describe cast
- Describe pulltrusion
- Describe liquid injection molding (e.g., silicone)
- Describe hybrid technology (e.g., metal injection molding [MIM], ceramics)
- Describe spray lay-up
- Describe rotational blow molding
- Describe multi-layered processing
- Describe co-processing (e.g., injection, extrusion, blow)

Competency: Describe fiberglass reinforced plastics (FRP) method

**Competency Builders:**
- Describe match die
- Describe hand lay-up
- Describe spray-up
- Describe rigidizing
- Describe bag
- Describe filament wind
- Describe centrifugal
- Describe pultrusion
- Describe stamping/cold forming
- Explain reinforced plastic molding methods
- Identify machines and molds used in reinforced plastic moldings
## Leveling of this competency...

<table>
<thead>
<tr>
<th>Competency: Describe thermoforming processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency Builders:</td>
</tr>
<tr>
<td>Describe vacuum forming</td>
</tr>
<tr>
<td>Describe drape forming</td>
</tr>
<tr>
<td>Describe match molding</td>
</tr>
<tr>
<td>Describe plug assist</td>
</tr>
<tr>
<td>Describe snap back</td>
</tr>
<tr>
<td>Describe pressure bubble</td>
</tr>
<tr>
<td>Describe trapped sheet</td>
</tr>
<tr>
<td>Describe free forming</td>
</tr>
<tr>
<td>Describe mechanical forming</td>
</tr>
</tbody>
</table>

## Leveling of this competency...

<table>
<thead>
<tr>
<th>Competency: Describe expansion and coating processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency Builders:</td>
</tr>
<tr>
<td>Describe in-place expansion (e.g., foam)</td>
</tr>
<tr>
<td>Describe spraying</td>
</tr>
<tr>
<td>Describe extrusion coating</td>
</tr>
<tr>
<td>Describe calendering</td>
</tr>
<tr>
<td>Describe powder coating</td>
</tr>
<tr>
<td>Describe transfer coating</td>
</tr>
<tr>
<td>Describe knife coating</td>
</tr>
<tr>
<td>Describe dip</td>
</tr>
<tr>
<td>Describe spray</td>
</tr>
<tr>
<td>Describe metal coating</td>
</tr>
<tr>
<td>Describe in-mold painting</td>
</tr>
<tr>
<td>Describe granular in-mold painting technology</td>
</tr>
</tbody>
</table>
Competency: Assemble plastics

Competency Builders:
- Explain how different adhesives are used in product assembly
- Describe solvent bonding processes
- Describe spin welding
- Describe fusion bonding
- Describe vibration welding
- Describe ultrasonic welding
- Describe dielectric sealing
- Describe induction bonding
- Describe cold pressing
- Describe hot boss staking
- Describe hot gas welding
- Describe riveting
- Describe mechanical assembly (screws/clips/hardware)
- Describe snap-fit and press fit assembly
- Describe heat staking

Competency: Print/coat plastics

Competency Builders:
- Explain hot stamping
- Explain pad printing
- Explain subliminal printing
- Explain electrostatic coating
- Explain ink jet
- Explain laser printing and etching
- Explain solvent and water based painting
- Explain electroplating
- Explain electroless plating
- Explain screen printing
- Explain vacuum metallizing/sputtering
- Explain corona discharge
Competency: Explain surface preparation

Competency Builders:
- Explain corona discharge
- Explain flame
- Explain plasma
- Explain chemical etching

Competency: Describe annealing

Competency Builders:
- Explain conduction
- Explain convection
- Explain what effect internal stresses have on plastics
- Explain post-part curing (annealing)

Competency: Explain deflashing

Competency Builders:
- Differentiate between various degrees of product cleanliness
- Explain cryogenics
- Explain vibration
- Explain media
- Explain tumbling
- Explain degreasing
- Explain ultrasonic bath
- Explain knife trimming
- Explain trim fixture
- Explain laser deflashing
- Explain water jet deflashing
- Explain glass beading
Unit: Plastics Manufacturing (Level 2)

Competency: Transport plastic parts from mold

Competency Builders:
- Use vibratory bowls
- Use pick and place
- Use robotics
- Use separators
- Use pickers
- Use conveyors
- Use chutes

Competency: Perform physical testing on final parts

Competency Builders:
- Use insert pull test
- Use bond strength test
- Use drop impact test
- Use vibration and cyclic loading test
- Use porosity weight test

Competency: Apply extrusion method

Competency Builders:
- Explain extrusion method
- Identify machines and dies used in extrusion
- Identify applications for extrusion
- Conduct extrusion method experiment
- Describe products which can be produced by extrusion
- Describe dies to produce various extrusion shapes
<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

**Competency: Apply compression molding method**

**Competency Builders:**
- Explain compression molding method
- Define well, draft, bulk factor, shrinkage, and molding cycle
- Identify machines and molds used in compression molding
- Identify applications for compression molding (e.g., flash molds, semi-positive)
- Conduct compression molding experiment
- Describe products which are compression molded
- Describe molds which are used to produce products utilizing the compression molding process

