

Instructional Framework

Electrical and Power Transmission Installation

46.0300.20

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 January 22, 2020.



Domain 1: Rough-In and Trim Methods

Instructional Time: 55 – 60%

STANDARD 5.0 EXAMINE ROUGH-IN METHODS

5.1 Relate information on Construction Documents or Technical Drawings (blueprints) to actual physical locations above ground	<ul style="list-style-type: none">• Scaling blueprints• Symbols• Details• Notes
5.2 Identify above-ground raceways according to the National Electric Code (NEC) [i.e., Electrical Metallic Tubing (EMT), Polyvinyl Chloride (PVC) schedule 40/80, Metal Clad (MC), Non-Metallic Cable (NM), flexible conduit, Galvanized Rigid Conduit (GRC), Intermediate Metallic Conduit (IMC), etc.]	<ul style="list-style-type: none">• Visual identification• Raceway types• Differentiate raceway types<ul style="list-style-type: none">◦ Apply NEC standards• Strapping requirements for all listed• Uses permitted/uses not permitted• Burial depths• Bending offsets, 90s, saddles
5.3 Identify above-ground fittings (i.e., connectors, couplings, condulets, etc.)	<ul style="list-style-type: none">• Conduit system components• Connector/coupling applications• Fitting types and uses, installation contexts• Identifying and selecting appropriate fittings• Match fittings to conduit type and application
5.4 Distinguish above-ground boxes/enclosures per National Electrical Manufacturers Association (NEMA) (i.e., plastic boxes, metal boxes, junction boxes, etc.)	<ul style="list-style-type: none">• Box ratings and types<ul style="list-style-type: none">◦ Differentiate NEMA1, NEMA 3R, 4X• Environmental requirements• Identify the correct enclosure for the application• Assess environment and match enclosure type

5.5 Identify proper tools for installing above-ground raceways and fittings (i.e., tape measure, hacksaw, pliers, reamer, level, pipe bender, etc.)	<ul style="list-style-type: none"> ● Tool <ul style="list-style-type: none"> ○ Function ○ Applications and safety ○ Maintenance ○ Selection and safe use ● Installation efficiency
5.6 Install boxes/enclosures and measure, cut, and join and support above-ground raceway	<ul style="list-style-type: none"> ● Installation standards ● Mounting requirements ● EMT, RMC, NM, MC <ul style="list-style-type: none"> ○ Cutting ○ Measuring ○ Fastening ● Assess environment and match enclosure type ● Match boxes to raceway type and application ● Use proper support systems
5.7 Select and install mud rings	<ul style="list-style-type: none"> ● Mud ring types and compatibility <ul style="list-style-type: none"> ○ Select appropriate mud ring for box type ● Sizing mud rings with box fill ● Proper alignment and securement
5.8 Determine physical distance of installed conduit run using a vacuum or fish tape, mule tape, or true tape	<ul style="list-style-type: none"> ● Mule and true tape <ul style="list-style-type: none"> ○ Identify types ○ Proper use of ● Accurately measure conduit runs ● Assess environment and select the best tool <ul style="list-style-type: none"> ○ Vacuum ○ Fish tape <ul style="list-style-type: none"> ■ Metallic or non-conductive
5.9 Prepare to pull wire or install Non-Metallic Cable (NM) (i.e., basketing, half-hitching, pulling soap, etc.)	<ul style="list-style-type: none"> ● Wire prep methods ● Labeling ● Lubricant use ● Tie knots commonly used in wire pulling ● Assess environment and select the best method to pull wire
5.10 Pull wire to boxes/enclosures without damaging wire or raceway	<ul style="list-style-type: none"> ● Wire type characteristics ● Conductor sizing ● Conduit fill ● Wire handling

	<ul style="list-style-type: none"> ● Use of wire pulling aids ● Set up of wire pulling tools <ul style="list-style-type: none"> ○ Wire carts ○ Power tugger, etc. ● Assess environment and select the best tools to pull wire
STANDARD 6.0 EXAMINE TRIM METHODS	
6.1 Interpret symbols and legends on Construction Documents or Technical Drawings (blueprints)	<ul style="list-style-type: none"> ● Symbol decoding ● Legend matching ● Common blueprint symbols for devices <ul style="list-style-type: none"> ○ Receptacles, switches, disconnects, etc. ● Homeruns ● Panels
6.2 Demonstrate secure wire connections per manufacturer (i.e., device terminals, wire nuts, Wagos, etc.)	<ul style="list-style-type: none"> ● Differentiate <ul style="list-style-type: none"> ○ Connection types ○ Connection methods ● Twisting ● Crimping connections ● Assess environment and select the best wire connection method
6.3 Wire switches (e.g., single pole, three-way, and four-way)	<ul style="list-style-type: none"> ● Switch types ● Switch function ● Wiring diagrams ● Connect wires to switches ● Install switches per configuration
6.4 Wire receptacles [e.g., Ground Fault Circuit Interrupters (GFCIs), standard, 15/20-amp 120-volt duplex receptacles, 240-volt receptacles]	<ul style="list-style-type: none"> ● Receptacle function ● Code compliance <ul style="list-style-type: none"> ○ Locations ○ Mounting ● Voltage/ampere ratings ● Wiring methods ● Wire various receptacle types ● Connect and mount receptacles ● Assess environment and select the best device
6.5 Wire luminaries and mount level and plumb	<ul style="list-style-type: none"> ● Lighting systems ● Mounting standards ● Fixture types ● Emergency lighting systems

