Welding Technician National Core Curriculum

Student Learning Outcomes

Appropriate for all postsecondary Welding Technician education programs

National Welding Education and Training Center

Weld-Ed

National Center for Welding Education and Training

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Background

What is a Welding Technician and why is it so hard to define?

The Weld-Ed Center has spent considerable time discussing and debating the definition of a welding technician. Some of the dilemma in building a consistent definition of a welding technician is the variation of job titles linked with postsecondary two-year education levels. This is further complicated by Department of Labor Standard Occupation Codes (SOC codes) that do not distinguish between welders, welding technicians and welding engineers. To finally put this dilemma to rest, an approach based on the practical experience of ten Weld-Ed Partner colleges and universities was used to define the core student learning outcomes that define the 'core' of a welding technician postsecondary program.

Why create a Welding Technician National Core Curriculum?

Education institutions are encouraged to use this document as a starting point in the development or review of welding technician programs. Does your program take your students to the level above entry-level welder? Are core student learning outcomes in each of the welding processes covered? What other student learning outcomes should be added to your program beyond the listed core?

This core curriculum provides a validated listing of the core of what students should know and be able to do after completing a welding technician program. This core is not comprehensive for every locale since labor market demands across the country vary based on the specific industries that are prevalent in respective regions. Welding technicians are hired within a wide range of industrial sectors, therefore, a one-size-fits-all curriculum delivered in two years or less is unrealistic. Instead, a core set of student learning outcomes, supplemented by a program tailored to fit a region's prevailing industry niche, is a reasonable approach to a national curriculum model.

Description of the Process to Determine Core Student Learning Outcomes

The process followed and the standards used to determine the core student learning outcomes for a welding technician utilized a technique based on expert consensus to define the elements of a national core curriculum for welding technicians at the postsecondary level. Experts in this process included Weld-Ed regional centers and a validation panel of education and industry representatives from across the country.

The Weld-Ed college and university regional centers, representing the welding technician, welding technologist and engineering programs are:

- **Chattanooga State Technical Community College,**
  Chattanooga, TN
- **Honolulu Community College,**
  Honolulu, HI
- **Illinois Central College,**
  East Peoria, IL
- **Lorain County Community College,**
  Elyria, OH
- **North Dakota State College of Science,**
  Wahpeton, ND
- **Pennsylvania College of Technology,**
  Williamsport, PA
- **Texas State Technical College,**
  Waco, TX
- **The Ohio State University,**
  Columbus, OH
- **Weber State University,**
  Ogden, UT
- **Yuba College,**
  Marysville, CA

Upon collecting and collating student learning outcomes from these ten regional centers, validation reviews were solicited from a variety of sources. Participants attending the Weld-Ed Welding Educator's Conference at FABTECH 2010 were asked to provide feedback on the learning outcomes list. Following that review, the list was segmented into two groups. Any student learning outcome with 60% agreement from all colleges and participants was deemed part of the final core. Any item with a rating less than 60% was distributed to the validation panel to determine inclusion. If the final average score from the validation panel and the regional partner schools reached 60%, the item was added to the final list. As a result of this process 45 items were added.

Validation panel members were recruited from advisory committees of the regional partners, American Welding Society (AWS) members and past educator participants of Weld-Ed educator professional development sessions. This distribution assured national coverage. The validation panel consisted of 24 members: seven members (29%) were industry representatives and 17 (71%) were postsecondary classroom educators. Several members served two roles among the categories of postsecondary educator, industry representative and secondary educator. This breadth of background helped to ensure that the input received from this validation panel enhanced the quality of the final product.

Outcomes

The National Core Curriculum Concept

This is a national core curriculum model. The student learning outcomes listed in the model are not intended to describe every conceivable student learning outcome that a postsecondary welding technician program might include. In fact, it is expected that most programs should include additional student learning outcomes that are germane to the specific location where students may be employed. A national core curriculum reflects objectives and outcomes as a starting point. Each institution is encouraged to add or delete from this list as it is relevant to the local demands and requirements of their labor market.

