Instructional Framework

Welding Technologies

48.0508.00

This Instructional Framework identifies, explains, and expands the content of the standards/measurement criteria, and, as well, guides the development of multiple-choice items for the Technical Skills Assessment. This document corresponds with the Technical Standards endorsed on May 19, 2021.

Domain 1: Shop and Tool Safety **Instructional Time: 25 – 30%**	
STANDARD 1.0 MAINTAIN THE SAFETY AND HEALTH OF WELDERS	

1.1 Use appropriate personal protective equipment (PPE) (e.g., helmets, shading, gloves, safety glasses, and hearing protection)	• Recognize and evaluate the proper use of safety equipment
	• Personal protective equipment (PPE)
	  ○ Helmets
	  ○ Shading
	  ○ Gloves
	  ○ Safety glasses
	  ○ Hearing protection
	  ○ Appropriate clothing
	  ▪ Material type

1.2 Explain safe operations for work in confined spaces	• OSHA guidelines

1.3 Identify types and safe use of respiratory equipment	• OSHA guidelines
	  ○ Particulates, vapors, and gases
	  ○ N95
	  ○ P100

1.4 Describe the best possible means of ventilation available for the management of welding, cutting, and brazing fumes and gases pre- and post-combustion	• Fume extraction awareness
	  ○ Natural Air Ventilation
	  ○ Mechanical Supply Ventilation
	  ○ Mechanical Exhausting
	  ○ Localized Exhausts

1.5 Explain Hot Work operations	• OSHA guidelines • Awareness of local (county/city) guidelines • Fire watch

1.6 Identify safe handling procedures and storage of compressed gas cylinders (i.e., label identification, cap placement, ANSI-Z-49, etc.)	● Compressed gas cylinder handling and storage ○ Label identification ○ Cap placement ○ ANSI-Z-49 ● Safe storage of fuel gases
1.7 Follow job safety regulations and procedures according to OSHA guidelines	● OSHA guidelines
1.8 Recognize the purpose of precautionary labels as well as Safety Data Sheets (SDSs)	● OSHA guidelines ○ Employer responsibilities ○ Employee responsibilities
1.9 Follow established procedures and policies for implementing emergency action plans and for the use of safety equipment	● OSHA standards ○ Benefits of an Emergency Action Plan ○ Elements of a Fire Protection Plan ○ Conditions under which evacuation actions may be necessary for an emergency ○ Conditions under which shelter-in-place may be necessary for an emergency ○ Characteristics of an effective emergency escape route ○ The five types of fire extinguishers, including the types of fires they can extinguish ○ Requirements for proper maintenance of portable fire extinguishers
1.10 Describe the proper use of fire safety equipment in the work area (i.e., fire extinguisher, fire blanket, etc.)	● Proper use of fire safety equipment ○ Fire extinguisher ○ Fire blanket
STANDARD 9.0 USE AUXILIARY EQUIPMENT AND TOOLS	
9.1 Perform safety inspections and assessment for serviceability of equipment and accessories (i.e., grinders, extension cords, etc.)	● Grinders ○ Inspect grinding wheels ○ Ensure all guards and handles are in place and operational ● Extension cords ● Input power cords and connections
9.2 Identify different abrasives and cutting equipment (i.e., cutting wheels, grinding wheels, flapper disks, wire wheels, band saw, cold saw, chop saw, etc.)	● Abrasives and cutting equipment ○ Cutting wheel/disc ○ Grinding wheel/disc

	○ Flapper wheel/disc ○ Wire wheels ○ Band saw ○ Cold saw ○ Chop saw, etc.
9.3 Use appropriate mechanical/abrasive cutting equipment [i.e., grinders (angle, tungsten, pedestal), belt sander, saws (chop, band, cold), etc.]	● Personal Protective Equipment (PPE) ● Mechanical/abrasive cutting equipment ○ Grinders (angle, tungsten, pedestal) ○ Belt sander ○ Saws (chop, band, cold) ● Operational technique ○ Ensure all guards are in place and operational ○ Follow manufacturer recommendations for RPM and material rating
9.4 Describe the use of metal forming equipment (i.e., ironworker, multi-purpose shear and punch, metal rollers, metal brakes, etc.)	● Personal Protective Equipment (PPE) ● Metal forming equipment ○ Ironworker ○ Multi-purpose shear and punch ○ Metal rollers ○ Metal brakes ● Operational technique ○ Follow proper manufacture operation ○ Follow proper techniques for setup and operations ○ Pinch points and appropriate use of guards
9.5 Use drilling equipment (i.e., drill press, hand drill, mag drill, etc.)	● Drilling equipment ○ Drill press ○ Hand drill ○ Mag drill ● Operational technique ○ Follow proper manufacture operation ○ Follow proper techniques for setup and operations ● Drill revolutions per minute (RPM) speed ● Use of cutting oils
9.6 Use welding-related hand tools (i.e., layout and measuring tools, scribes, center punch, squares, vice grips, clamps, welpers, etc.)	● Welding-related hand tools ○ Layout and measuring tools ■ Scribes

