Guidance for Evaluating Utility Worker Training and Qualifications Best Practice #262

Facility: EFCOG Electrical Safety Task Team, 2022 Summer Workshop @ NREL

Best Practice Title: Utility Training and Qualifications Best Practice

Points of Contact:

Don Lehman, INL, don.lehman@inl.gov, (208) 821-5947

Kiley Taylor, (303) 275-4631

Melkie Tega, DOE-SC-41, Melkie.Tega@science.doe.gov, (630) 225-2695

Joe Dobbins, DOE EHSS-11, joseph.dobbins@hq.doe.gov, (301) 903-5638

Brief Description of Best Practice: This best practice is intended to guide a program with evaluating and determining training and qualifications for existing utility personnel, personnel who transfer in, or new hires for the utility department. The Utility Training Evaluation Checklist can be used to compare the needed skills for a DOE facility to an individual's background or to the background of an entire group. The intent is to identify and remedy any gaps for needed skill sets.

Why the best practice was used: During bench marking between DOE facilities, inconsistencies were found between core training and qualifications for utility workers from one site to another. New utility workers come to DOE facilities with varied backgrounds. A new employee's previous experience, whether highly specialized or a general skill set, may not match up with the needs and requirements of a DOE facility's utility department.

What are the benefits of the best practice: Using this best practice will allow DOE contractors to evaluate their training and qualification criteria for utility workers with a more consistent approach between DOE facilities.

What problems/issues were associated with the best practice: Electric utility operations are among the highest hazard activities performed on DOE sites. This BP is developed to help sites evaluate utility training and qualifications and reduce the associated risk to those individuals who are performing these types of activities.

How the success of the Best Practice was measured: This best practice was developed using several experienced utility personnel from multiple DOE sites.

Description of process experience using the Best Practice: The known operating experience to date is limited to a few sites associated with the development of this product who have successfully employed some or all of the components of this Best Practice at their respective sites.

Utility Training Evaluation Checklist

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Using the Utility Training Evaluation Checklist:

- Review the checklist and remove sections or specific content items that do not apply at the DOE facility.
- Compare the remaining, relevant checklist items to training content currently available and utilized at the DOE facility and determine:
    - Is training content on specific topic(s) missing from your current training curriculum?
    - Is the missing training needed for the entire group or specific individuals (new, specialized background, etc.)
- Determine the best method to develop and deliver effective training covering the identified missing topic(s) to the individual or the entire group.

Utility Training Evaluation Checklist

Core Requirements:

1. **Site Specifics:**
    a. General Site Qualifications
    b. Required Reading
2. **Qualified Electrical Worker (QEW) – Shock/Arc Flash exposure training**
3. **Medium Voltage and High Voltage Utility Safety**
    a. Step and Touch Potential
    b. OSHA 29CFR1910.269
        i. Clearances vs Lockout/Tagout (LOTO) vs Hold Orders
            (1) Clearances: Person-in-charge vs. Regional operator
        ii. Minimum Approach Distances (MAD) vs Limited and Restricted Approach Boundaries (LAB/RAB)
    c. National Electrical Safety Code (NESC)
        i. Arc-Rated PPE required at ≥ 2 cal/cm2
        ii. MAD
    d. NFPA 70E
        i. Arc-Rated PPE required at ≥ 1.2 cal/cm2
        ii. LAB/RAB
        iii. Arc Flash Boundary
4. **Electrical Fundamentals (specific to electrical utility style work)**
    a. Discuss and explain specific site requirements and fundamentals
    b. Thoroughly understand electrical diagrams (maps, single line diagrams, switching diagrams, ANSI device numbers, metering, and relaying diagrams, etc.)
    c. site specific intricacies
5. **Radio/Phone Etiquette**
    a. 3-way communication
    b. Phonetic alphabet
    c. Requirements for radio vs phone
    d. Coordination when radios can't be used (confined space, respirators, etc.)
6. **Heavy Equipment - OSHA 1926 Subpart V & CC, 1910.269(p)**
    a. Crane
    b. Digger Derricks
    c. Bucket Trucks
    d. Backhoe
    e. Trenchers/Excavators
    f. ATV/UTV
    g. Towing/Trailers
    h. Cable Spoolers/Pullers