It is assumed that students will also be enrolled in English, mathematics and science courses that will supplement the content of this listing. Each postsecondary institution has academic requirements beyond those of their welding student learning outcomes. The list does not attempt to include or identify these core academic competencies.

Further, the list does not address instructional strategies. Instructional strategies in the delivery of this curriculum should assure that students learn teamwork, self-management skills, critical thinking, strategies for locating information independently and leadership amongst peers.

Hence, personal effectiveness, academic and workplace competence are all foundations that need to be imbedded into the curriculum through academic requirements of individual institutions and through instructional strategies. These student learning outcomes are vital if the graduate is to be a successful welding technician.

Student Learning Outcomes

Why Student Learning Outcomes instead of Curriculum Competencies?

A student learning outcomes specifies what a student should learn as a result of their educational experience in the classroom and laboratory. That experience might also include internships or other industry experiences. An outcome reflects the consequences or results of what the student learns, not what the instructor teaches. Hence any approach to instruction that, in the end, results in the student's acquisition of the knowledge or behavior listed in this model is appropriate.

Organization of the Core Student Learning Outcomes for Welding Technicians

Core student learning outcomes are arranged by subject areas, which are listed in alphabetical order and are not intended to imply any special order or importance. Each subject area is indicated by an alpha designator and student learning outcomes within this subject area are listed by a number.

Regional Variations

Much of the regional variation to the final listing of student learning outcomes, which a college or university might include in a college major, is a reflection of the local industrial base within which welding technician graduates are hired. The above illustration illustrates one such conceptual model where a college, if situated near the aerospace industry, might supplement the core with one set of student learning outcomes while another college, located within the automotive manufacturing region, might include a different set of supplemental outcomes. This variation in the content of a welding technician curriculum is both expected and encouraged.

The National Core Curriculum for Welding Technicians — Subject Areas

A. Blueprint Reading

1. Read and layout drawing measurements using various scales (architect's, metric).
2. Apply neat and legible lettering to drawing and sketches.
3. Demonstrate the use of geometric constructions for preparing drawings.
4. Interpret and prepare orthographic projection drawings.
5. Interpret and prepare oblique and isometric drawings.
6. Prepare freehand technical sketches from objects and drawings.
7. Demonstrate an understanding of sections and prepare full and half section drawings.
8. Interpret and prepare welding symbols.
9. Interpret and prepare developments along with bend allowances.
10. Place dimensions and tolerances on drawings and technical sketches in accordance with ANSI Y14.5M.
11. Interpret metric dimensions and tolerances in accordance with ISO 1101.
12. Interpret title block information, general notes, revision blocks, abbreviations, parts lists, drawing references, numbering systems, and other technical information.
13. Interpret technical information used on industrial working and assembly drawings.
14. Demonstrate CAD and discuss the importance of CAD databases (this competency is included if lab facilities are available and/or scheduled by the instructor).
15. Explain the importance of weld print reading skills in industry.

B. CNC Programming

1. Work safely and avoid practices that could pose a danger to others.
2. Describe major components/equipment used in CNC programming and operation.
3. Identify the different types of materials that may be cut by the thermal and chemical processes.
4. Utilize proper software and programming techniques.
5. Understand the basic CNC programming concepts.
6. Utilize appropriate mathematical skills to solve applied problems.

C. Flux Cored & Sub-Arc

1. Weld safely and avoid practices that could pose a danger to others.
2. Describe the health hazards associated with the FCAW/SAW processes.
3. Fabricate weldments using various types and sizes of electrodes used in the FCAW/SAW processes.
4. Understand the difference between gases (primary and mixtures).
5. Define the advantages and disadvantages of the various gases used in FCAW.
6. Demonstrate correct welding procedures for FCAW/SAW.
7. Define primary, secondary and pre-selected variables.
8. Understand the AWS numbering system for both the FCAW and SAW processes.
9. Troubleshoot and identify problems in the FCAW/SAW welding processes.
10. Operate various types of power sources along with the wire feeders.
11. Set up and operate a plasma-cutting torch.
12. Identify gases and mixtures of gases used in FCAW.
13. Determine cu. ft./hr. (CFH) flow rates.
14. Identify the various types of welding guns/torches used in FCAW and SAW.
15. Determine the types of drive rolls used for FCAW.
16. Set up welding variables in both FCAW and SAW processes.
17. Explain slope, inductance, and their relationship to position and joint configuration.
18. Fabricate (weld) various weldments using the forehand and backhand techniques.