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

**Competency: Apply injection molding method**

**Competency Builders:**
- Explain injection molding methods (e.g., horizontal, vertical)
- Identify components of 2-plate injection mold and their functions
- Identify components of 3-plate injection mold and their functions
- Determine shrinkage allowance
- Calculate clamp pressure
- Identify machines and molds used in injection molding
- Identify application for injection molding
- Conduct injection molding experiment
- Describe products which can be injection molded
- Describe molds for injection molding

259

186
Competency: Apply blow molding method

Competency Builders:
Explain blow molding method
Identify machines and molds used in blow molding
Identify applications for blow molding
Describe the high volume input and output characteristics of blow molding
Conduct blow molding experiment
Describe product that can be blow-molded
Describe molds for products produced using the blow-mold process

Competency: Apply thermoforming method(s)

Competency Builders:
Explain thermoforming method
Identify machines and molds used in thermoforming
Identify applications for thermoforming
Describe downstream equipment for thermoformed parts
Conduct thermoforming experiment

Competency: Apply rotational molding method

Competency Builders:
Explain rotational molding method
Identify machines and molds used in rotational molding
Identify applications for rotational molding
Conduct rotational molding experiment
Competency: Apply calendering method

Competency Builders:
Explain calendering method
Identify machines and molds used in calendering
Identify applications for calendering
Conduct calendering experiment

Competency: Apply foam processes method

Competency Builders:
Explain foam processes method
Identify machines and materials used in foam processing
Identify applications for foam processes
Conduct foam processes experiment
Describe structural foam
Explain gas assist
Describe expandable beads
Describe foaming agents

Competency: Apply powder coating method(s)

Competency Builders:
Explain powder coating method
Identify machines and materials used in powder coating
Identify applications for powder coating
Conduct powder coating experiment
Competency: Describe thermoset sheet molding (i.e., mechanical forming)

**Competency Builders:**
- Explain sheet molding method
- Identify machines and molds used in sheet molding
- Identify applications for sheet molding
- Describe products which utilize contact, vacuum bag, pressure bag, autoclave, matched die, filament wound and spray processes
- Describe molds to produce products using contact, vacuum bag, pressure bag, autoclave, matched die, filament wound and spray molding processes

Competency: Describe slush, rotational, and dip casting

**Competency Builders:**
- Explain slush, rotational, and dip casting
- Identify machines and molds used in slush, rotational, and dip casting
- Identify applications for slush, rotational, and dip casting
- Describe products which are formed by slush, rotational or dip casting
- Describe molds to produce products utilizing slush, rotational and dip casting processes

Competency: Describe transfer molding

**Competency Builders:**
- Explain transfer molding method
- Identify machines and molds used in transfer molding
- Identify applications for transfer molding
- Identify compositions associated with transfer molds
<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency: Describe pressure forming</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

**Competency Builders:**
- Explain pressure forming methods
- Identify machines and molds used in pressure forming
- Identify applications for pressure forming
- Describe products which are pressure formed
- Describe pressure forming molds

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency: Describe vacuum forming</td>
<td>C</td>
<td>P</td>
<td>R</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

**Competency Builders:**
- Explain vacuum forming methods
- Identify machines and molds used in vacuum forming
- Identify applications for vacuum forming
- Describe products which are vacuum formed
- Describe patterns and molds to produce products using the vacuum forming process

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency: Describe polymer nomenclature</td>
<td>1</td>
<td>R</td>
<td>P</td>
<td>M</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

**Competency Builders:**
- Locate the major polymer names
- Locate the major material trade names
- Define terms (See Sample Glossary on pp. 197–201.)
Competency: Finish/assemble plastic products

Competency Builders:
Describe the processes, tools, materials, and machines necessary to finish/assemble plastic products
Flash remove plastic product
Slot cut plastic product
Polish plastic product
Anneal plastic product
Saw plastic product
File plastic product
Drill plastic product
Tap plastic product
Turn plastic product
Plane plastic product
Mill plastic product
Shape plastic product
Route plastic product
Sand plastic product
Shear plastic product
Punch plastic product
Laser cut plastic product
Tumble plastic product
Grind plastic product
Determine ash content of plastic product
Buff plastic product
Transparent coat plastic product
Polish by solvent plastic product
Post-cure plastic product
Describe types of assembly methods which can be performed on various types and classes of plastic products
Identify types of products which can be used to perform successful repairs
Identify appropriate tools, machines, and processes which can be used to perform successful repair of plastic products
Describe cohesive cementing of plastic products
Describe solvent cementing of plastic products
Describe mechanical fastening of plastic products
Describe stapling of plastic products
Describe snap fit of plastic products
Describe press fit of plastic products
Competency Builders: (continued from previous page)
Describe heat staking of plastic products
Describe ultrasonic staking of plastic products
Describe thermal sealing of plastic products
Describe impulse sealing of plastic products
Describe ultrasonic sealing of plastic products
Describe dielectric sealing of plastic products
Describe hot gas welding of plastic products
Describe spin welding of plastic products
Describe hot plate welding of plastic products
Describe ultrasonic welding of plastic products
Describe hot blade welding of plastic products
Describe high pressure lamination of plastic products

