

Use of Engineering Controls to Reduce Worker
Exposure to Electrical Hazards for Facility
Distribution Equipment and R&D Electrical
Equipment

Facility Distribution Equipment – New Installations

Reducing arc flash severity:

- Design structure to re-direct/exhaust arc flash (IEEE standard)
- Remote racking/operation of equipment/OCPD's.
- Design to allow the use of live line tools to increase worker distance from hazard.
- Windows on switchgear for thermography
- Application of current limiting fusing and CBs
- Transformers - Consider size/impedance to coordinate fault current with OCPDs to minimize incident energy
- Specify metal clad instead metal enclosed switchgear
 - Separately enclosed main breakers and feeder breakers
- High/Low resistance/reactance grounding schemes
- Increased working clearances for equipment
- Install ground fault sensing down to 400A breakers

Facility Distribution Equipment – New Installations

Reducing probability of Arc Flash:

- Insulated bus
- Use of captive hardware and hinged enclosures
- Physical arc flash barriers to protect live parts
- Properly engineered equipment locations.

Facility Distribution Equipment – New Installations

Verifying disconnect and zero energy state:

- Equipment windows to visually verify open condition
- Use of low arc flash hazard (AFH) test points
- External test meters/other visual indications
- Test at lower AFH location

Facility Distribution Equipment – New Installations

Reducing shock hazard:

- Finger/hand safe components (IEC 60529 – IP20, IP41).
 - MCC buckets
 - Shutter mechanisms on draw-out gear (IEEE-C37-specification)
 - Interface terminal boxes for R&D applications
- Specify non-hazardous control voltages where feasible.
- Separating non-hazardous voltage from hazardous voltage.
- Specify metallic raceways for embedded runs.
- Install signal trace with buried utilities (PVC) with test well.
- Discourage use of multiwire (shared neutral) branch circuits except where required for single utilization equipment.

Facility Distribution Equipment – New Installations

Designing systems to minimize arc incident energy:

- Perform arc flash study in conjunction with coordination study to validate design.
- Develop database of OCPDs during design/installation – Configuration Management!
 - Acquire OEM OCPD trip characteristics
- Use smaller dry type (<125kVA) transformers (Ref: IEEE-1584)
- Specify breakers with maintenance mode to reduce trip time
- Specify electronic trip (LSIG) OCPDs.
- Use of opto-electronic arc detection OCPDs for fault clearing
- Transformer/Bus differential relaying.
- Zone selective interlocking.
- Arc flash mitigating breakers/switchgear.
- Current limiting reactors.

Facility Distribution Equipment – New Installations

Other methods to increase safety

- Remote breaker operations
- Remote racking
- Equipment specific technical training (e.g. separately derived control voltages).

R&D Equipment – New Installations

Reducing Electrical Shock

- Use non-hazardous voltages instead of hazardous voltage where practical
- Separate control signals from power distribution
- Use fingersafe components
- Externally accessible fuses/breakers
- Modular/Removable subassemblies and rack chassis's to permit inspection/maintenance in a workbench environment
- Tool-less installation of components

Facility Distribution Equipment – Maintenance/Modification of Existing Installations

Reducing arc flash hazard:

- Power system analysis and adjustment of trip settings
- Retrofit TM breakers/trip units with electronic trip OCPD's.
- Adjust breakers to reduce trip time prior to maintenance.
- Replacement of existing fuses with faster acting fuses.
- Adequate maintenance must be performed – Arc flash calculations are meaningless if you cannot guarantee proper equipment operation.
- Addition of listed IR windows .
- Use of opto-electronic arc detection equipment for fault clearing.
- All modifications need to be approved.
- Better lighting and HVAC.
- Manholes – utilize remote thermography.

Facility Distribution Equipment – Maintenance/Modification of Existing Installations

Reducing shock hazard:

- Installation of finger/hand safe components or installing barriers that render the equipment finger safe (IEC 60529 – IP20, IP41).
- Dielectric/insulating blankets.
- Eliminate or label multiwire branch circuits when found
- Configuration management – one line diagrams, panel schedules

R&D Equipment – Maintenance/Modifications of Existing Installations

Reducing shock hazard:

- Install temporary guards when troubleshooting
- Maintain configuration management – updated schematics & bill of materials
- Establish decommissioning procedures that follow NEC requirements, i.e., no exposed hazards left.
- Proper inspection/approval by AHJ of modifications.

Engineered Controls – Other Methods

- Proximity detection systems for overhead lines fitted to cranes, excavators, fire trucks, etc.
- Install 2/0 bc ground in top of ductbank and install test wells next to manholes.
- Use of NRTL electronic drill stops.
- Use vacuum excavator for potholing and excavation.
- Use of listed insulated tools.

Other Engineering Controls – Wish List

How else can engineering solutions and products improve safety?

- Can test equipment be improved? How?
- Smart meters (talking)
- Robotic technology
- Proximity devices at end of drill bits
- Self testing meters
- Smart gear to self report conditions/PPE requirements (IEEE-????, condition monitoring).
- Simulator type equipment for training

How to Publish Engineering Solutions

What is the desired way to document and distribute engineering solutions?

- Publish through Center of Excellence
- Adopt locally through Engineering Standards
- Appendix to DOE Electrical Safety Handbook
- Incorporate into Electrical Worker/Engineer Training