D. Gas Metal Arc

1. Weld safely and avoid practices that could pose a danger to others.
2. Set up and operate gas metal arc welding equipment.
3. Identify the various types of welding guns used in gas metal arc welding.
4. Identify and state uses of different types of inert gases.
5. Identify types of welding wire and various diameters.
6. Understand and develop basic techniques used with forehand and backhand welding.
7. Identify major types of ferrous and non-ferrous metals.
8. Understand the basic principles of voltage and current as it relates to consumable wire electrodes.
9. Understand and demonstrate the various arc modes for the various welding positions.
10. Understand and select proper filler metals.
11. Understand correct welding procedures, metal prep, current, polarity, tacking, position and electrode techniques.
12. Understand and prepare inert gases for ferrous/non-ferrous metals.
13. Understand, select and prepare electrodes for welding.
14. Understand and identify the problems of welding ferrous and non-ferrous metals.
15. Demonstrate personal safety, good work habits and job safety.
16. Set up and trouble shoot gas metal arc welding equipment.
17. Understand constant voltage, constant potential welding power units and their polarities as applied to gas metal arc welding.
18. Understand the set up of flow meters and regulators.
19. Set up and trouble shoot wire feeders used in gas metal arc welding.
20. Select the proper shielding gases used in GMAW.
21. Understand and set up the welding gun and cable assembly, air/water connections and component parts.
22. Understand and set up appropriate equipment to weld ferrous and non-ferrous metals.
23. Understand and set up weld techniques for sheet, plate, tubing and pipe.
24. Set up and operate plasma cutting torches.
25. Understand and perform metal shapes identification to industry standards.
26. Weld on ferrous and non-ferrous material in various positions using basic joint designs.

E. Gas Tungsten Arc

1. Weld safely and avoid practices that could pose a danger to others.
2. Describe safety issues as it pertains to shop safety, industrial safety and personal safety.
3. Describe the major components and equipment used in gas tungsten arc welding.
4. Explain the major electrical current flow concepts and usage.
5. Identify the different types of carbon steels, aluminum, magnesium, stainless steels by number and physical and mechanical properties.
6. Apply proper usage of free hand and walking-the-cup techniques.
7. Understand multi-beads and its applications in gas tungsten arc welding.
8. Select the proper joint design to facilitate the welding of different thicknesses.
9. Select the correct filler materials to meet specific welding procedures.
10. Weld ferrous and non-ferrous metals with the gas tungsten arc welding process.
11. Describe health hazards associated with gas tungsten arc welding.
12. Join carbon steel, stainless steel and aluminum in the flat position acceptable to standards, such as AWS or ASME.
13. Understand the welding of magnesium and its alloys.
14. Describe the major components of semi-automatic and automatic equipment used in gas tungsten arc welding.
15. Understand multi-beading and application in gas tungsten arc welding for the welding of pipe and tube.
16. Select proper joint design to facilitate the welding of different thickness of pipe and tube.
17. Select the proper filler materials for welding various alloys.
18. Demonstrate relevant research skills.
19. Identify and fabricate pipe and tube using the open root technique.
20. Demonstrate techniques commonly used to weld pipe and tube in the 1G, 2G, 5G and 6G positions.
21. Understand the difficulties when welding pipe or tubes where restrictions are involved and apply previously learned skills to complete the task.
22. Understand acceptable quality standards and testing procedures related to pipe welding.
23. Describe the physical and mechanical properties of metals as related to gas tungsten arc welding.
24. Use appropriate mathematical skills and competencies to solve applied problems.
25. Complete minor repairs to welding equipment and accessories.
26. Describe the fitting, tubing and tungsten used in the orbital tube welding process.