<table>
<thead>
<tr>
<th>Leveling of this competency...</th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>V</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

Competency: Demonstrate basic knowledge of material handling

Competency Builders:
Describe identification of received material (e.g., type, nomenclature, etc.)
Describe major polymer names and their abbreviations (e.g., Acrylonitrile-Butadiene-Styrene [ABS], Polycarbonate [PC])
Describe major material trade names (e.g., ABS [Cycolac, Lustran])
Define a letter of material certification
List procedures of testing incoming materials (e.g., thermo-analysis)
Describe good housekeeping procedures to prevent dust and water contamination
Define proper lift truck techniques in moving materials (e.g., stacking, accessibility)
Explain material quarantine
Describe "First in—First out" concept
Define safety concerns in lift truck operations
Define proper storing of materials (e.g., location, room temperature, ventilation)
Describe necessity of strict stock control system

215

192
Competency: Demonstrate basic knowledge of material types for proper handling procedures

Competency Builders:
- Describe amorphous resins
- List examples of amorphous materials
- Describe crystalline resins
- List examples of crystalline materials
- Describe hygroscopic materials
- Describe non-hygroscopic materials

Competency: Demonstrate basic knowledge of material drying techniques

Competency Builders:
- Describe vented machine method
- Describe oven drying
- Describe vacuum method of drying
- Describe desiccant drying
- Describe auto hopper loader
- Explain insulation of inlet air lines to dryers
- Describe hopper insulation
- Describe use of temperature monitors at hopper inlets
- Describe dewpoint
- Describe continuous dewpoint analyzer
- Describe air flow meter
- Define effect of air temperature
- Define effect of moisture content in resin
- Define effect of residence time
- Define effect of air flow rate
- Define effect of moisture content of air
- Explain formula to calculate hopper size
- Explain formula to calculate airflow requirements
- Explain formula to calculate resin throughput
Competency Builders: (continued from previous page)
Describe drying range for soft flow materials
Describe drying range for hard flow materials
Describe drying temperatures and time for commonly used materials (e.g., acetal, ABS, nylon, polycarbonate, and polyurethanes)

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

Competency: Describe basic knowledge of regrind materials

Competency Builders:
Describe effect of regrind percentage on physical properties (e.g., 25%-50%-75%)
Define importance of proper size, design, and maintenance of granulator
Define cascade regrind system
Describe "fines" and their adverse affect on melt quality
Describe relationship of blades to screens
Explain importance of screen hole sizes and monitoring wear
Describe best materials for granulator blades (e.g., tungsten carbide, etc.)
Describe blade gaps and how they should be set (e.g., PE-Polypro—.003 to .005)
Describe soundproofing safety (e.g., OSHA limit)
Explain safety concerns in granulator operations

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>12</th>
<th>AD</th>
<th>BD</th>
<th>WS</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveling of this competency...</td>
<td>I</td>
<td>C</td>
<td>P</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>

Competency: Describe basic knowledge of blending/mixing material

Competency Builders:
Describe gravimetric blender
Describe proportional or volumetric blender
Describe methods of weighing
Define how to determine let down ratios and percentages
Describe basic tumbling equipment
Describe tumbling methods
Describe effects of static electricity

194
Competency: Demonstrate knowledge of material conveying and loading systems

**Competency Builders:**
- Describe equipment used for hand filling machine hoppers
- Describe hopper loaders and their function
- Describe tube system operations
- Describe use and operation of tipsters
- Describe the functions of cyclones
- Describe advantage of machine side granulators
- Describe maintenance of loading and conveying systems
- Define importance of constant monitoring of systems
- Describe source and type of material contamination in the work area
- Describe source and type of material contamination in molding operations
- Describe preventative methods and procedures to eliminate material contamination
Sample Glossary of Terms

**Automatic Mold:** A mold for injection, compression or transfer molding that repeatedly goes through the entire molding cycle, including ejection, without human assistance.

**Back Pressure:** Pressure applied to the rear end of a screw to slow its rate of return to a starting position.

**Cavity:** Female or recessed portion of a mold which shapes the surface opposite that formed by a core.

**Center Gated Mold:** An injection or transfer mold wherein the cavity is filled with molding material through a sprue or gate directly into the center of the part.

**Clamping Force:** In injection molding and in transfer molding, the pressure which is applied to the mold to keep it closed.

**Clamping Plate:** A plate fitted to a mold and used to fasten mold to a molding machine.

**Cooling Channels:** Channels or passageways located within the body of a mold through which a cooling medium can be circulated to control temperature on the mold surface. May also be used for heating a mold by circulating steam, hot oil or other heated fluid through channels as in molding of the thermosetting and some thermoplastic materials.

**Core (n.):** Male portion of a mold which shapes the inside of a hollow part. Also called force, plug or male section.

**Cycle:** A series of operations which performs all or part of a mold sequence. In injection molding a single cycle involves closing a mold, injection material, cooling the piece, opening the mold, and ejection. The cycle time is the elapsed time between a certain point in one cycle and the same point in the next cycle.