	■ Center punch ■ Squares ○ Pliers ■ Locking pliers (vice grips) ■ Welpers (MIG pliers) ○ Metal forming tools ■ Metal files ■ Metalworking chisels ■ Ball-peen hammer ○ Clamps ○ Wire cutters ○ Wire brush ○ Chipping hammers ● Operational technique ○ Follow proper manufacture operation ○ Follow proper techniques for setup and operations
Domain 2: Thermal Cutting and Blueprint Reading **Instructional Time: 20 – 25%**	
STANDARD 2.0 LAY OUT AND FIT UP A PROJECT FROM A BLUEPRINT	
2.1 Identify basic elements of a fabrication drawing	● Weld symbols ○ Reference line, tail and arrow components of the drawing ● Welding symbols ○ Grooves ○ Fillets ○ Specialty symbols
2.2 Interpret welding symbols and Welding Specification Procedure (WPS)	● Welding symbols ○ Identify key elements (arrow side, other side, etc.) ○ Location of symbols
2.3 Use measuring devices and perform conversions (i.e., standard, metric, tape measure, digital or laser measurement tool, fillet weld gauges, V-WAC, etc.)	● Measuring devices and tools for layout ○ Standard ○ Metric ○ Tape measure ○ Digital or laser measurement tool ○ Fillet weld gauges ○ V-WAC

	○ Measuring calipers ○ Squares ● Math conversions ○ Decimals to fractions; fractions to decimals
2.4 Prepare an applicable bill of materials	● Bill of materials ○ Calculate materials costs ○ Calculate material needs for project ○ Labor
2.5 Use weld symbols (i.e., weld length, location, size, grind flush, etc.) and joint design (i.e., WPS) to prepare and fabricate parts from a fabrication drawing	● Weld symbols ○ Weld length ○ Location ○ Size ● Weld contours ○ Grind flush ○ Convex ○ Concave ● Joint design ○ WPS ● Identification of symbols of the manufacturing process ○ Edge prep ○ Weld finish
2.6 Prepare weld joints and perform welding operations using welding symbol information (i.e., grinding, cleaning, wire wheel, abrasives, etc.)	● Weld finish ○ Grinding and abrasives ○ Cleaning ○ Wire wheel
STANDARD 7.0 SET UP AND USE THERMAL CUTTING EQUIPMENT	
7.1 Describe basic thermal cutting theory for OFC, PAC, CAC, and CAG	● Ferrous metals ● Non-ferrous metals ● Setup of equipment ○ OFC ○ PAC ○ CAC ○ CAG ● Application ○ OFC ○ PAC

	○ CAC ○ CAG ● Fuel gas selection ○ OFC
7.2 Perform safety inspections and make minor repairs on OFC, PAC, CAC, and CAG equipment and accessories	● OFC ○ Gas cylinder inspection ○ Regulator inspection ■ Leaks ■ Cracks ■ Proper adjustment of adjusting screw ○ Check gas hoses and torch for damage and leaks ● PAC ○ Input power ○ Torch leads ○ Work lead ○ Torch parts ■ Tips ■ Nozzles ○ Dry air supply ● CAC/CAG ○ Input power ○ Torch lead ○ Work leads ○ Dry air supply
7.3 Set up and perform thermal cutting processes [i.e., OFC, PAC, CAC, CAG, semi-automatic cutting (track torch), etc.] making straight, bevel, and shape cuts (i.e., acetylene, propylene, propane, MAP gas, etc.)	● Personal Protective Equipment (PPE) ● Remove fire hazards ● OFC ○ Open gas cylinder valves correctly ○ Set correct pressure on regulators ○ Fuel gas selection ■ Acetylene ■ Propylene ■ Propane ■ MAP gas ● PAC ○ Set machine for correct material thickness ○ Set air pressure for correct material thickness ○ Proper torch and ground for cutting

	• CAC/CAG
	  ○ Set machine and amps to correct material thickness
	  ○ Set air pressure
	  ○ Set ground and torch correctly
	• Semi-automatic cutting (track torch)
	  ○ Open gas cylinder valves correctly
	  ○ Set correct pressure on regulators
	  ○ Select cutting speed (inches per minute, IPM)

