EFCOG
Electrical Safety Task Group

Leveraging Current Events in DOE to Maximize Electrical Safety Improvement

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EFCOG Electrical Safety Workshop
Richland Washington
June 24-28, 2017

EFCOG promotes excellence in all aspects of the operation, management, and integration of DOE facilities in a safe, environmentally sound, efficient and cost-effective manner through the ongoing exchange of information on lessons learned.

Key Topics

- Impending revision of 10CRF851
- Flow down of Electrical AHJ to site
- Complex wide Electrical AHJ
- Update of the DOE Electrical Safety Handbook
- Training DOE site electrical SMEs and Facility Reps
- Consistency of Electrical Safety Program across the complex
- Contractor Assurance Metrics to measure programs

Contributions of EFCOG Workshops

- **DOE Electrical Safety Handbook**
  - Revisions – 2004, 2013, likely 2018
  - New material – excavations, equipment approval, hazard classification
- **10CFR851**
  - Includes “must have electrical safety program to cover R&D”
- **NFPA 70E**
  - 2009 – Article 350 (R&D)
  - 2012 – DC approach shock boundaries, DC arc flash calculations
  - 2015 – DC task tables, etc.
  - 2018 – eliminated article 340 (Safe Work Practices) covered in other Articles enhanced Article 350 (e.g., capacitor safety)
- **Best practices**
  - Lightning protection, hazardous energy control, DC analysis
  - Equipment approval reciprocity
  - Electrical Severity Measurement Tool
  - Risk Assessment (based on 2015 NFPA 70E)
  - NEC and 70E impact analyses for contract modification