i. Helicopters
j. Drones
k. Man Lifts
l. Forklifts
m. Skid Loaders
n. Rock Drill

7. Hoisting and Rigging

a. Spotters
b. Clearances from overhead lines
c. Capacity/Equipment Limitations
d. Visual Inspections
e. Slings/chokers/chains
f. Angle of rigging
g. Eyes/Hooks/Clevis
h. Chain Falls/Capstan/Winches
i. Tag Lines
j. Hand Lines
k. Knots

8. Load Securement

a. Endorsement for wire/cable reels (if applicable)
b. Expectations for all classes of vehicles
c. State/local regulation

9. Traffic and Work Area Control

a. Work zone traffic control
    i. Manual on Uniform Traffic Control Devices (MUTCD)
b. Access/egress to work areas
c. Pedestrian control
d. Drop Zones
e. Material Laydown

10. Substation Access Control

a. General Hazard Awareness Training
b. Escort Training
c. Access Control Authorization
d. Materials Storage Near Energized lines or Equipment plus maximum sag and side swing of all conductors and for the height and movement of material-handling equipment
    i. 50 kV or less, 10 ft
    ii. More than 50 kV, 10 ft plus 4 inches for every 10 kV over 50 kV

11. Personal Protective Equipment (PPE)

a. Arc Rated PPE
b. Voltage Rated Gloves
c. Dielectric Overshoes (Not EH rated)

d. Construction
e. Fall Protection
f. Selection, Inspection, Use, Care, and Limitations, for PPE
    i. Know how to select or who to ask for help
    ii. Proper laundering
    iii. Inspect before use
    iv. Emphasize PPE is last line of defense

12. Live Line Tools

a. Hot Sticks
b. Shotgun
c. Phasing Sticks
d. Blankets
e. Line Hose/Gutting
f. Meters/Voltage Indicators/Hot Horns/Proximity Testers
g. Selection, Inspection, Use, Care, Storage, and Limits of use, for Live Line Tools
    i. Wipe clean and visually inspect for defects daily
    ii. Remove from service every 2 years and test accordingly

13. Grounding

a. Equipment protection vs Personal protective grounding
b. Equipotential Grounding
    i. Overhead
    ii. Underground
c. Other Ground Mounted Equipment
d. Mobile Equipment
e. Substation/Ground Grid

14. Risk Assessment (Should be incorporated into the work planning and control process)

a. Overhead
b. Underground
c. Arc in a Box vs Open air
d. Confined Space
e. Fall Protection
f. Stored Energy
    i. Batteries
    ii. Capacitors
    iii. MV Cables
    iv. Other equipment that could store energy and present a hazard

15. Pre-Job Briefing

a. Notifications
b. Hazards associated with the job
c. Work procedures involved
d. Job assignments

e. Special precautions
f. Energy-source controls
g. PPE requirements
h. Site specifics
i. Emergency response