7.4 Perform gouging operations and weld removal	• Gouging operations and weld removal
	  ○ OFC
	  ○ PAC
	  ○ CAG

Domain 3: Weldment Testing **Instructional Time: 15 – 20%**	
STANDARD 3.0 SET UP AND USE SHIELDED METAL ARC WELDING (SMAW) EQUIPMENT	

3.1 Describe basic SMAW theory (i.e., DC/AC current, CC/CV voltage output, polarity, etc.)	• DC/AC current
	• CC/CV voltage output
	• Polarity
	  ○ DCEN
	  ○ DCEP

3.2 Perform safety inspections of SMAW equipment and accessories	• Power connections • Welding leads for exposed wire • Ventilation systems • Insulation on Electrode Holder/Stinger • Machine settings

3.3 Set up and perform SMAW operations	• Correct amperage
	• Type of current for processes
	• Proper Personal Protective Equipment (PPE)
	• Electrode/rod selection
	• Electrode manipulation
	  ○ Weaves
	  ○ Whip and pause
	  ○ Stringers

3.4 Describe the use, storage, and handling of various types of electrodes (i.e., rod ovens, electrode classification, etc.)	● Rod ovens ○ Low hydrogen electrodes ● Electrode classification and type ● Electrode polarity ● Number classifications ○ American Welding Society (AWS) ● Storage for different electrodes
3.5 Perform surface welding (i.e., bead on plate, pad welding, etc.)	● Bead on plate ● Pad welding ● Buildup of weld ● Electrode/rod selection ● Welding techniques ○ Stringers ● Hard facing
3.6 Perform fillet and groove welds in all positions	● Flat ● Horizontal ● Vertical ● Overhead
3.7 Perform minor external repairs to equipment and accessories (i.e., change out electrode holder or work-piece clamp, etc.)	● Change out/maintenance of electrode holder or work-piece clamp ● Machine diagnostics
3.8 Identify and inspect repairs in welding cables and demonstrate proper welding cable repairs using approved guidelines.	● Inspection of welding leads ○ Lead insulation ○ Electrode holder ○ Work piece clamp ● Replacement of welding leads
STANDARD 8.0 PERFORM WELDMENT TESTING	
8.1 Describe the theory of weld testing and inspection (i.e., destructive, non-destructive, etc.)	● Destructive ○ Guided bend test ○ Cut and etching ○ Tensile testing ○ Break test ● Non-destructive ○ Visual

	○ Radiographic ○ Dye inspection
8.2 Inspect all welds including FIT-UP, tacks, root passes, intermediate layers, and completed welds (i.e., discontinuities, defects, size, location, quality, etc.)	● Discontinuities ● Defects ○ Size ○ Location ● Weld quality
8.3 Use typical inspection tools (i.e., fillet weld gauges, lighting, magnification, ruler, scale, caliper, v-wac gauge, guided bend tester, magnetic particle testing, dye penetrant testing, etc.)	● Inspection tools ○ Fillet weld gauges ○ Lighting ○ Magnification ○ Ruler ○ Scale ○ Caliper ○ V-wac gauge ● Testing tools ○ Guided bend tester ○ Magnetic particle tester ○ Dye penetrant
8.4 Perform a visual inspection on a weld	● Visual inspection ○ Weld defects ○ Weld discontinuities
8.5 Perform destructive testing methods	● Destructive testing methods ○ Guided bend test ○ Tensile strength ○ Cut and etching ○ Break test
Domain 4: Wire Feeding Processes **Instructional Time: 15 – 20%**	
STANDARD 4.0 SET UP AND USE GAS METAL ARC WELDING (GMAW) EQUIPMENT (MIG)	
4.1 Describe basic GMAW theory (e.g., transfer modes, short circuit, globular, spray transfer, and pulse)	● Transfer modes ○ Short circuit ○ Globular

	○ Spray transfer ○ Pulse ● Gas selection/pressure settings ● Wire selection/diameter ● Weld technique ● Machine settings ○ Voltage ○ Wire feed speed/amperage
4.2 Perform safety inspections and make minor external repairs on GMAW equipment and accessories (i.e., liners, etc.)	● Gun liners ● Input power cords ● Welding lead ● Torch part ○ Nozzle ○ Contact tip ○ Diffuser ○ Trigger ● Drive wheels/rollers ● Work connection ● Shielding gas supply ○ Regulator/flow meter ○ Hoses
4.3 Set up and perform GMAW operations (i.e., change wire spools, drive rolls, etc.)	● Change wire spools ● Drive wheels/rollers ○ V-knurled ○ V-groove ○ U-groove ● Voltage ● Personal Protective Equipment (PPE)
4.4 Identify the use, storage, and handling of various types of filler materials	● Wire classifications ● Number classifications ○ American Welding Society (AWS) ● Storage for different types of weld wire ● Wire diameter
4.5 Identify proper shielding gases and flow rates	● Shielding gas selection ○ Mixed gases ○ Pure gases

