TA-53 Arc-Flash Accident

"Active Thinking and Evaluation of Controls"

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Joint Accident Investigation Team Member

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DOE Construction Safety
Advisory Committee

Presenter Background

- Twenty seven years in DOE operations and engineering positions including nuclear, electrical, explosives and accelerators.
- Operations oversight includes work at Rocky Flats, HQ, INL, WIPP and LANL.
  - Ten years of involvement in electrical safety at LANL.
  - Involvement in two previous near-miss to fatality electrical event investigations at LANL.
  - 4 Facility Rep assignments and 2 in system safety
  - Close involvement in work control, conduct of operations and engineering processes.

Central Points

- Event Synopsis
- Analysis - People, Processes and Procedures
- Human failure modes must be evaluated
- Events don’t just happen;
  - humans in complex environments set them up
- Thinking safety isn’t enough
- Active safety behaviors reduce the odds of undesirable events, including tragedy.

Goals

1. **Increase active thinking during work planning *and* execution to overcome human nature and ensure efficiency does not compromise safety.**
2. **By reconsidering hindsight we can turn it into foresight.**

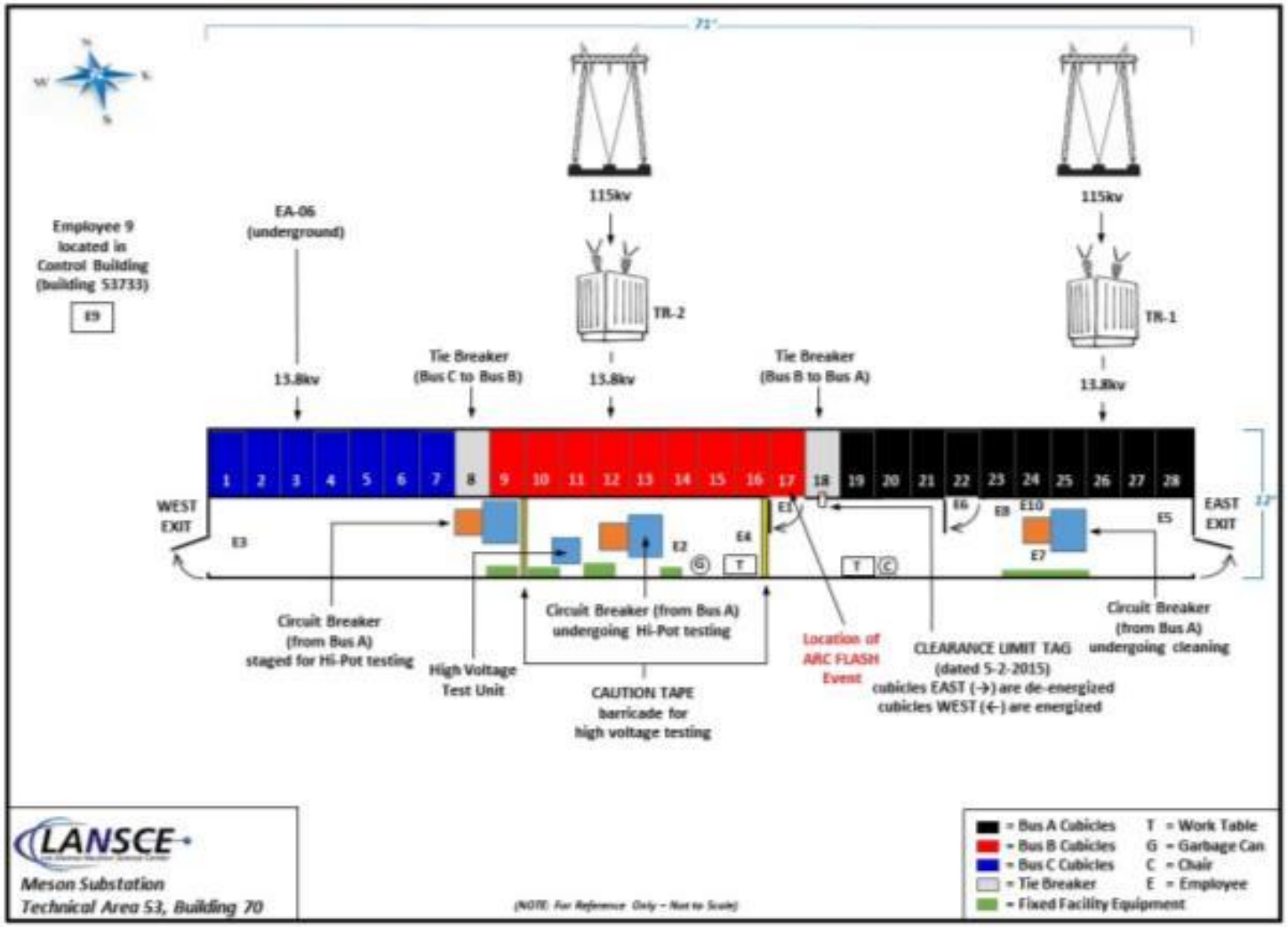
Overview of Equipment and Facility

Substation transforms 115kV to 13kV, powers largest single facility, LANSCE – the accelerator is nearly a mile long.