16. **Training and Qualifications for Clearances**
    a. w/regional control (Dispatch)
    b. w/o regional control
17. **Training and Qualifications for Switching Instructions**
    a. 6 steps of switching
18. **Training and Qualifications for Control and coordination w/others**
    a. Customer vs. Utility (outside of complex)
19. **Training and Qualifications for Hold Orders**
20. **Training and Qualifications for Paralleling**
21. **Switching / Operation**
    a. 6 Basic Steps of Switching
        i. All switching operations shall be guided and tested by the fundamental principles, "Start with the correct procedure and follow it exactly." This shall be accomplished by following:
            (1) Carry the switching program with you while switching.
            (2) Touch or point to the device identification nameplate to verify its/your location.
            (3) Recheck the switching program for right location and right sequence.
            (4) Verify anticipated device position.
            (5) Perform requested action on the device. Introduction 16 of 80
            (6) Verify desired device position.
    b. Notifications
    c. Following switching order / procedure
    d. Paralleling
22. **Emergency Response Training**
    a. CPR Trained (per certifying body)
    b. AED Trained (per certifying body)
    c. First Aid Trained (per certifying body)
    d. Contact Release Trained (annual retraining per 70E)
    e. Fire Extinguisher Trained (annually per 1910.157)
23. **Work Package/Work Control Knowledge**
    a. Ensure site-specific work package/work control processes are understood
    b. Performance of Integrated Safety Management (ISM) for work package development
    c. Configuration Management

Utility Training Evaluation Checklist

Dispatcher:

1. **Electrical Fundamentals**
    a. Electrical theory
    b. Equipment types and function
    c. Electrical diagrams/map boards
    d. Supervisory Control And Data Acquisition (SCADA) or Command and Control System
    e. Site Electrical System
2. **Procedures**
    a. Site Operational Procedures
    b. Switching Procedures (prepare, review and/or issue)
    c. System risk assessment
3. **Operations**
    a. Scheduling
    b. Shift Turnover
    c. System modification
    d. Outage/work permits
    e. Emergency response
4. **Clearances**
    a. Clearance Procedures
    b. Authorized Holders
    c. Clearance tracking system/log
5. **Utility Regulations/System Compliance**
    a. Local utility interconnections
    b. Interfacing protocols
6. **Switching Orders**
    a. Preparation
    b. Review
    c. Issue
7. **Safety**
    a. Substation/utility site access
    b. Accountability/Overwatch

Utility Training Evaluation Checklist

Substation and Substation Equipment:

1. **Access requirements**
    a. Qualified personnel
    b. Unqualified personnel
    c. Subcontractors
2. **Escort responsibilities**
    a. Pre-job briefing
    b. Must be present during work
3. **Minimum approach distances**
4. **Arc flash hazards**
    a. Yard
    b. Control building
5. **Substation equipment safety**
    a. SF6
    b. Oil filled
    c. Vacuum interrupters
    d. Remote switching and racking
    e. Storage of spare parts/pieces
6. **Grounding**
    a. Specific grounding equipment for different applications
    b. Personal protective grounds
    c. Step potential
    d. Bucket trucks, lifts, cranes, digger derricks, trailers, etc.
7. **Substation equipment operation and maintenance**
    a. Outdoor Breakers and circuit protection
    b. Transformers
        i. Controls/Alarms
        ii. Load Tap Changer (LTC)
        iii. Nitrogen
    c. Indoor switchgear and breakers
    d. Ground operated switches
    e. Battery systems
    f. Capacitor banks
    g. Current Transformer/Potential Transformer (CT/PT)
    h. Connected research equipment
    i. SCADA/Telecom
    j. Relays/Protection
8. **Environmental requirements**
    a. SF6
    b. Oil filled equipment
    c. Batteries/battery acid

   d. Gas/Diesel
9. **Fall protection**
10. **Confined/Enclosed space**
11. **Lightning protection**

Utility Training Evaluation Checklist

Meter/Relay Technician:

1. **Electrical Fundamentals**
    a. Electrical theory
    b. Equipment types and functionality
        i. ANSI device numbers
    c. Electrical schematics/diagrams/map boards
2. **Procedures**
    a. Site Operational Procedures
    b. Switching Procedures (prepare, review and/or issue)
    c. Testing procedures
3. **Operations**
    a. Scheduling
    b. Outage/work permits
    c. Substation access
4. **Specialized Equipment (Remote Terminal Unit (RTU), Relays, Meters)**
    a. Specific certifications for testing
        i. electro-mechanical
        ii. solid state/microprocessor
    b. Test equipment
    c. Programming/modifications of specific protection equipment
    d. Equipment software suites
5. **SCADA or Command/Control System**
    a. Programming
    b. Display/Points list modifications
6. **Safety**
    a. DC Systems
    b. Batteries
    c. Capacitors
    d. MV/HV systems
    e. Grounding
    f. LOTO/Clearances
    g. Electrical Safety/arc flash
7. **North American Electric Reliability Corporation (NERC)/Federal Energy Regulatory Commission(FERC) Regulations**
    a. Protection System Compliance
    b. Interconnect agreement compliance