	• Gas classification • Wire classification • Identification of gas labels

4.6 Perform surface, fillet, and groove welds in all positions	• Weldability
	  ○ Ferrous
	  ○ Non-ferrous
	• Fillet
	  ○ T-joint
	  ○ Lap
	• Groove
	  ○ Square groove
	  ○ Single V
	  ○ Single bevel, etc.
	• Weld position
	  ○ Flat
	  ○ Horizontal
	  ○ Vertical
	  ○ Overhead
	• Welding techniques

STANDARD 5.0 SET UP AND USE FLUX CORED ARC WELDING (FCAW) EQUIPMENT	

5.1 Describe basic FCAW theory [e.g., polarity, self-shielded (FCAW-S), gas-shielded (FCAW-G), and CV]	• Polarity
	  ○ DCEN
	  ○ DCEP
	• Self-shielded (FCAW-S)
	  ○ Internal shielding
	• Gas-shielded (FCAW-G)
	  ○ External shielding
	• Constant voltage (CV)

5.2 Perform safety inspections and make minor external repairs on FCAW equipment and accessories	• Gun liners
	• Input power cords
	• Welding lead
	• Torch part
	  ○ Nozzle
	  ○ Contact tip
	  ○ Diffuser
	  ○ Trigger

	● Drive wheels/rollers ● Work connection ● Shielding gas supply (FCAW-G) ○ Regulator/flow meter ○ Hoses
5.3 Set up and perform FCAW (gas-shielded and self-shielded) operations (i.e., change wire spools, drive rolls, etc.)	● Change wire spools ● Drive wheels/rollers ○ V knurled ● Voltage ● Wire feed speed ● Personal Protective Equipment (PPE) ● Gas selection (FCAW-G) ● Polarity selection ○ DCEN ○ DCEP
5.4 Identify the electrode classification and the use, storage, and handling of various types of filler material	● Wire classifications ○ American Welding Society (AWS) ● Number classifications ● Storage for different weld wire
5.5 Perform surface, fillet, and groove welds in all positions	● Weldability ● Welder performance qualification ○ American Welding Society (AWS) certification ● Fillet ○ T joint ○ Lap ● Groove ○ Square groove ○ Single V ○ Single bevel, etc. ● Weld position ○ Flat ○ Horizontal ○ Vertical ○ Overhead

Domain 5: GTAW **Instructional Time: 10 – 15%**	
STANDARD 6.0 SET UP AND USE GAS TUNGSTEN ARC WELDING (GTAW) EQUIPMENT (TIG)	

6.1 Describe basic GTAW theory (e.g., wave forms, torch parts, current, polarity, and tungsten types)	• Wave forms
	• Torch parts
	  ○ Collet
	  ○ Collet body
	  ○ Back caps
	  ○ Cup size, etc.
	• Current
	• Polarity
	• Tungsten types
	• Tungsten grinding

6.2 Perform safety inspections and make minor repairs on GTAW equipment and accessories	• Input power cords
	• Welding torch/foot pedal
	• Torch parts
	  ○ Nozzle/cup
	  ○ Collet
	  ○ Collet body
	  ○ Back cap
	• Shielding gas supply
	  ○ Regulator/flow meter
	  ○ Hoses

6.3 Set up and perform GTAW operations [i.e., tungsten grinding, torch set-up (collets, collet bodies, gas nozzles), etc.]	• Personal Protective Equipment (PPE)
	• Torch set-up
	  ○ Collets
	  ○ Collet bodies
	  ○ Gas nozzles
	• Correct current
	  ○ DC/AC
	• Shielding gas selection
	• Tungsten, material, and filler metal selection
	• Tungsten grinding
	• Fillet welds
	• Groove welds

6.4 Identify the filler rod classification and the use, storage, and handling of various types of filler material	• Filler metal classifications ○ American Welding Society (AWS) • Storage for filler metal • Tungsten classification • Shielding gas selection and flow rate
6.5 Select and use proper shielding gases and flow rates	• Gas classification • Identification of gas labels • Shielding gas selection and flow rate

6.6 Perform surface, fillet, and groove welds in all positions using different alloys (i.e., carbon steel, aluminum, stainless steel, etc.)	• Carbon steel
	• Aluminum
	• Stainless steel
	• Filler metal classifications
	  ○ American Welding Society (AWS)
	• Tungsten classification
	  ○ American Welding Society (AWS)
	• Shielding gas selection and flow rate
	• Current selection
	• Cup size selection