F. Inspection

1. Demonstrate basic NDT methods in liquid penetrant, magnetic particle, ultrasonic and radiographic testing methods.
2. Communicate and/or pass judgment on usage, techniques, procedures and interpretation of NDT tests.
3. Operate various non-destructive testing equipment.
4. Describe the physical and mechanical properties of materials as related to NDT.
5. Separate acceptable and unacceptable materials in accordance with predetermined standards and codes.
6. Utilize the appropriate mathematical skills to solve applied problems.
7. Recognize and apply approved safety principles.
8. Write technical reports on NDT findings.
9. Demonstrate attitudes and work habits required of the NDT professional.
10. Work as a member of a problem-solving team.
11. Describe different methods of destructive testing used to test welds.
12. Explain the basic content use of NDE requirements.
13. Describe quality assurance and control procedures.
14. Describe the fundamentals of VT, MT, PT, UT, LT, AET and ET.
15. Document procedure and performance qualification requirements.
16. Perform destructive testing and similar forms of destructive testing.

G. Metallurgy

1. Explain the structure and use of the periodic table and distinguish between metals and non-metals.
2. Explain the differences between elements, mixtures, compounds and alloys.
3. Describe basic atomic structure, chemical bonding, phases of matter and crystalline structure.
4. Identify crystalline structures in metal samples.

5. Discuss the elastic properties of metals including stress and strain, modulus of rigidity, elastic limit and ultimate strength.
6. Discuss metal fatigue and failure modes and relate this to metallic microstructures and material design in manufacturing.
7. Explain the effect of heat on metals including thermal transfer principles, phase changes, resistive effect and isothermal transformations.
8. Cite the historical background of minerals and metals production and its effect in society.
9. Conduct hardness testing of metals and analyze sources of measurement error.
10. Explain the hardening and tempering of carbon steels and demonstrate this in typical materials.
11. Explain the processes of annealing, normalizing and stress relieving. Demonstrate these processes on typical metal samples.
12. Discuss the metallurgy of welding and investigate common welding processes and their effects on metals.
13. Analyze surface chemistry of metals, especially corrosion processes. Investigate and explain the different corrosion routes. Choose appropriate anticorrosion technology and demonstrate same.
14. Describe other related manufacturing processes and the impact metallurgy has on their application, namely: powdered metallurgy, casting processes, extrusion, forging and stamping.
15. Recite and demonstrate proper laboratory safety procedures for the metallurgical laboratory.
16. Analyze bulk material properties, such as density, hardness, ductility and brittleness, heat conductance and specific heat, in metals.
17. Evaluate metals for tensile strength.
18. Analyze the effect of different heat treatment regimes on controlled samples with hardness testing. Identify sources of error and suggest process adaptations.
19. Analyze the effect of different heat treatment regimes on the crystalline structure of metals through the use of proper metallurgical sample preparation. Compare against standards and demonstrate understanding of physical structure as a result of processing history.
20. Prepare metallurgical samples for inspection using metallurgical microscopes; investigate the polycrystalline nature of metals and typical physical structures found in metals.
21. Test various metals with different hardness testing methods including Brinell, Rockwell, elastic rebound and microhardness. Distinguish between the different methods and demonstrate appropriate choices for the type of test.
22. Explain the weldability of commercial alloys.

H. Occupational Health & Safety

1. Understand the safety practices within the work environment.
2. List the types of personal protection equipment and its limitations.
3. Discuss the regulations governing industrial noise, machine guarding, heat stress, industrial chemical exposure and electrical exposure.
4. Identify reference materials related to occupational safety.
5. Define the legal responsibilities of supervisors and the "Right to Know" regulations.
6. Recognize existing hazards in a sample environment and identify applicable standards.
7. Demonstrate safety regulations and procedures for confined spaces.
8. Demonstrate proper use and handling of hazardous materials and communications.
9. Demonstrate proper completion and use of Material Safety Data Sheets (MSDS).