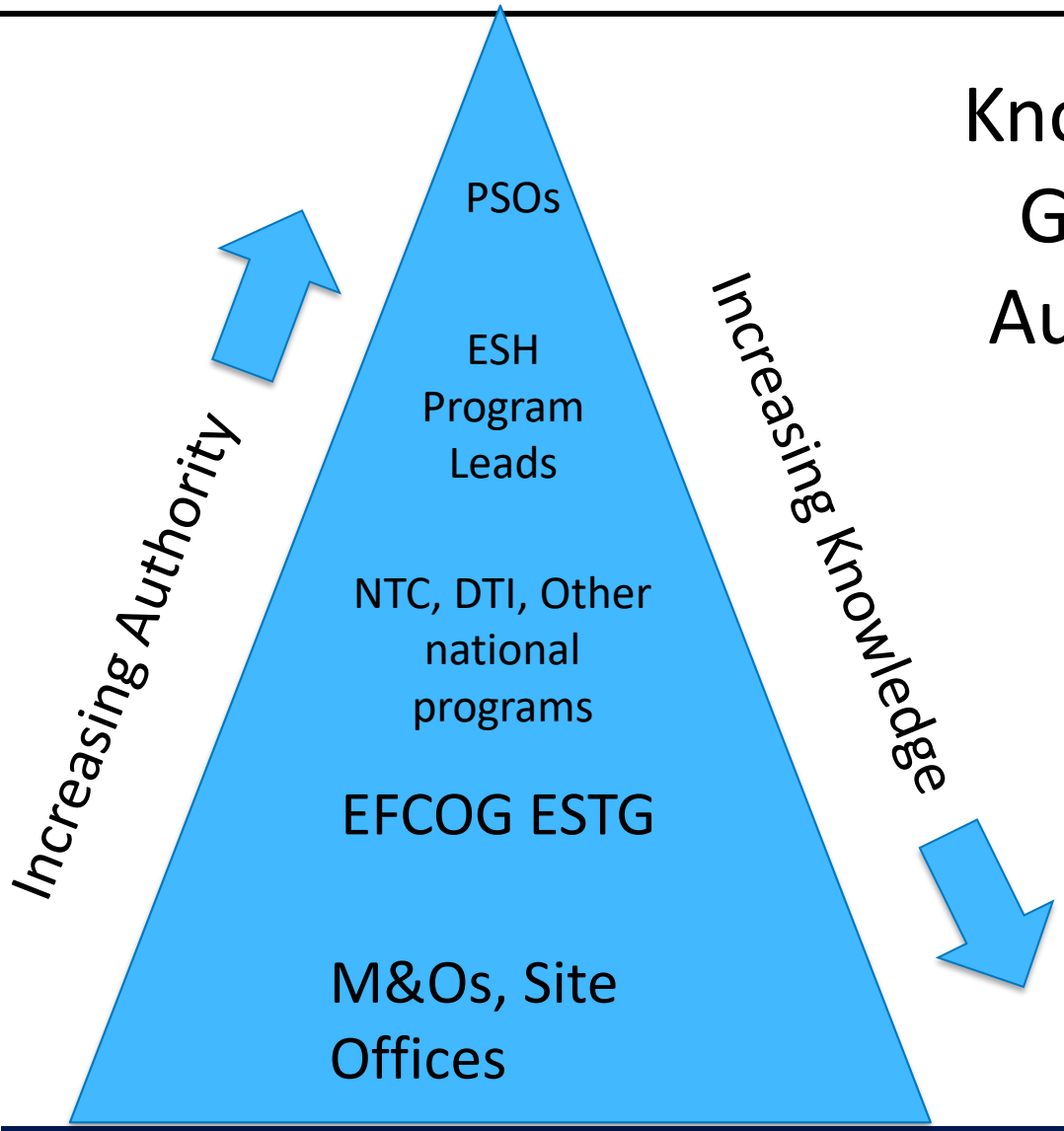
Big Picture - 1

- **New Administration, bent on Regulatory Reduction/ROI**
  - Efficiency and Accountability
- **AHJ structure for DOE environment is not clearly documented, nor well understood by most management and leadership**
  - e.g. [concepts] in 70E apply to R&D, [not] the content of 70E, except short R&D section
  - Approval of unlisted equipment enables [most] of the important work in DOE, yet few really grasp this legal fact. In contrast, they do grasp you [never] do rad work without qualified support, approval of equipment and operations procedures [readiness reviews] etc.
  - Education needed to propagate facts that 851 = 835, Electricity is a far greater source of injury than Rad in DOE
- **851 change – 2014 NEC and 2015 70E**
  - Same OSHA 1910/1926, still no NESC
  - Change will drive gain – getting 70E-2015 off the ground

Big Picture - 2

- **New Handbook enables standardized program, in turn standardized training and standard of performance**
  - As site contracts roll over, new HDBK will set the bar for all key program elements
  - Emphasize & integrate requirements for electrical equipment maintenance
  - Subcontractor guidance to address historical trend in events across DOE
- **Metrics and Assessment –**
  - What gets measured gets done
  - No data = no clear direction
- **Training across the DOE/NNSA complex for federal managers and oversight professionals**
  - Focus on all of the above with the intention of driving contractor performance improvement

Program Structure



Knowledge Guiding Authority

First things First

- **What is the grand scheme of AHJ in DOE (NA, EM, SC, NE)**
  - Expertise of the ESTG counsels & guides authority of site offices, PSOs.
  - DOE O 420.1C – AHJ is delegated from the PSO to the site managers, to the M&O. Must follow AHJ structure prescribed in any applicable code or standard. May be delegated by federal site manager or retained.
  - Body of knowledge rests with M&O's/some site offices, focused by the EFCOG ESTG
  - Risk Acceptance Authority is each federal site manager, and HQ
- **Distributed AHJ model is met by M&O/sites as the body of experts, DOE officials as final authority.**
  - Clarifies roles of federal elements and contractors.
  - Ensures efficiency and equity.