**Ejector Pin:** Or ejector sleeve. A rod, pin or sleeve which pushes a molding off of a force out of a cavity of a mold. It is attached to an ejector bar or plate which can be actuated by the ejector rod(s) of the press or by auxiliary hydraulic or air cylinders.

**Family Mold:** A multi-cavity mold wherein each of the cavities forms one of the component parts of the assembled finished object. The term often applied to molds wherein parts from different customers are grouped together in one mold for economy of production. Sometimes called Combination Mold.
Sample Glossary of Terms (continued)

Flash: Extra plastic attached to a molding along the parting line; under most conditions it would be objectionable and must be removed before the parts are acceptable.

Flights: The spaces between the "turns" of a screw.

Flow: A qualitative description of the fluidity of a plastic material during the process of molding.

Force: That portion of the mold which forms the inside of the molded part. Sometimes called a Core or a Plunger.

Gate (mold): Restricted opening leading from a runner to a cavity.

Hopper: Container (located at the feed end of an injection machine) from which pellets drop by gravity into the heating cylinder, or into a feed mechanism.

Injection Molding: A molding procedure whereby a heat-softened plastic material is forced from a cylinder into a cavity which gives the article the desired shape.

Mold (n.): The tool which imparts final shape to the molten plastic. Injection molds are machined from tool steel, special types of aluminum, and may have cores and cavities of beryllium copper. Molds are also referred to as tooling.

Molding Material: Plastic material in varying stages of granulation often comprising resin, filler, pigments, plasticizers and other ingredients, ready for use in the molding operation. Also called Molding Compound or Powder.

Mold Release Agent: A lubricant used to coat a mold cavity to prevent the molded piece from sticking to it, and thus to facilitate its removal from the mold. Also called Release Agent.

Moveable Platen: The moving platen of a injection molding machine to which half of the mold is secured during operation. This platen is moved either by hydraulic ram or toggle mechanism.

Nozzle: An adapter containing an orifice through which hot plastic flows from the heating cylinder into the sprue bushing.
Sample Glossary of Terms (continued)

**Packing**: The term applied when a slight excess of plastic is pushed into a cavity while the molded part is cooling and shrinking. Packing can cause sticking; can cause hidden stresses in a molded part. Packing increases shot weight, which runs the cost of the job higher.

**Pellet**: Small, uniform particles of thermoplastic material usually cylindrical or cubical in shape, with a cross section of 1/8 to 1/16 inch.

**Plastic**: Natural and synthetic material and chemicals that can be transformed into a solid, as either or both heat and pressure is applied.

**Plasticate**: To render a plastic workable by means of heat or mechanical shearing.

**Plasticity**: A property of plastics which allows the material to be deformed continuously and permanently without rupture upon the application of a force that exceeds the yield value of the material.

**Platen**: Rugged steel plate which provides the means for clamping the mold and exerting clamping pressure.

**Purging**: Cleaning one color or type of material from the cylinder of an injection molding machine by forcing it out with new color or material to be used in subsequent production. Purging materials are also available.

**Pyrometer**: A device for measuring temperature. Electronic controllers regulate the current furnished to heating bands, based on pyrometer signals.

**Reject (n.)**: A molded product that does not meet manufacturing specifications.

**Residence Time**: The total time required for pellets to be conveyed from the feed end of a heating cylinder to the sprue bushing.

**Rhythm**: The ability of the machine operator to regulate his movements in time with the established molding cycle.

**Runner**: Feed channels cut into the mold on the parting line to direct the plastic to cavities. The term, runner, also applied to the cooled plastic formed in the channel.

**Runner System**: (Refers to plastic) The term usually applied to all the material in the form of sprues, runners and gates which lead material from the nozzle of an injection machine to the mold cavity.
Sample Glossary of Terms (continued)

**Screw:** A device that accepts the pellets and conveys them forward into the heated barrel, where the pellets are melted. The melted plastics coming off of the end of the screw cause the screw to pump itself backward thereby preparing the next shot of plastics for molding.

**Semi-Automatic Molding Machine:** A molding machine in which only part of the operation is controlled by the direct action of a human. The automatic part of the operation is controlled by the machine according to a predetermined program.

**Shearing:** An action which results in one portion of a substance or body to slide away from, or be torn from, another portion.

**Short and Short Shot:** A molded part produced when the mold has not been filled completely.

**Shot:** The amount of plastic that can be injected by one forward stroke of the injection ram.

**Shot Capacity:** The maximum weight of material which a machine can produce from one forward motion of the plunger or screw.

**Sink Mark:** A depression or dimple on the surface of an injection molded part due to collapsing of the surface following local internal shrinkage after the gate seals.

**Sprue Bushing:** A steel insert, usually cylindrical, containing a tapered hole in its center, and a spherical seat which mates with the nozzle of the injection cylinder. Heat-softened plastic flows through the sprue bushing, either directly into a mold cavity, or to runners which lead to cavities. The term, sprue, applied to the cooled plastic formed in the sprue bushing.