I. Oxy-Fuel Welding & Cutting

1. Understand safety issues as they pertain to shop safety, occupational safety and personal safety.
2. Perform welding and cutting procedures safely and avoid practices which are unsafe to others.
3. Understand basic geometric methods of basic joint design.
4. Identify major types of metals (ferrous and non-ferrous).
5. Understand the basic principles of heat, expansion and contraction as it relates to metals.
6. Perform basic manipulative techniques used in oxy-fuel welding and cutting operations.
7. Identify the CGA oxy-fuel fittings and connections.
8. Identify the different types of welding and cutting torches.
9. Understand the types and uses of fuel gases used for welding, brazing and cutting.
10. Identify the types and uses of oxy-fuel flames.
11. Identify the various types of oxy-fuel welding and brazing rods.
12. Identify the various fluxes used in oxy-fuel welding and brazing.
13. Identify, set-up and operate oxy-fuel welding and cutting equipment.
14. Weld and braze the basic weld joints using various sizes and types of oxy-acetylene welding/brazing rods.
15. Identify and use the correct type and size filler material to meet specific purposes.
16. Identify the various types and uses of the various oxy-acetylene flame settings.
17. Identify the types and uses of fuel gases as they relate to welding, brazing and cutting applications.
18. Use appropriate mathematical skills and competencies to solve applied problems as they relate to oxy-fuel applications.

J. Robotic Welding

1. Understand safety issues related to robotics and robotic work cells.
2. Operate a robotic unit safely and avoid practices that could pose a danger to others.
3. Define robotic system configurations.
4. Understand the basic terms and nomenclature related to robotics.
5. Demonstrate use of operator controls.
6. Demonstrate operating modes; single cycle through automatic.
7. Program welding parameters using the teach pendant.

K. Shielded Metal Arc

1. Identify and describe the health hazards associated with welding.
2. Set up and operate equipment used in shielded metal arc welding.
3. Identify the correct type, size and number electrode to meet the specific purposes.
4. Understand and demonstrate the proper handling and storage of electrodes.
5. Identify and fabricate basic weldments.
6. Explain the characteristics of arc blow.
7. Weld in the flat position using the various electrodes and welding techniques.
8. Select the proper current and polarity for a given electrode.
9. Work safely and avoid practices that could pose a danger to others.
10. Identify and safely operate the various equipment used in Shielded Metal Arc Welding (SMAW).
11. Weld the basic weld joints using various sizes and types of electrodes.
12. Identify the major types of ferrous metals.
13. Describe the physical and mechanical properties of steel as related to SMAW.
14. Use appropriate mathematical skills and competencies to solve applied problems.
15. Describe the health hazards associated with shielded metal arc welding.
16. Demonstrate job safety in the set-up and operation of arc welding equipment.
17. Describe the fundamentals of shielded metal arc welding, as it relates to the AWS, ASME, API and other welding codes and standards.
18. Identify and use the proper welding process, procedure, supplies, etc. based on cost limitations.
19. Describe the physical and mechanical properties of metals as related to weldability.
20. Demonstrate critical thinking to resolve problems pertaining to lay-out and welding of different materials.
21. Identify welding faults and their correction through welding performance tests.
22. Demonstrate speech and writing skills appropriate to the welding technician level.
23. Remove backing rings with oxy-acetylene hand cutting torches.
24. Set up and prepare bevel coupons for shielded metal arc welding.

25. Sequence multiple pass welds on various plate thicknesses using SMAW.
26. Fabricate (weld) plate in various positions.
27. Use SMAW procedures to weld open root using E-6010 and E-7018 electrodes.
28. Use low-hydrogen electrodes to weld plate as addressed by the AWS code.
29. Apply tack weld procedures to the fabrication process.
30. Perform air carbon arc weld removal.