An Integrated Program Landscape

- **HDBK model program is updated as overall framework and content guidance document**
  - Focus on R&D methods of safe work, such as meeting 70E intent.
  - Risk assessment combined with HPI to engage the worker in managing human failure modes
- **AHJ structure is clarified so non-experts can read and grasp quickly, will guide managers & leaders on roles & responsibilities**
  - Clarifies Drivers and Regulatory Structure of 851, 420.1C, Codes & Standards

An Integrated Program Landscape

- **Drive competency requirements top to bottom**
  - ISM Guiding Principle – *Competency Commensurate with Responsibility*
  - Training & Federal TQP – Baseline federal competence to drive performance, mesh with federal qualification programs (FR, SSO, SME)
- **Increase Focus on Human Performance – the new frontier in DOE**
  - ESTG continuing support in process and tool development
  - Data will drive focus for biggest gains –pilot novel changes, gather data, propagate when effectiveness is demonstrated
- **Change to support CAS contract structure with assessments and data, both locally and at national level – driven by Order 226.1, NNSA SD-226**

Drivers for change in Electrical Safety Program

- **10 CFR 851 - Worker Safety and Health Program Revision**
- **Need for further improvement in program safety record**
- **Continued Emphasis on CAS e.g. NA issued SD 226.1**
- **Improve and clarify AHJ function – big focus by HQ and DNFSB**
- **lists the Electrical Codes and Standards that must be met by a contractor, Based on Scope/activities**
  - (Appendix A, part 10) states that "contractors must implement a comprehensive electrical safety program appropriate for the activities at their site"

Government and National Codes and Standards for Electrical Safety

- **10CFR851**
  - OSHA - Title 29, Parts CFR 1910 and 1926
  - NEC - National Electrical Code (2014/2017)
  - NFPA 70E - Standard for Electrical Safety in the Workplace (2015/2018)
- **Others**
  - DOE Electrical Safety Handbook (2013)
  - ASTM, ANSI, and IEEE Standards
  - NRTL Standards (e.g., UL)

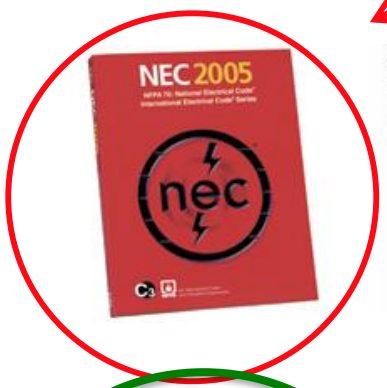
National Electrical Codes and Standards Referenced by 10CFR851