**Stationary Platen:** The plate of an injection or compression molding machine to which the front plate of the mold is secured during operation. This platen does not move during normal operation.

**Thermoplastic:** (a) Capable of being repeatedly softened by heat and hardened by cooling. (b) A material that will repeatedly soften when heated and harden when cooled. Typical of the thermoplastic family are the styrene polymers and copolymers, acrylics, cellulosics, polyethylenes, polypropylene, vinyls, nylons, and the various fluorocarbon materials.
Sample Glossary of Terms (continued)

**Toggle Action:** A mechanism which exerts pressure developed by the application of force on a knee joint. It is used as a method of closing presses and also to apply pressure at the same time.

**Torque:** Power applied to turn the screw.

**Vent:** In a mold, a shallow channel or minute hole cut in the cavity to allow air to escape as the material enters. Also called Breathers.

**Warpage:** Dimensional distortion on a plastic object after molding.

**Weld Line:** A mark on a molded piece made by the meeting of two flow fronts during molding.
Plastics Technical Competency Profile Index

p.3  Unit:  Communications Literacy
p.19 Unit:  Mathematics Literacy
p.29 Unit:  Science Literacy
p.48 Unit:  Technology Literacy

Unit:  Employability Skills
p.50 Competency:  Develop a career plan
p.51 Competency:  Prepare for employment
p.52 Competency:  Evaluate the importance of self-esteem as an employability skill
p.52 Competency:  Demonstrate job retention skills
p.53 Competency:  Demonstrate knowledge of work ethic
p.53 Competency:  Exhibit appropriate work ethic
p.54 Competency:  Apply decision-making techniques
p.54 Competency:  Apply problem-solving techniques
p.55 Competency:  Exhibit characteristics for job advancement

Unit:  Professionalism
p.56 Competency:  Project professional image
p.56 Competency:  Achieve individual and professional goals
p.57 Competency:  Manage personal finances
p.57 Competency:  Support community well-being
p.57 Competency:  Achieve organizational goals
p.58 Competency:  Demonstrate positive relations in the workplace
p.58 Competency:  Manage stressful situations
p.59 Competency:  Analyze effects of family on work and work on family
p.59 Competency:  Apply lifelong learning skills
p.60 Competency:  Manage professional development

Unit:  Teamwork
p.61 Competency:  Demonstrate knowledge of teamwork
p.62 Competency:  Demonstrate teamwork
p.62 Competency:  Use teamwork to solve problems
p.63 Competency:  Conduct team meetings

Unit:  Technical Recording and Reporting
p.64 Competency:  Demonstrate technical recording skills
p.64 Competency:  Demonstrate technical reporting skills

224
201
<table>
<thead>
<tr>
<th>Unit: Plastics Technical Competency Profile Index (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit:</strong> Problem Analysis</td>
</tr>
<tr>
<td>p.65 Competency: Appraise situations</td>
</tr>
<tr>
<td>p.65 Competency: Analyze potential problems</td>
</tr>
<tr>
<td>p.65 Competency: Analyze actual problems</td>
</tr>
<tr>
<td>p.66 Competency: Analyze decision(s)</td>
</tr>
<tr>
<td><strong>Unit:</strong> Project Management</td>
</tr>
<tr>
<td>p.67 Competency: Explain project management</td>
</tr>
<tr>
<td>p.67 Competency: Plan projects</td>
</tr>
<tr>
<td>p.67 Competency: Implement projects</td>
</tr>
<tr>
<td>p.68 Competency: Evaluate projects</td>
</tr>
<tr>
<td><strong>Unit:</strong> Computer Literacy</td>
</tr>
<tr>
<td>p.69 Competency: Describe personal computer operations</td>
</tr>
<tr>
<td>p.69 Competency: Explain information processing cycle</td>
</tr>
<tr>
<td>p.70 Competency: Operate computer hardware</td>
</tr>
<tr>
<td>p.70 Competency: Use software</td>
</tr>
<tr>
<td><strong>Unit:</strong> Basic Economics</td>
</tr>
<tr>
<td>p.71 Competency: Explain basic economic concepts</td>
</tr>
<tr>
<td>p.71 Competency: Identify cost and profit influences</td>
</tr>
<tr>
<td>p.72 Competency: Explain basic business concepts</td>
</tr>
<tr>
<td><strong>Unit:</strong> Workplace Safety (Level 1)</td>
</tr>
<tr>
<td>p.73 Competency: Describe general workplace safety and hazards and understand both personal and company responsibility</td>
</tr>
<tr>
<td>p.74 Competency: Apply general workplace safety precautions/procedures</td>
</tr>
<tr>
<td>p.75 Competency: Perform first aid</td>
</tr>
<tr>
<td>p.75 Competency: Explain purpose of industrial pollution control systems</td>
</tr>
<tr>
<td>p.76 Competency: Maintain environmental health and safety regulations</td>
</tr>
<tr>
<td>p.76 Competency: Explain basic ergonomics in the workplace</td>
</tr>
<tr>
<td><strong>Unit:</strong> Workplace Safety (Level 2)</td>
</tr>
<tr>
<td>p.77 Competency: Maintain cardiopulmonary resuscitation (CPR) certification</td>
</tr>
</tbody>
</table>