L. Shielded Metal Arc/Pipe

1. Cut pipe using stationary or portable SMAW equipment.
2. Set up and prepare plate and pipe coupons for shielded metal arc welding.
3. Sequence multiple pass welds on plate and pipe using SMAW.
4. Weld plate and pipe in accordance with AWS, ASME and API standards.
5. Use SMAW procedures to weld open root using E-6010 and E-7018 electrodes.
6. Set up and weld pipe in a safe and proficient manner and avoid practices that could pose a danger to others.
7. Sequence multiple pass welds on light and heavy wall pipe using SMAW.
8. Weld pipe in the 1G, 2G, 5G and 6G positions using SMAW.
9. Use low-hydrogen electrodes to fill out and cap pipe weldments using SMAW.
10. Demonstrate the proper technique for tack welding pipe joints.

M. Subject Area: Welding Design

1. Work safely and avoid practices that could pose a danger to Identify and use the proper welding process for various weldments.
3. Demonstrate the layout of plate and sheet metals.
4. Demonstrate the use of jigs, fixtures and positioners.
5. Recognize and apply approved methods to control distortion.
6. Demonstrate proper preparation of plate metals for weldments.
7. Determine load conditions using appropriate math skills and software.
8. Identify the types of structural steel beams and shapes.
9. Demonstrate the uses of AutoCad, Sigmanest, SmartCam and other software.
10. Perform practical projects with minimum supervision.

N. Welding Fabrication & Repair

1. Perform preheat and postweld heat treatments.
2. Perform stress and distortion control.
3. Identify basic hand and power tools and equipment related to welding.
4. Safely use and maintain basic hand and power tools equipment related to welding (such as drill press, band saw, abrasive sander, abrasive grinder, metal shears, hydraulic press, plasma cutter, etc.).
5. Develop/derive a welding procedure specification.
6. Demonstrate the repair of defective welds or base materials.
7. Solve problems using applied trigonometry, solid and plane geometry and physics.
8. Describe basic construction techniques as related to welding.
9. Describe basic fabrication techniques as related to welding.
10. Describe material specifications, base metal compliance and storage and handling.
11. Classify filler metal and consumable types and describe their characteristics and storage and handling.

About Weld-Ed

The National Center for Welding Education and Training is a dynamic partnership between business and industry, community and technical colleges, universities, the American Welding Society and the government sector. The Center does business as Weld-Ed through funding support from the National Science Foundation. Weld-Ed is located in the Nord Advanced Technologies Center at Lorain County Community College in Elyria, Ohio.

Weld-Ed, in collaboration with business and industry, improves the quality, quantity and availability of welding technicians through advancements in educational curricula and instructor professional development. To accomplish its mission, the Center's staff and partners work collaboratively on the development of new and improved curricula in all areas of the materials joining industry. As a result of these efforts, faculty and instructors are offered continuing education opportunities throughout the academic year and in the summer months. These programs are specifically designed to train the next generation of workers for the materials joining industry and to upgrade the skills of existing workers.

The Weld-Ed Mission

Vision

Weld-Ed is a national partnership of colleges, universities, professional societies, government sectors, and private industry committed to increasing the number and quality of welding and materials joining technicians to meet industry demand.

Mission

Weld-Ed strives to improve the quality of education and training services to address the hiring and professional development needs of the welding industry.

Center Goals

The Center's goals are to:

- Increase the number of welding technicians to meet ongoing workforce needs;
- Promote comprehensive reform of welding education; and
- Promote and enhance faculty professional development and continuing education for welding educators.

The accomplishment of these goals will be a driver in the future of the materials joining industry in the U.S. Working together the educational partners, business partners and AWS are identifying the new and emerging technologies and methods that will be keys to the competitiveness of the industry. That information will be the foundation in building future curricula and services to meet the needs of current and future welding technicians.

National Center for Welding Education and Training. (2011).
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Weld-Ed

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