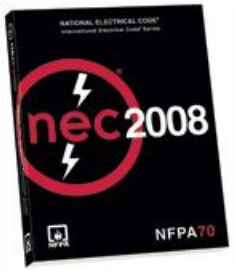
Current 10CFR851

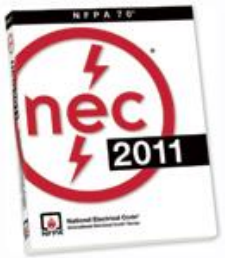
NEC

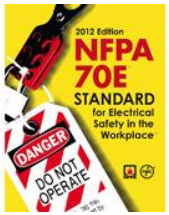
OSHA

70E









Upcoming 10CFR851

2018 70E
Sept. 2017

EFCOG
Electrical Safety Task Group

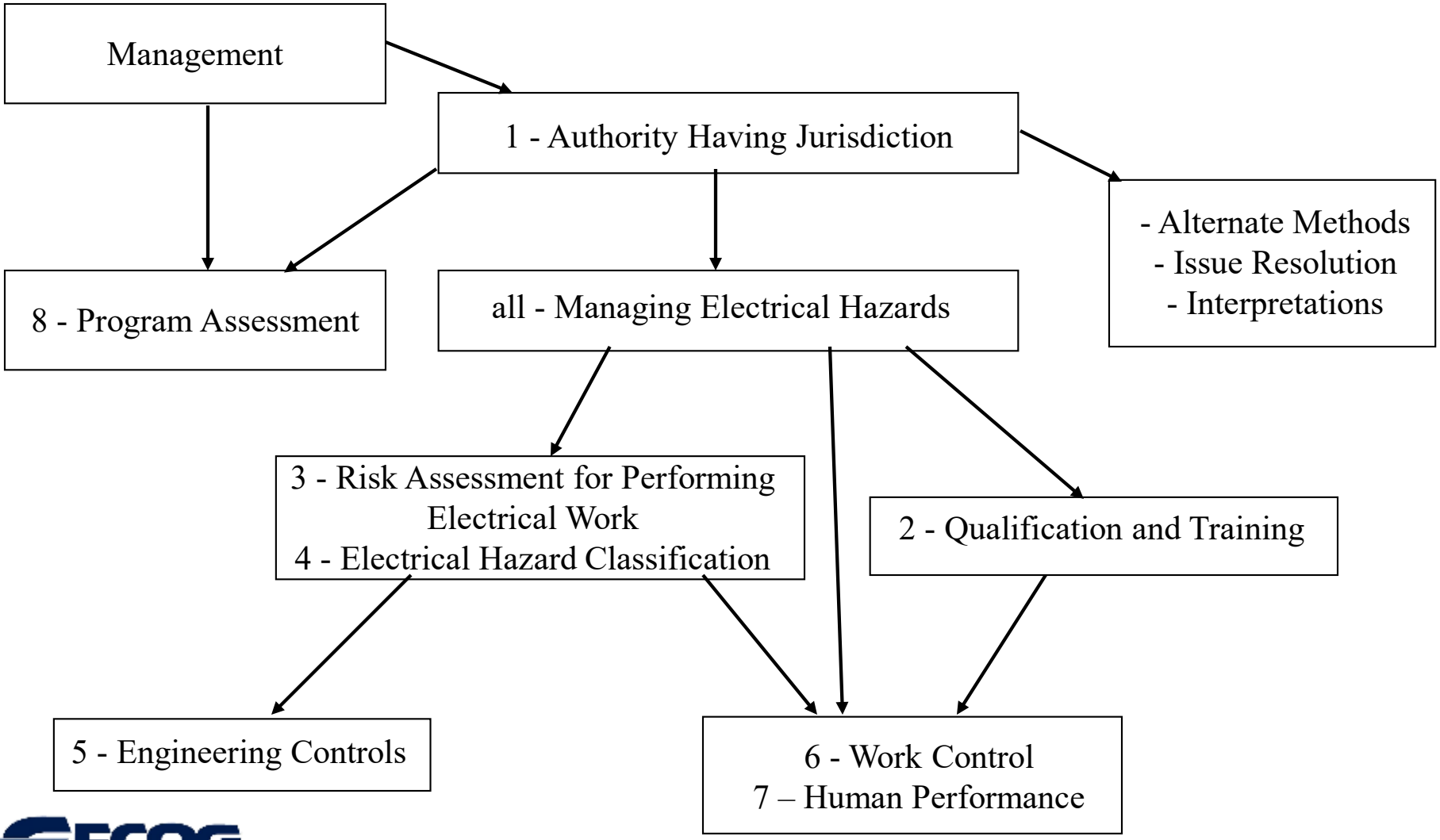
Course given to DOE Electrical SMEs and Facility Representatives