202
Unit: **Industrial Electricity**

- p.78 Competency: Explain basic industrial electricity theory
- p.78 Competency: Use the National Electrical Code (NEC)
- p.78 Competency: Explain operation of electrical distribution systems
- p.79 Competency: Maintain basic electrical systems
- p.79 Competency: Read and apply electrical/electronic drawings
- p.80 Competency: Demonstrate proficiency in direct current (DC) circuits
- p.81 Competency: Demonstrate proficiency in alternating current (AC) circuits
- p.82 Competency: Demonstrate proficiency in power distribution systems
- p.82 Competency: Demonstrate proficiency in power distribution equipment
- p.83 Competency: Demonstrate proficiency in motors and motor control
- p.84 Competency: Apply electromechanical maintenance management practices

Unit: **Electrical Test and Measurement Equipment**

- p.85 Competency: Demonstrate proficient use of electrical test equipment
- p.85 Competency: Demonstrate proficient use of electrical measurement equipment

Unit: **Drafting Technology**

- p.86 Competency: Apply basic drafting skills
- p.87 Competency: Apply advanced drafting skills
- p.88 Competency: Prepare mechanical drawings
- p.89 Competency: Explain geometric dimensioning and tolerancing
- p.89 Competency: Convert dimensions and tolerances
- p.90 Competency: Demonstrate dimensioning techniques
- p.91 Competency: Apply geometric dimensioning and tolerancing

Unit: **Print Reading**

- p.92 Competency: Interpret drawings/prints/schematics
- p.93 Competency: Interpret structural drawings

Unit: **CAD Fundamentals**

- p.94 Competency: Demonstrate basic use of computer operating system
- p.95 Competency: Operate a CAD system
Plastics Technical Competency Profile Index (continued)

Unit: Equipment Maintenance
p.97 Competency: Perform housekeeping
p.97 Competency: Perform recordkeeping
p.98 Competency: Inspect machine systems
p.98 Competency: Perform machine maintenance
p.99 Competency: Maintain hand tools
p.99 Competency: Maintain portable power tools
p.100 Competency: Maintain stationary equipment

Unit: Electromechanical Technology
p.101 Competency: Interpret electromechanical drawings
p.101 Competency: Describe and demonstrate proficiency in transducers (sensors) and instrumentation

Unit: Basic Machining
p.103 Competency: Perform prerequisite machining skills
p.103 Competency: Analyze machine shop jobs
p.103 Competency: Explain basic machining operations
p.104 Competency: Perform bench operations
p.104 Competency: Operate metal cutting saw
p.105 Competency: Operate drill press
p.105 Competency: Operate tool and cutter grinding machine
p.106 Competency: Operate pedestal grinder
p.106 Competency: Operate lathe
p.107 Competency: Operate milling machine
p.108 Competency: Operate surface grinder
p.108 Competency: Select materials for job
p.109 Competency: Explain nontraditional machining processes
p.110 Competency: Demonstrate use of precision layout devices

Unit: Hydraulics and Pneumatics
p.111 Competency: Describe fluid flow concepts
p.111 Competency: Describe energy considerations
p.112 Competency: Describe system losses
p.112 Competency: Describe hydrostatics
p.112 Competency: Design basic hydraulic/pneumatic system
p.113 Competency: Describe component operation
p.113 Competency: Interpret hydraulic and pneumatic schematics
p.113 Competency: Perform hydraulic system maintenance and repair
(continued on next page)
Plastics Technical Competency Profile Index (continued)

Unit: **Hydraulics & Pneumatics (continued)**
- p.114 Competency: Maintain piping and accessories for high and low pressure fluid power systems
- p.114 Competency: Maintain hydraulic system components
- p.115 Competency: Troubleshoot hydraulic systems
- p.115 Competency: Describe reciprocating and rotary air compressors
- p.116 Competency: Maintain pneumatic systems
- p.117 Competency: Maintain vacuum systems
- p.117 Competency: Calculate energy

Unit: **Industrial Manufacturing Technology (Level 1)**
- p.118 Competency: Describe industrial manufacturing process
- p.118 Competency: Describe materials requirements planning
- p.119 Competency: Describe role of supply materials
- p.119 Competency: Describe plant layouts
- p.119 Competency: Describe material flow
- p.120 Competency: Maintain quality control of materials handling
- p.120 Competency: Describe post-production control
- p.121 Competency: Analyze a manufacturing project

Unit: **Industrial Manufacturing Technology (Level 2)**
- p.122 Competency: Demonstrate knowledge of JIT
- p.122 Competency: Apply JIT

Unit: **Programmable Logic Controllers (PLCs)**
- p.123 Competency: Differentiate among process controls
- p.123 Competency: Explain basic operation of PLCs
- p.124 Competency: Demonstrate use of PLCs
- p.125 Competency: Apply robot fundamentals