2000 Amp bus segmented by 2 tie-breakers, with one alternate feed that is normally isolated.

Bus A Work Area

Diagram of Work at Time of Event



Arc Flash Event Synopsis

- On Saturday May 2, 2015, maintenance personnel at Los Alamos National Laboratory (LANL) were conducting **two-year breaker preventative maintenance** (PM) **and five-year substation cleaning** PM on equipment that powers the LANSCE facility area.
- Some elements of this maintenance were complete Saturday evening, **two of the three buses in the switchgear were re-energized** to support equipment and systems.
- On Sunday morning, May 3, 2015, work resumed on the last bus, which remained isolated from Saturday.

Clearance Point Established Saturday

Accident, no tape found on #17

Clearance Tag

Informal completion tracking Blue=Clean Red=Breaker Tested

Synopsis Continued

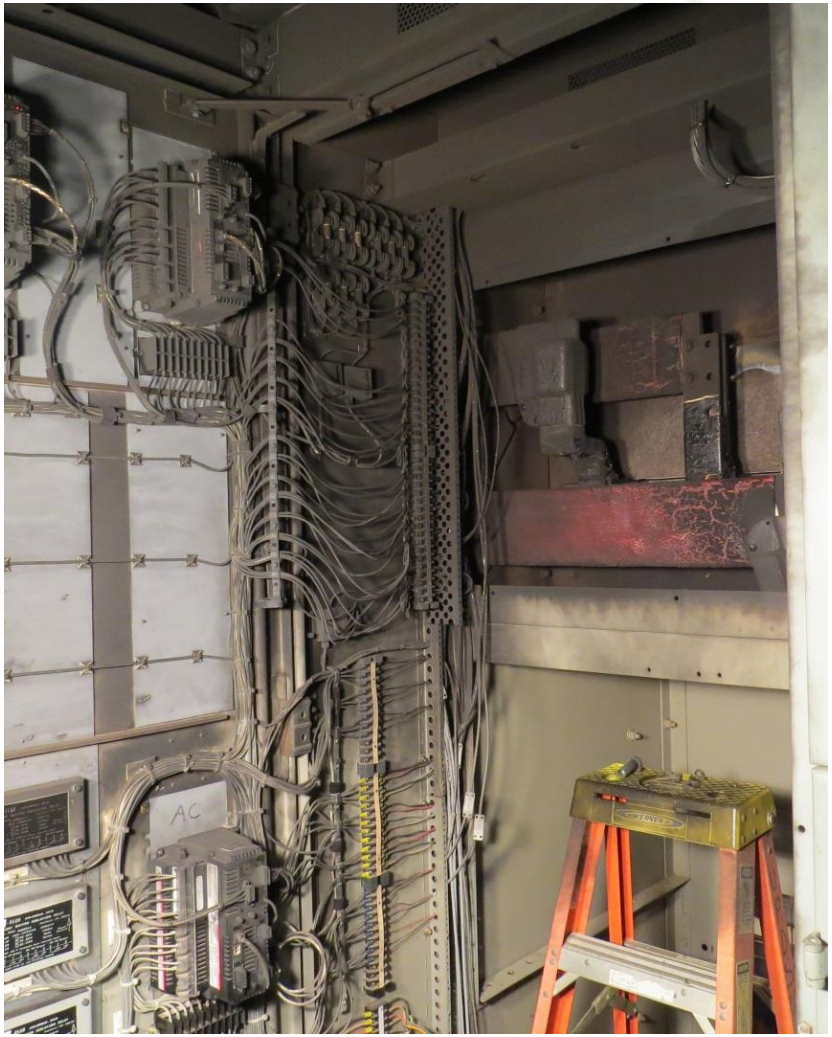
- A crew member **entered a cubicle on the wrong side of the clearance tag** that contained only instrumentation with bus bars passing through. Visual and physical indications of power were misleading at best.
- Based on physical evidence, spraying cleaning **solution created an electrical breakdown** between the 13.8-kV bus and the grounded cubicle wall, **resulting in an arc-flash and blast**.
- The resulting **blast ejected him from the cubicle**, resulting in significant burns and a head injury as he fell backward and struck test equipment positioned on the floor.

Cubicle 17 from West Side, Yellow Tape

Unclassified

Accident Scene

Arc Flash Damage in Cubicle 17



Victim Impact

Clothing

Worker was estimated close to 24 inches on initiation of fault but knocked back to floor. Damage to PPE shows an estimated exposure of 20 – 25 cal/cm^2.

Event Analysis - Procedures

- The two standing work orders for switchgear maintenance were familiar to most on the crew.
- According to the foreman and others, these were worked separately in the past.
- No “meeting of the minds” discussion was held between managers and crew to consider compensating controls for partially energized equipment or concurrent tasks.
- This resulted in uncertainty of zero voltage checks required for each cubicle, no consideration of Look-Alike Equipment, inadequate consideration of work flow during concurrent tasks.