6.6 Install covers level and plumb (i.e., switches, receptacles, luminaries, etc.)	<ul style="list-style-type: none"> • Cover plate types • Safety • Aesthetics • Code compliance • Select appropriate cover for box type
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Domain 2: Safety and Tools

Instructional Time: 20 – 25%

STANDARD 1.0 MAINTAIN A SAFE WORK ENVIRONMENT IN ACCORDANCE WITH OSHA (OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION) REGULATIONS

1.1 Define fall hazard	<ul style="list-style-type: none"> • OSHA (Occupational Safety and Health Administration) definitions • Hazard classification • Fall risk factors in construction environments
1.2 Recognize major types of fall hazards in construction (e.g., improper scaffold construction, leading edges, roof/floor openings, structural steel, unprotected roof edges, and unsafe portable ladders)	<ul style="list-style-type: none"> • Identify and distinguish fall hazards • Site inspection • Visual assessment of ladders
1.3 Recognize how to protect workers from fall hazards (e.g., safe ladder use, training, and fall protection equipment)	<ul style="list-style-type: none"> • Personal Fall Arrest Systems (PFAS) • Personal Protective Equipment (PPE) inspection and setup • Select and apply fall protection methods
1.4 Recognize employer requirements to protect workers from falls (e.g., ladder use and condition, proper scaffold construction, provide fall protection, training, and worksite maintenance)	<ul style="list-style-type: none"> • Competent person role and responsibilities • OSHA (Occupational Safety and Health Administration) employer obligations • Select and apply fall protection methods • Training requirements • Interpret and apply policy requirements
1.5 Define caught-in or caught-between hazards	<ul style="list-style-type: none"> • Hazard types per OSHA (Occupational Safety and Health Administration)
1.6 Recognize common types of caught-in or caught-between hazards in construction (e.g., buried-in or -by, machinery with unguarded moving parts, and pinned between)	<ul style="list-style-type: none"> • Caught, crushed, squeezed, compressed, or pinched between two or more objects • Unguarded piece of machinery • Buried by trench cave-ins • Getting pinned, etc.

1.7 Recognize how to protect workers from caught-in or caught-between hazards in construction (e.g., ensure machinery is supported, protect workers from being pinned between equipment, protect workers on excavation sites, secured or otherwise made safe, training, and properly guarded machinery)	<ul style="list-style-type: none"> ● High-risk activities and equipment ● Hazard recognition in real time ● Perform visual safety checks ● Lockout/Tagout ● Trench protection ● Machine guarding ● Implement preventative practices
1.8 Recognize employer requirements to protect workers from caught-in or caught-between hazards in construction (e.g., designate a competent person; provide guards on power tools and other equipment with moving parts, a means to avoid the collapse of structures scaffolds, a means to avoid workers being crushed by collapsing walls, protection for workers during trenching and excavation work, and training for workers; support, secure, or otherwise make safe equipment with parts; take measures to prevent workers being crushed by heavy equipment; and take measures to prevent workers from being pinned between equipment)	<ul style="list-style-type: none"> ● Competent person role and responsibilities ● OSHA (Occupational Safety and Health Administration) employer obligations ● Select and apply caught-in or caught-between prevention methods ● Training requirements ● Interpret and apply policy requirements
1.9 Define struck-by hazards	<ul style="list-style-type: none"> ● Hazard types per OSHA (Occupational Safety and Health Administration)
1.10 Recognize common types of struck-by hazards in construction (e.g., falling, flying, rolling, and swinging objects)	<ul style="list-style-type: none"> ● Kinetic energy ● Motion-related risks ● Gravity ● Jobsite traffic, etc.
1.11 Recognize how to protect workers from struck-by hazards in construction [e.g., general safe work practices, heavy equipment, motor vehicles, and personal protective equipment (PPE)]	<ul style="list-style-type: none"> ● Personal Protective Equipment (PPE) <ul style="list-style-type: none"> ○ Application ○ Selection and fitting
1.12 Recognize employer requirements to protect workers from struck-by hazards in construction [e.g., general requirements for protecting workers, heavy equipment, motor vehicles, provide personal protective equipment (PPE), and training]	<ul style="list-style-type: none"> ● Competent person role and responsibilities ● OSHA (Occupational Safety and Health Administration) employer obligations ● Select and apply struck by hazards prevention methods ● Training requirements ● Interpret and apply policy requirements
1.13 Define an electrocution hazard	<ul style="list-style-type: none"> ● Hazard types per OSHA (Occupational Safety and Health Administration)