Unit: **Welding Basics**
- p.126 Competency: Explain welding/cutting processes
- p.127 Competency: Perform basic gas welding, brazing, and cutting
- p.127 Competency: Perform basic arc welding/cutting (i.e., stick)
- p.128 Competency: Evaluate welds

Unit: **Supervision**
- p.129 Competency: Perform supervisory functions
- p.130 Competency: Coordinate training
| Unit: Quality Assurance (Level 1) | p.131 Competency: Demonstrate knowledge of inspection |
| p.132 Competency: Demonstrate knowledge of quality assurance |
| p.133 Competency: Explain importance of interdepartmental relationships to quality assurance |
| p.133 Competency: Demonstrate knowledge of basic statistics |
| p.133 Competency: Demonstrate knowledge of precontrol |

| Unit: Quality Assurance (Level 2) | p.134 Competency: Demonstrate knowledge of engineering a quality product |
| p.134 Competency: Inspect machinery, materials, and products |
| p.135 Competency: Use testing equipment |
| p.135 Competency: Demonstrate knowledge of nondestructive testing |
| p.136 Competency: Demonstrate knowledge of basic statistics |
| p.136 Competency: Demonstrate knowledge of precontrol |
| p.136 Competency: Construct X and R charts |
| p.137 Competency: Interpret X and R charts |
| p.137 Competency: Demonstrate knowledge of scattergrams |
| p.138 Competency: Use quality control charts |
| p.138 Competency: Demonstrate knowledge of process capability |
| p.139 Competency: Demonstrate knowledge of quality/cost implications |
| p.139 Competency: Manipulate quality cost data |
| p.139 Competency: Manipulate cost control data |

| Unit: Quality Assurance (Level 3) | p.140 Competency: Demonstrate knowledge of engineering a quality product |
| p.140 Competency: Demonstrate knowledge of probability theory |
| p.141 Competency: Conduct process improvement studies |
| p.141 Competency: Explain importance of interdepartmental relationships to quality assurance |
| p.141 Competency: Demonstrate knowledge of quality/cost implications |

| Unit: Plastics Press Technology (Level 1) | p.142 Competency: Explain press operation |
| p.142 Competency: Demonstrate knowledge of auxiliary press accessories |
Plastics Technical Competency Profile Index (continued)

Unit: Plastics Press Technology (Level 2)
- p.143 Competency: Explain various controls
- p.143 Competency: Perform preventive maintenance of control systems
- p.143 Competency: Prepare setup sheet
- p.144 Competency: Describe basic press operations
- p.144 Competency: Describe relay control operations
- p.144 Competency: Describe solid state control operations
- p.145 Competency: Describe NC and CNC control operations

Unit: Sheet Metal Fabrication
- p.146 Competency: Describe sheet metal fabrication
- p.146 Competency: Describe types of metal fabrication manufacturing
- p.147 Competency: Explain machining fabrication processes
- p.147 Competency: Layout sheet metal
- p.147 Competency: Fabricate components
- p.148 Competency: Perform sheet metal fabrication

Unit: Moldmaking (Level 1)
- p.149 Competency: Explain basics of building molds
- p.150 Competency: Explain heating and cooling of molds
- p.150 Competency: Explain injection mold runners and gates

Unit: Moldmaking (Level 2)
- p.151 Competency: Explain heating and cooling of molds
- p.151 Competency: Describe the machining and/or manufacturing of plastics tooling

Unit: Polymer Technology (Level 1)
- p.152 Competency: Demonstrate knowledge of plastics
- p.153 Competency: Demonstrate basic knowledge of rubber manufacturing
- p.153 Competency: Define plastics materials
- p.154 Competency: Describe additives
- p.155 Competency: Demonstrate knowledge of polymer chemistry
- p.155 Competency: Describe basic polymer processing
- p.156 Competency: Prepare polymer blends and alloys
- p.156 Competency: Demonstrate knowledge of polymeric testing
- p.157 Competency: Perform analytical testing of polymeric materials
- p.158 Competency: Describe effects of weathering and aging on polymeric materials

(continued on next page)
Plastics Technical Competency Profile Index (continued)

Unit: Polymer Technology (Level 1 continued)
p.158 Competency: Tensile test polymeric materials
p.159 Competency: Identify electrical and weathering properties
p.159 Competency: Identify optical properties and material characterization tests
p.160 Competency: Identify flammability, chemical properties, and analytical tests
p.160 Competency: Identify tests and identification analysis of polymers
p.160 Competency: Identify testing of foam plastics and nondestructives

Unit: Polymer Technology (Level 2)
p.161 Competency: Demonstrate knowledge of polymer chemistry
p.162 Competency: Apply instrumental methods of analysis

Unit: Plastics Troubleshooting (Level 1)
p.163 Competency: Identify abnormal conditions

Unit: Plastics Troubleshooting (Level 2)
p.164 Competency: Correct abnormal conditions

Unit: Plastics Product Design
p.165 Competency: Define product requirements
p.165 Competency: Select a plastic material based on evaluating constraints
p.166 Competency: Describe plastic product design concepts
p.167 Competency: Select process based on criteria
p.168 Competency: Describe advanced part/tool design concepts

