
Implementation of NFPA Arc Flash in D&D

West Valley Nuclear Services Company
(WVNSCO)
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Overview of Best Practice

- Implementation of Arc Flash Requirements in the D&D setting is a safety awareness taken from NFPA 70E “**Standard for Electrical Safety in the Work Place.**” This standard provides a **baseline safety format/program** to assist the “person in the field” while working on or adjacent to electrically energized components. Although the ultimate goal is to work in an electrically de-energized state, the West Valley Nuclear Services Company (WVNSCO) program provides a pro-active approach to risk management and treats all situations as “suspected energized.”
- **Work activities** in Deactivation & Decommissioning projects must be approached with a “**Cold & Dark**” endpoint philosophy driven by an integration of engineering, as-built documentation, field walk down, and confirmation of controlled isolation. The fundamental ISMS approach of verification, feedback, and confirmation allows WVNSCO to prove energy source control before dismantlement activities begin.

Overview of Best Practice

- Prior to proceeding with D&D activities, “**initial isolation**” of electrical sources is strictly managed to produce a **physical “Air Gap”** thereby providing a “safe to work” environment. The “Air Gap” condition is the only effective measure to safely achieve a Cold & Dark state. The air gap method of isolation is a proven example of core ISMS requirements.
- The “Air Gap” method is initiated through engineering controlled work instructions that receive cycles of review by peers, operations, Subject Matter Experts, Cognizant System Engineers, qualified electricians, and/or I&C technicians. The Hazard Screen Review Process is performed to identify any other required reviewers from other support groups or hazard specialists.

Overview of Best Practice

- Once the work document is issued, coordination of electrical service shutdown is conducted by the **qualified electrician** utilizing proper Lock Out-Tag Out and Confirmation practices. Donned in proper PPE, qualified electricians will open the de-energized enclosures, test for the absence of voltage, and then remove the cable connection at the source. The “Air Gap” cut location (primary run of conduit) is then carefully marked where it leaves its source enclosure, at the facility wall penetrations, and at the field load (i.e. motor – panel board, etc). The “Air Gap” cut location markings are independently verified as correct by walk-down of the entire conduit run.
- Required steps in the work document include **witness signatures** (Hold Point) that “Air Gap” markings have been applied and **authorize the physical act of cutting** a 12 to 24 inch section of raceway and cable to produce an “Air Gap” that can not be reconnected without extreme efforts.

Overview of Best Practice

- Labels are then applied to the conduit, cable assembly, or equipment scheduled for Dismantlement activities. WVNSCO's labeling requirement, which is considered a critical step in our program, consists of a burgundy label with a large white arrow which is also a writing area for specific information, including the work document number. The arrow is required to point in the direction of approved removal.
- **All work up to this point shall be performed ONLY by qualified maintenance electricians or I&C techs.**
- At this point, the D&D worker(s) and supervisor(s) begin the "Turnover Receipt of Cold and Dark" acceptance process from the qualified electrical and I&C personnel and sign off on the Air Gap work instruction.
- **Project Safe-to-Work Point !**

Meaning of Arc Flash in D&D

- **ISMS** provides an integrated policy to eliminate conditions of possible Arc Flash Hazards prior to initiating D&D activities.
- **System** shutdown/decommissioning receives same level of ISMS evaluation and hazard mitigation control as a facility review.
- **D&D System Work:** To render a system physically isolated and free of “electrical energized risk” providing a safe-to-work boundary.
- **D&D Facility Work:** To render a facility or building physically isolated and free of “electrical energized risk” providing a safe-to-work boundary .

Clarification

■ Cold & Dark:

- Electrical feeder and branch sources of voltage have been physically disconnected from service. Air-Gap(s) have been installed and “turn-over” verification has taken place between electricians/I&C techs and D&D personnel.
- Circumstances vary from system to system, building to building and site to site. Many issues must be addressed, resolved and managed, such as: exact *End State*, temporary utilities in support of D&D activities (HVAC, Lighting, Sumps, etc).

- ## ■ Air Gap:
- The act of physical removal of a section of service the renders original configuration unusable. Usually 12” to 24” of length removed (air gap), sufficient to prevent reconnecting without significant team effort.

Definitions

- **Air Gap:** a physical separation that isolates a connection to a voltage source or potential. Reconnection of physical separation shall require extreme effort, or shall be impossible.
- **Arc-Flash:** When an electric charge passes through air between ungrounded- grounded conductors. Can produce extremely high temperatures causing serious burns to skin and clothing.
- **Arc Blast:** The tremendous temperature of the arc causes the explosive expansion of both surrounding air and the metal in the arc path.
- **Cold & Dark:** To place a system or building in a de-energized state, free of hazards to allow safe deactivation or dismantlement.
- **De-energized:** Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth.

Definitions

- **Electrically Safe Work Condition:** A state in which the component, system or facility to be worked on has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary.
- **Electrical Safety:** Recognized hazards associated with the use of electrical energy and taking precautions so that hazards do not cause injury or death.
- **Energized:** Electrically connected to or having a source of voltage.
- **Exposed (as applied to live parts):** Capable of being inadvertently touched or approached nearer than a safe distance by a person.