1.14 Recognize the major types of electrocution hazards (e.g., contact with energized sources, contact with power lines, and improper use of extension and flexible cords)	<ul style="list-style-type: none"> • Types of contact <ul style="list-style-type: none"> ◦ Direct contact ◦ Arching ◦ Step potential, etc. • Electrical current behavior • Shock vs. electrocution • Identify when electrical hazards are present • Current pathways • Wiring faults • Overhead line dangers
1.15 Recognize how to protect oneself from electrocution hazards [e.g., follow lockout/tagout (LOTO) procedures, inspect portable tools and extension cords, maintain safe distance from overhead power lines, use ground-fault circuit interrupters (GFCI), use power tools and equipment as designed]	<ul style="list-style-type: none"> • Grounding principles • Tool inspection • Execute and inspect Lockout/Tagout (LOTO)
1.16 Recognize employer requirements to protect workers from electrocutions [e.g., enforce lockout/tagout (LOTO) safety-related work practices; ensure overhead power line safety, power tools maintained in safe condition, proper guarding, and proper use of flexible cords; establish and implement an Assured Equipment Grounding Conductor Program (AEGCP), isolate electrical parts, provide training, supply ground-fault circuit interrupters (GFCI)]	<ul style="list-style-type: none"> • Interpret and apply policy requirements • Conduct training • Safe electrical practices • Competent person role and responsibilities • OSHA (Occupational Safety and Health Administration) employer obligations • Select and apply stored energy prevention methods • Training requirements
1.17 Use basic protective equipment (PPE) appropriate for the job (i.e., safety glasses/goggles, hard hats, gloves, safety vests, work boots, etc.)	<ul style="list-style-type: none"> • Personal Protective Equipment (PPE) <ul style="list-style-type: none"> ◦ Ratings, types, and uses ◦ Care of PPE ◦ Proper donning of PPE
STANDARD 3.0 EXAMINE STANDARD ELECTRICAL TOOLS	
3.1 Identify the use of basic hand tools (i.e., nut driver set, insulated tools, torque wrench, crimper, etc.) (e.g., manual pipe bender, tape measure, hacksaw, wire stripper, screwdriver set, side cutting pliers, lineman's pliers, adjustable pliers/wrenches, utility blade, spirit level, hammer, etc.)	<ul style="list-style-type: none"> • Identify tools with proper and common names • Identify appropriate tool for the job or task • Inspect tools for damage
3.2 Identify the use of basic power tools [i.e., band saw, reciprocating saw, drills (cordless and corded), etc.]	<ul style="list-style-type: none"> • Identify tools with proper and common names • Power tool types and functions • Proper working order for tools <ul style="list-style-type: none"> ◦ Check for damaged cords

	<ul style="list-style-type: none"> ○ Sharp blades, etc. ● Battery-operated tool use <ul style="list-style-type: none"> ○ Replacing bits and blades safely
3.3 Identify the use of multimeters and non-contact voltage testers	<ul style="list-style-type: none"> ● Meter symbols <ul style="list-style-type: none"> ○ Voltage, current, and continuity ● Meter settings/functions <ul style="list-style-type: none"> ○ Voltage, current, and continuity ● Test circuits safely and effectively ● Assess environment and select the best testing equipment
3.4 Inspect, set up, and use A-frame and extension ladders	<ul style="list-style-type: none"> ● OSHA (Occupational Safety and Health Administration) ladder safety rules ● Load ratings ● Ladder angles ● Differentiate ladder types ● Inspect for damage ● Climb and work from ladders safely