Event Analysis - Processes

- LANL Integrated Work Control Processes Established in 2004, revamped several times.
  - Multiple concerted efforts to improve, driven by accidents, incidents, partially effective. Culture and HPI continue to be a challenge.
  - Balancing efficiency (brevity) with Safety – Most Standing Work Orders written at the job level with few hold points or task level details.
  - No Time to Write or Alter each Order with Task-Level Controls – Rely on Skill-of-Craft.

Event Analysis - People

- Crew composed of journeyman linemen, switchgear electricians, wiremen electricians and a switchgear apprentice. All were current in training on electrical safety.
- Inconsistent zero energy verification on job – some felt lineman isolation (clearance) was the zero energy verification. At least one worker checked cubicles before working inside.
- The maintenance crew was under the supervision of a journeyman lineman because the switchgear is inside a utility fence line with exclusive access.

Humans are Fallible Systems

- The work planner and lineman foreman both felt that combining work tasks and partially reenergized gear did not require new controls.
- Two Schools of Thought – Convergent and Divergent Thinking – Which One are You From?
  - Convergent Thinkers use logical deductions and *reasonable* assumptions to narrow in on *likely* outcomes. Usually STEM majors.
  - Divergent Thinkers consider *unlikely* scenarios and *possibilities* to arrive at a more *inclusive* set of possible outcomes. Usually creative folks.
  - Reference – John Channing "*Safety at Work*"

Thinking “Safety” Isn’t Enough

- Convergent thinking *will* eventually open the door to an event. Seek input from the team or a fresh set of eyes.
- Divergent thinking by experienced workers *reduces the odds* of setting up an event.
- Dry runs and tabletop runs get folks thinking about the unexpected.
- **Active thinking** and a **questioning attitude** are *professional responsibilities*, for everyone.
  - We collectively need to make a conscious effort to cultivate, embrace and reward visible examples of these two activities.
  - Done well, done early…. *and* done while working… it will save time and reduce risk.

Making Safety Thinking a Behavior

- Something that has not yet occurred or been built is harder to evaluate. There *is* only paper to critique.
- *Starting* with a Standing Work Order is Fine, but Changes to Hazardous Work require a fresh perspective – *Especially* that of the Workers Involved.
- Divergent thinking and honest discussion *really* pays. Remember "Talk is cheap, but accidents are not."
- This is where *YOU* come in – ask yourselves, not just "Am I thinking this through?" but are *others* thinking this through **as a team**? Is there evidence of that thinking, and are folks at multiple levels soliciting new and unique thoughts or truncating them?

Human Performance Issues (HPI)

- Crowded conditions and concurrent work activities (cleaning and breaker testing). Nine workers in 40’ isle with equipment and breakers.
- Yellow Caution Tape between cubicle 16 and 17 and no completion (blue) tape on #17 to indicate cleaning completed – two potentially misleading visual cues that #17 was within work scope.
- No designated tasks assigned or formal method to track work completion opened the door to error.

Active Safety Thinking – Grass Roots

- It is *literally* both a matter of *and* a method for showing professional regard for coworkers.
- Managers are charged with setting ethical expectations in an organization. Accepting a complacent attitude is an unethical action.
- Show work crews *their* opinion is the one that counts the most, because they have the most to lose. Get them thinking well before the task is at hand, especially when conditions change.

LANL Improvements and Enhancements to Work Safety are Ongoing

Numerous improvements and enhancements to:

- Work control
- Electrical safety work implementation
- Human performance
- Hazard identification
- Subcontractor oversight

Improvements in Work Planning and Implementation - past and ongoing

- Increased involvement in planning and oversight by the responsible line managers
- Improved hazard identification as a function of the task
- Additional work planning review and validation
- Focus to involve workers in planning
- Assurance of review and approval by SMEs

Improvements in Human Performance – past and ongoing

- Focused programs in
  - Human performance initiative
  - Behavior Based Safety
- Emphasis to all workers and managers to
  - Look out and care for each other
  - Being a leader in safety
  - Perform real time risk assessment throughout work
  - Share concerns and pause work

Improvements to Electrical Safety – past and ongoing

- Implementing 2015 NFPA 70E concepts of Risk Assessment as a function of
  - Hazard
  - Exposure
  - Task or activity
- Training enhancements to re enforce:
  - Real time risk assessment
  - Noninstrusive and intrusive scope-of-work
  - Recognizing hidden hazards
  - Looking out for each other

Focus on ISM principles – with examples for arc flash accident

- Line Management Responsibility for Safety
  - Manager aware of an involved in hazardous work
- Clear Roles and Responsibilities
  - Line crew vs electricians, person in charge, safety watch
- Competence Commensurate with Responsibilities
  - Line crew vs maintenance electricians, work planner
- Balanced Priorities
  - Facility maintenance vs program needs
- Identification of Safety Standards and Requirements
  - NFPA 70E vs NESC in mixed worker environments
- Hazard Controls Tailored to Work Being Performed
  - Controls to compensate for mixed work, changing conditions, etc.
- Operations Authorization

Any questions?

Please contact Jeff Williams

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