Definitions

- **Flash Hazard:** A dangerous condition associated with the energy release caused by an electric arc.
- **Hazard/Risk Evaluation Procedure:** An electrical safety program shall identify the procedures for working on or near live parts operating at 50 volts or more or where an electrical hazard exists before work is started.
- **Qualified Person:** One who has skills and knowledge related to the construction and operation of the electrical equipment/ system/ facility and installations thereof AND has received specific safety training on the hazards involved. This includes, but is not limited to Electricians, I&C Tech's, Engineers and IS&H personnel.

Acronyms & Abbreviations

- SME Subject Matter Expert
- WRG Work Review Group
- WGS Work Group Supervisor
- CSE Cognizant System Engineer
- FM Facility Manager
- PM Project Manager
- D&D Decommission & Dismantlement
- ISMS Integrated Safety Management System
- URT Underground Review Team
- PPE Personal Protective Equipment

Acronyms & Abbreviations

- IWP Industrial Work Permit
- RWP Radiation Work Permit
- EWP Energized Work Permit
- I & C Instrumentation & Control Technician
- LOTO Lock-out, Tag-out and Confirm
- NFPA National Fire Prevention Association

Responsibilities

■ Management:

- Ensures document control compliance
- Ensures proper training compliance
- Ensures proper PPE program compliance

■ Engineering:

- Ensures personal training qualifications are current
- Ensures inherent work hazards are addressed and reflected within work instruction.
- Ensures preplanning documentation receives thorough review cycle for compliance

■ Subject Matter Expert:

- Ensures proposed work scope is acceptable to project team.
- Ensures systems & facilities that remain operating are not compromised from an Operations, Engineering or Safety standpoint.

Responsibilities

■ **Safety Representative:**

- Ensures issued work instruction compliance during field execution
- Ensures proper PPE used
- Ensures work instruction “Hold Point” compliance

■ **Responsible Work Group Supervisor:**

- Ensures Training Qualifications are up to date
- Ensures qualified personnel are assigned to work instruction walk-down
- Ensures proper PPE secured
- Ensures proper permits (IWP, RWP, EWP, GDP, etc.) are in place
- Ensures safety culture throughout work execution

■ **Responsible Work Group Workers:**

- Ensure work scope and hazards are clear
- Ensure safety culture throughout work execution
- Ensure personal commitment to safely performing work, always
- Ensure work stand-down if unexpected factors arise while performing work

Responsibilities

■ Work Planning

- WVNSCO has established a Work Review Group (WRG) assigned to review all work documents from a SME, and Peer level. Members of the WRG include: Industrial Hygiene & Safety, Criticality Safety Engineer, Radiation Protection, Environmental Affairs, Emergency Management, Waste Shipping & Disposal, Fire Protection, Facility Managers, Operations Shift Supervisor, USQD Originator
- Ensures Hazard Screen issues are mitigated.
- Ensures feasibility of work scope
- Ensures that authors of work instructions resolve all comments
- Ensures proper approving signatures are secured to safeguard workers and minimize or mitigate risk prior to issuing Work Instruction.

Process - Exposed Utility

- During **D&D** work scope development the Project Manager (PM) and various SME's perform a walk-down during the early planning stages of said project to determine the need and magnitude of Cold & Dark/Air Gap requirements.
- The **PM and Chief Engineer assign** the task of developing concise work packages to the appropriate engineer that matches the skills necessary to achieve a thorough and safe "Cold & Dark/ Air Gap" for utility isolation. This assignment is **discipline specific**.
- Each engineer **reviews** proposed scope, and performs interviews with Operations, Subject Matter Experts (SME), Cognizant System Engineers (CSE), Maint. Personnel, etc. to gain a handle on system and physical requirements.
- Each engineer **assembles** existing document package (drawings/SOP's/etc), and performs a document walk-down to develop an "as-built" state condition. As-built walk-down includes Maintenance and Operations personnel as needed. **Documentation MUST MATCH the field!**
- Most often the initial phase of a D&D project requires the engineers to develop thorough and **precise as-built documentation** before isolation points can be evaluated and developed for project use.

Use this SLIDE along with Flow Chart #1 & #2

Process - Exposed Utility

- Engineer **develops DRAFT** “Work Instruction Plan”.
- Engineer **develops “Hazard Identification Screen”**
- Engineer **consults** with Hazard Specialists for hazard mitigation input.
- Engineer **distributes** draft of Work Instruction Package and Hazard Screen to Hazard Specialists, SME, CSE, Facility Manager and Responsible Work Group Supervisor for additional level of review, and field walk-down.
- Engineer **resolves** comments from all reviewers.
- Engineer **provides final** version of Work Instruction to Responsible Work Group Supervisor for Final Walk-Down by field personnel.
- Engineer **obtains** Approval Walk-Down Signature from field personnel.