Domain 3: Electrical Theory

Instructional Time: 10 – 15%

STANDARD 2.0 EXAMINE ELECTRICAL THEORY

2.1 Examine electrical theory (e.g., generation, transmission to distribution, and consumption)	<ul style="list-style-type: none"> ● Powerlines ● Substations ● Transformers ● Metering equipment
2.2 Distinguish between alternating current (AC) and direct current (DC)	<ul style="list-style-type: none"> ● Current types ● Sine waves ● Applications and differences ● Identify the correct current for the task
2.3 Define grounding, grounded, and bonding	<ul style="list-style-type: none"> ● National Electrical Code (NEC) definitions and applications
2.4 Define three-phase and single-phase power supply [e.g., voltage (120 to 480)]	<ul style="list-style-type: none"> ● Applications in residential/commercial settings ● Match systems to job requirements
2.5 Summarize the purpose of a transformer	<ul style="list-style-type: none"> ● Explain transformer function ● Buck-boost transformers

2.6 Identify wire sizes [i.e., circular mills (CM), American Wire Gauge (AWG) #14 to 4/0, etc.]	<ul style="list-style-type: none"> ● Identify wire sizes ● Determine ampacities using the National Electrical Code (NEC) <ul style="list-style-type: none"> ○ Copper vs. aluminum ampacities ○ Select appropriate wire gauge
2.7 Identify wire types (i.e., copper, aluminum, solid, stranded, insulation, etc.)	<ul style="list-style-type: none"> ● Conductor materials and insulation ● Match the wire type to the application ● Conductor construction <ul style="list-style-type: none"> ○ Compacted stranded, stranded, solid
2.8 Differentiate devices (e.g., switches and resistors/receptacles)	<ul style="list-style-type: none"> ● Device identification ● Match device to system needs ● Current flow ● Resistance in devices
2.9 Summarize the purpose of Ground Fault Circuit Interrupters (GFCIs), Arc Fault Circuit Interrupters (AFCIs), and service panel breakers/fuses	<ul style="list-style-type: none"> ● Circuit protection principles ● Safety functions and National Electrical Code (NEC) rules ● Select proper protection device per the National Electrical Code (NEC) ● Service panel breakers/fuses <ul style="list-style-type: none"> ○ Number of poles ○ Load rating ○ Circuit labeling
2.10 Explain Ohm's Law	<ul style="list-style-type: none"> ● Ohm's Law formula ● Ohm's Law calculations

Domain 4: Underground Installation

Instructional Time: 5 – 10%

STANDARD 4.0 EXAMINE UNDERGROUND INSTALLATION METHODS

4.1 Relate information on Construction Documents or Technical Drawings (blueprints) to actual physical locations underground	<ul style="list-style-type: none"> ● Scaling blueprints ● Legend matching ● Common blueprint symbols for devices <ul style="list-style-type: none"> ○ Receptacles, switches, disconnects, etc. ● Homeruns ● Panels
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4.2 Identify underground raceways [i.e., Polyvinyl Chloride (PVC) schedule 40/80, Galvanized Rigid Conduit (GRC), Intermediate Metallic Conduit (IMC), etc.]	<ul style="list-style-type: none"> ● Installation standards, mounting requirements ● National Electrical Code (NEC) burial depths ● Assess the environment and match raceway type ● Match boxes to raceway type and application ● Use proper support systems
4.3 Identify underground enclosures (i.e., floor boxes, handholes, Christy boxes, underground junction boxes, etc.)	<ul style="list-style-type: none"> ● Types and purposes
4.4 Identify underground fittings [i.e., 22s, 30s, 45s, 90s, couplings, female adapter (FA), male adapter (MA), etc.]	<ul style="list-style-type: none"> ● Types and purposes
4.5 Identify proper tools for installing underground raceways and fittings (i.e., tape measure, hacksaw, pliers, reamer, etc.)	<ul style="list-style-type: none"> ● Tool installation identification
4.6 Measure, cut, and join an underground raceway	<ul style="list-style-type: none"> ● Installation standards, mounting requirements ● Cutting, measuring, and fastening RMC, PVC, etc.
4.7 Determine physical distance of installed conduit run using a vacuum or fish tape, mule tape, or true tape	<ul style="list-style-type: none"> ● Mule and true tape <ul style="list-style-type: none"> ○ Identify types ○ Proper use of ● Accurately measure conduit runs ● Assess environment and select the best tool <ul style="list-style-type: none"> ○ Vacuum ○ Fish tape
4.8 Prepare to pull wire (i.e., basketing, half-hitching, pulling soap, etc.)	<ul style="list-style-type: none"> ● Wire prep methods ● Labeling ● Lubricant use ● Tie knots commonly used in wire pulling ● Assess environment and select the best method to pull wire
4.9 Pull wire to enclosure without damaging wire or raceway	<ul style="list-style-type: none"> ● Wire type characteristics ● Conductor sizing ● Conduit fill ● Wire handling ● Use of wire pulling aids ● Set up of wire pulling tools <ul style="list-style-type: none"> ○ Wire carts ○ Power tugger, etc. ● Assess environment and select the best tools to pull wire