Utility Training Evaluation Checklist

Underground Network:

1. **Confined and enclosed spaces for utilities**
2. **Electrical safety for confined spaces**
    a. De-energization requirements
    b. Energized work requirements
    c. Remote spiking and cutting
    d. Inspecting current conditions
3. **Cable pulling through confined spaces**
4. **Splicing and terminating hazards in confined spaces**
    a. Lead cables
    b. Oil filled cables
    c. Torches
    d. Oxygen deficiency/asphyxiation
5. **Core drilling**
6. **Penetration for drilling/mounting supports**
7. **Drainage/water removal**
8. **Maintenance**
    a. Tops
    b. Ladders
    c. Supports
    d. Drainage
9. **Cable identification**
10. **Test equipment**

Utility Training Evaluation Checklist

Overhead Transmission and Distribution Lines:

1. **General Knowledge**
   a. Pole testing/pole condition
   b. Numbering schemes for poles/equipment
   c. Transmission/distribution circuits
   d. Guys/anchors
   e. Splicing/terminating/tying
2. **Grounding**
   a. Specific grounding equipment for different applications
   b. Equipotential/Personal protective grounds
   c. Bucket trucks, lifts, cranes, digger derricks, trailers, etc.
3. **Equipment operation and maintenance**
   a. Outdoor Breakers and circuit protection
   b. Transformers
   c. Ground operated switches
   d. Capacitor banks
   e. Current Transformer/Potential Transformer (CT/PT)
4. **Heavy Equipment - OSHA 1926 Subpart V & CC, 1910.269(p)**
   a. Crane
   b. Digger Derricks
   c. Bucket Trucks
   d. Backhoe
   e. Trenchers/Excavators
   f. ATV/UTV
   g. Towing/Trailers
   h. Cable Spoolers/Pullers
   i. Helicopters
   j. Drones
   k. Man Lifts
   l. Forklifts
   m. Skid Loaders
   n. Rock Drill
5. **Hoisting and Rigging**
   a. Spotters
   b. Clearances from overhead lines
   c. Capacity/Equipment Limitations
   d. Visual Inspections
   e. Slings/chokers/chains
   f. Angle of rigging
   g. Eyes/Hooks/Clevis
   h. Chain Falls/Capstan/Winches

i. Tag Lines
j. Hand Lines
k. Knots

6. Load Securement
a. Endorsement for wire/cable reels (if applicable)
b. Expectations for all classes of vehicles
c. State/local regulation

7. Traffic and Work Area Control
a. Work zone traffic control
    i. Manual on Uniform Traffic Control Devices (MUTCD)
b. Access/egress to work areas
c. Pedestrian control
d. Drop Zones
e. Material Laydown

8. Personal Protective Equipment (PPE)
a. Arc Rated PPE
b. Voltage Rated Gloves
c. Dielectric Overshoes (Not EH rated)
d. Construction PPE
e. Fall Protection
f. Selection, Inspection, Use, Care, and Limitations, for PPE
    i. Know how to select or who to ask for help
    ii. Proper laundering
    iii. Inspect before use
    iv. Emphasize PPE is last line of defense

9. Live Line Tools
a. Hot Sticks
b. Shotgun
c. Phasing Sticks
d. Blankets
e. Line Hose/Gutting
f. Meters/Voltage Indicators/Hot Horns/Proximity Testers
g. Selection, Inspection, Use, Care, Storage, and Limits of use, for Live Line Tools
    i. Wipe clean and visually inspect for defects daily
    ii. Remove from service every 2 years and test accordingly