Unit: Color Matching (Level 1)
p.169 Competency: Explain how color is perceived
p.169 Competency: Explain color measurement principles
p.169 Competency: Analyze colorants
p.170 Competency: Formulate colored plastic compounds

Unit: Color Matching (Level 2)
p.171 Competency: Interpret spectral curves
p.171 Competency: Explain industry coloring materials
<table>
<thead>
<tr>
<th>Unit: Plastics Technical Competency Profile Index (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit:</strong> Instrumental Methods (Level 1)</td>
</tr>
<tr>
<td>p.172 Competency: Explain principles of instrumental analysis</td>
</tr>
<tr>
<td>p.172 Competency: Explain microscopy methods</td>
</tr>
<tr>
<td>p.172 Competency: Explain non-destructive testing methods</td>
</tr>
<tr>
<td>p.173 Competency: Perform instrumental analysis</td>
</tr>
<tr>
<td><strong>Unit:</strong> Instrumental Methods (Level 2)</td>
</tr>
<tr>
<td>p.174 Competency: Explain spectroscopic methods</td>
</tr>
<tr>
<td>p.174 Competency: Explain thermal analysis methods</td>
</tr>
<tr>
<td>p.174 Competency: Explain chromatographic methods</td>
</tr>
<tr>
<td><strong>Unit:</strong> Rheology</td>
</tr>
<tr>
<td>p.175 Competency: Describe the effects of heat on polymers</td>
</tr>
<tr>
<td>p.175 Competency: Describe types of polymer flow</td>
</tr>
<tr>
<td>p.175 Competency: Describe the effects of polymer flow on molded parts</td>
</tr>
<tr>
<td>p.176 Competency: Describe the influence of orientation in thermosets</td>
</tr>
<tr>
<td>p.176 Competency: Describe the concepts of shear rheology</td>
</tr>
<tr>
<td>p.177 Competency: Describe the effects of orientation in injection molded parts</td>
</tr>
<tr>
<td>p.177 Competency: Describe the effects of orientation in compression molded parts</td>
</tr>
<tr>
<td>p.177 Competency: Describe the effects of orientation in transfer molded parts</td>
</tr>
<tr>
<td>p.177 Competency: Describe the effects of orientation in extruded parts</td>
</tr>
<tr>
<td>p.178 Competency: Describe processes which induce little orientation</td>
</tr>
<tr>
<td>p.178 Competency: Describe the effects of orientation in reinforced molded parts</td>
</tr>
<tr>
<td>p.179 Competency: Describe viscoelasticity using dynamic mechanical rheology and methods</td>
</tr>
<tr>
<td><strong>Unit:</strong> Plastics Manufacturing (Level 1)</td>
</tr>
<tr>
<td>p.180 Competency: Identify plastic forms</td>
</tr>
<tr>
<td>p.180 Competency: Identify property enhancers</td>
</tr>
<tr>
<td>p.181 Competency: Identify plastics processing methods</td>
</tr>
<tr>
<td>p.181 Competency: Describe fiberglass reinforced plastics (FRP) method</td>
</tr>
<tr>
<td>p.182 Competency: Describe thermoforming processes</td>
</tr>
<tr>
<td>p.182 Competency: Describe expansion and coating processes</td>
</tr>
<tr>
<td>p.183 Competency: Assemble plastics</td>
</tr>
<tr>
<td>p.183 Competency: Print/coat plastics</td>
</tr>
<tr>
<td>p.184 Competency: Explain surface preparation</td>
</tr>
<tr>
<td>p.184 Competency: Describe annealing</td>
</tr>
<tr>
<td>p.184 Competency: Explain deflashing</td>
</tr>
</tbody>
</table>
Plastics Technical Competency Profile Index (continued)

Unit: Plastics Manufacturing (Level 2)

p.185 Competency: Transport plastic parts from mold
p.185 Competency: Perform physical testing on final parts
p.185 Competency: Apply extrusion method
p.186 Competency: Apply compression molding method
p.186 Competency: Apply injection molding method
p.187 Competency: Apply blow molding method
p.187 Competency: Apply thermoforming method(s)

p.187 Competency: Apply rotational molding method
p.188 Competency: Apply calendering method
p.188 Competency: Apply foam processes method
p.188 Competency: Apply powder coating method(s)
p.189 Competency: Describe thermoset sheet molding (i.e., mechanical forming)

p.189 Competency: Describe slush, rotational, and dip casting
p.189 Competency: Describe transfer molding
p.190 Competency: Describe pressure forming
p.190 Competency: Describe vacuum forming
p.190 Competency: Describe polymer nomenclature
p.191 Competency: Finish/assemble plastic products
p.192 Competency: Demonstrate basic knowledge of material handling
p.193 Competency: Demonstrate basic knowledge of material types for proper handling procedures
p.193 Competency: Demonstrate basic knowledge of material drying techniques
p.194 Competency: Describe basic knowledge of regrind materials
p.194 Competency: Describe basic knowledge of blending/mixing material
p.195 Competency: Demonstrate knowledge of material conveying and loading systems

p.196 Sample Glossary of Terms