Use this SLIDE along with Flow Chart # 3

Process - Exposed Utility

- Engineer **routes** 'Field Walk Down Approved' Work Instruction Package to Work Review Group, Hazard Specialists, SME and CSE for final approval signature. The Facility Manager has final signoff.
-Work Instruction Package includes: Instruction steps, hazard screen, supporting permits (Industrial Work, Hot Work, Energized Work, Radiation, etc) drawings, and field photographs.
- Once **all approvals** are secured the work instruction package is issued to appropriate Work Group Supervisor (WGS).
- WGS **assigns** Work Instruction to qualified electrician that performed initial walk-down.
- Qualified electrician **coordinates shutdown** of system utilizing proper Lock, Tag & Confirm Practice.
- Qualified electrician, **donned in NFPA 70E PPE** accesses de-energized source location, tests for Zero Voltage and then physically removes cable connection from source.
- Qualified electrician carefully marks the Air Gap "**Cut-Point**" **locations** on the conduit run – at the source enclosure, where the conduit passes through walls, and at the field equipment location.

Use this SLIDE along with Flow Charts # 3, 4, 5 & 6

Process - Exposed Utility

- All “marked” Cut-Point locations are **independently verified** and documented as correct.
- Work Instruction requires **approval signature** that Air Gap markings have been applied, and witnessed as correct.
- Approval Signature, and Work Instruction **authorizes** physical act of cutting a 12” to 24” section of raceway/cable. **AIR GAPPED.**
- Labels are applied to the Air Gapped conduit/cable, utility or equipment scheduled for dismantlement activities. **CRITICAL STEP !**
- Labels are Burgundy color with a large white arrow (for writing Work Instruction Control Number). Arrow points in the direction of approved dismantlement.

Use this SLIDE along with Flow Chart # 6

Process - Underground Utility

- If utilities are “underground”, per our procedure # WV-370 “***Underground Utility Review Policy***”, a request for Ground Disturbance Permit is filed by the project engineer or the cognizant engineer and transmitted to the Underground Review Team (URT) for formal compilation.
- The URT develops a **composite permit package** that includes boundary scope, multidiscipline set of drawings and historical photo’s. Based of initial evaluation, the URT compiles a list of underground elements that need to be physically located and marked in the field.
- The URT utilizes **various tools** to identify existence, actual function and existing routing of each element. The next step is to compare and “match up” field found elements with the corresponding “engineering released” documents. This level of comparison will determine if the engineering released documents need to be as-built corrected.

Process - Underground Utility

- **URT Tools:**
 - Engineering released drawings
 - Controlled sketches
 - Historical photos of previous excavation
 - LOTO cycling to prove source control (presence and removal) for utilities such as: Water, Air, Steam, Electric, etc
 - Ground Penetrating equipment
 - Metro Tech Line Locater: High Frequency Transmitter & Receiver used to locate underground piping, conduit and cabling.
 - Magna-Trak Magnetic Line Locater

- Engineer **develops DRAFT** “Work Instruction Plan“ as laid out above.

Training - NFPA 70E

- **WVNSCO** has developed three (3) distinct levels of Arc Flash training for site personnel, and Sub-Contractors. Each level of training represents a level of “qualification” that is sensitive to the level of risk associated with a given category of work, as follows:
 - **Category 0 (training ID # AF0):** Training breakdown of understanding the risk, the proper PPE and procedure compliance for this level of Arc Flash incident energy = **0.1 to 3.9 cal/cm²**
 - **Category 2 (training ID # AF2):** Training breakdown of understanding the risk, the proper PPE and procedure compliance for this level of Arc Flash incident energy of = **4.0 to 24.9 cal/cm²**
 - **Category 4 (training ID # AF4):** Training breakdown of understanding the risk, the proper PPE and procedure compliance for this level of Arc Flash incident energy of = **25 cal/cm² and above.**

Risk

General Con-Ops

- Exposed electrical work shall normally be performed in a de-energized state.
- Energized electrical work requires special approval, and requires an approved Energized Work Permit.
- Energized work may be necessary only in those cases where a greater hazard will be introduced by de-energizing, i.e. Critical Ventilation for Radiation Control, or where actual testing requires system or equipment to be energized.

Risk

D&D Con-Ops

- The nature of D&D work requires a level of awareness of the inherent risks associated with this type of work.
- The D&D Operations personnel must be placed in a risk controlled environment.
- The D&D Operations personnel shall not proceed with dismantlement activities without first receiving proper Air-Gap turnover.
- If D&D operations personnel perceive a risk as suspect, they are authorized to “Stop The Job” until the risk is resolved.

Risk

General Conditions

- Improper work instruction – not sufficient in detail
- Walk-down Oversight – work condition oversight not verified in field
- Assumptions were made and not field verified
- Human errors by inattention to details

Improvements

- **Walk-downs:**

All work instructions require a walk-down process

- **Compliance:**

Responsible work groups shall work within the steps of the issued Work Instruction or Standard Operating Procedure and be prepared to Stop The Job if the evolution is outside the boundary of procedure or work instruction.