10. Pre-Job Briefing
a. Notifications
b. Hazards associated with the job
c. Work procedures involved

Utility Training Evaluation Checklist

11. Safety

a. Arc flash hazards
b. MAD distances
c. Step potential
d. First Aid/CPR/AED
e. Pole top rescue
f. Fire extinguisher
g. Weather hazards/wind speed limits

Utility Training Evaluation Checklist

Preventative Maintenance (PM) Crews:

1. **Electrical Fundamentals**
    a. Electrical theory
    b. Equipment types and function
        i. ANSI device numbers
    c. Electrical diagrams/map boards
2. **Procedures**
    a. Site Operational Procedures
    b. Switching Procedures (prepare, review and/or issue)
    c. Testing procedures
3. **Operations**
    a. Scheduling
    b. Outage/work permits
    c. Preventative Maintenance
4. **Specialized Test Equipment**
5. **Bucket trucks, lifts, cranes, digger derricks, trailers, etc.**
6. **Safety**
    a. Electrical safety/arc flash
    b. LOTO/Clearances
    c. PPE
    d. Substation access/control
    e. Grounding
    f. Fall protection
    g. Confined/Enclosed space
    h. CPR/First Aid/AED

Utility Training Evaluation Checklist

Generators:

1. **Associated hazards with generators.**
    a. Mechanical
        i. Rotational
        ii. Thermal
    b. Electrical
        i. Shock
        ii. Arc flash
        iii. Grounding/bonding
        iv. Batteries
    c. Flammable Materials
    d. Exhaust regulations.
2. **Proper PPE for generator, transfer switches, and associated equipment.**
    a. Electrical Hazards
    b. Mechanical Hazards
    c. Hearing protection
    d. Barriers and Guards
3. **LOTO procedures**
    a. Interconnected power
    b. Backfeed ability
    c. Grounding
    d. Mechanical rotation
    e. Removal of battery
    f. Accessories (battery charger, control voltage, block heaters)
4. **Electrical Fundamentals**
    a. Electrical theory
    b. Equipment types and functionality
    c. Electrical diagrams/map boards
    d. Knowledge of system and circuits
    e. Backfeeds
5. **Commissioning and Acceptance testing**
    a. Training on new equipment
    b. Methods and procedures to place equipment in service
    c. Generator support systems
    d. Transfer systems

Utility Training Evaluation Checklist

Capacitors:

1. **Capacitor Safety**
    a. Capacitor hazard levels
        i. <100V and >100 joules
        ii. >100V and >1 joule
        iii. >400V and >.25 joules
    b. PPE
    c. Arc Blast Hazard
    d. Hearing Protection Boundary
    e. Lung Protection Boundary
    f. Chemical hazards
    g. Storage and disposal
2. **LOTO**
    a. Written discharge procedures
    b. Characteristics of Capacitors in Series vs Capacitors in Parallel
    c. Charge transfer
    d. Bleed Resistor
    e. Ground Stick
        i. Hard Grounding
        ii. Soft Grounding
3. **Capacitor maintenance requirements**
    a. Electrical tests
    b. Visual inspections
    c. Grounding/bonding

Utility Training Evaluation Checklist

Batteries:

1. **Battery Safety**
    a. Battery types
    b. Fire hazards
    c. Ventilation
    d. PPE
    e. Shock hazards
    f. Arc flash hazard
    g. Chemical hazards
    h. Battery chargers
    i. Storage and disposal
2. **LOTO**
    a. Specific procedures
        i. Splitting strings
        ii. Load transfers
        iii. Battery chargers
    b. Outage coordination
3. **Battery maintenance requirements**
    a. Electrical tests
    b. Visual inspections
    c. Chemistry
    d. Battery chargers
    e. Load tests