May 1 – 2, 2017

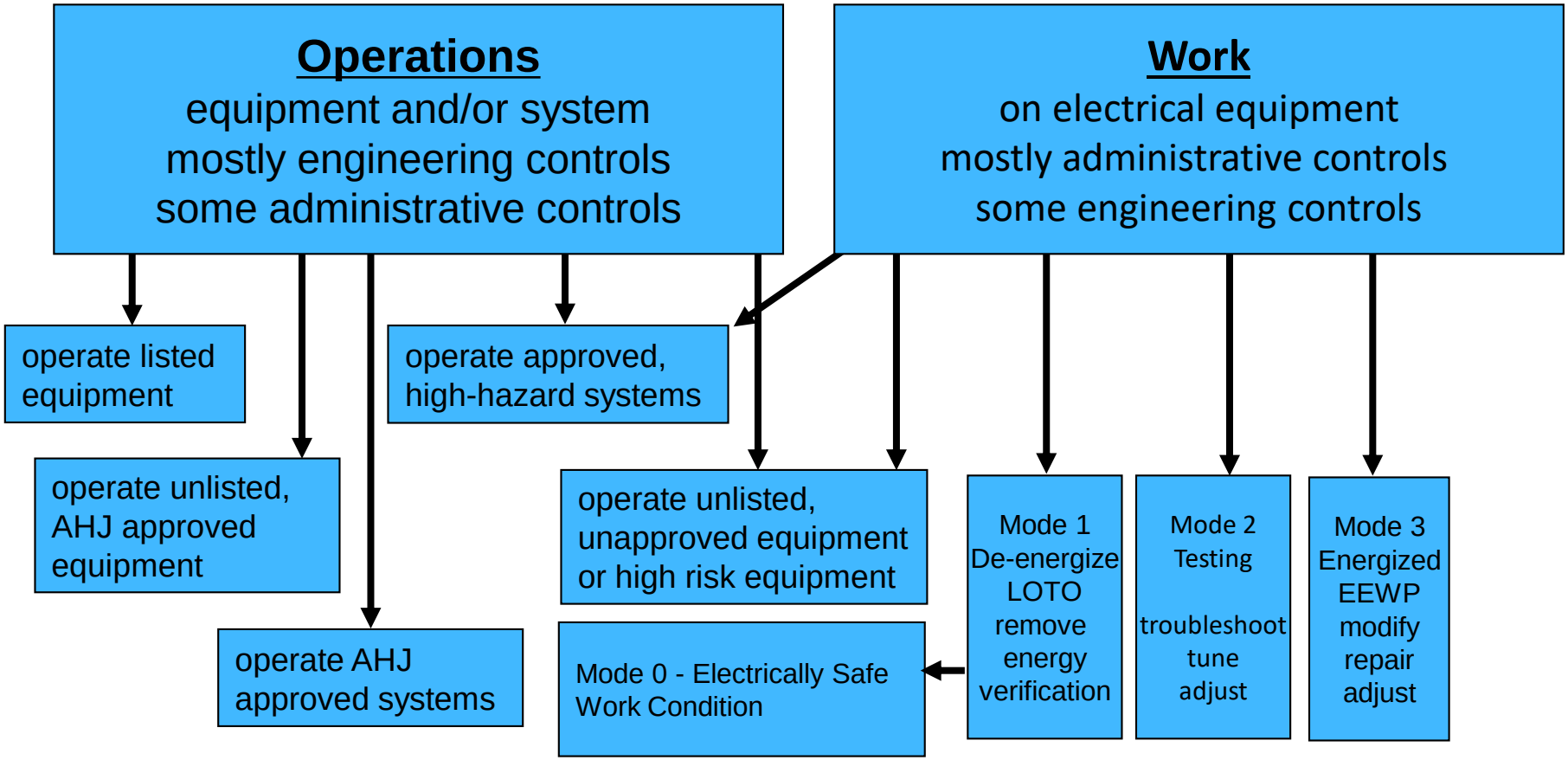
Las Vegas

EFCOG promotes excellence in all aspects of the operation, management, and integration of DOE facilities in a safe, environmentally sound, efficient and cost-effective manner through the ongoing exchange of information on lessons learned.

This course will cover the following *elements* of an Electrical Safety Program



Worker Interface with Electrical Hazards



NRTL or Unlisted Equipment Approval
Design, review and documentation
Failure analysis
Construction and inspection
Configuration management
Maintenance, inspection and testing

Processes

Integrated Safety Management
Training and Qualification
Personal protective equipment
Human behavior and performance

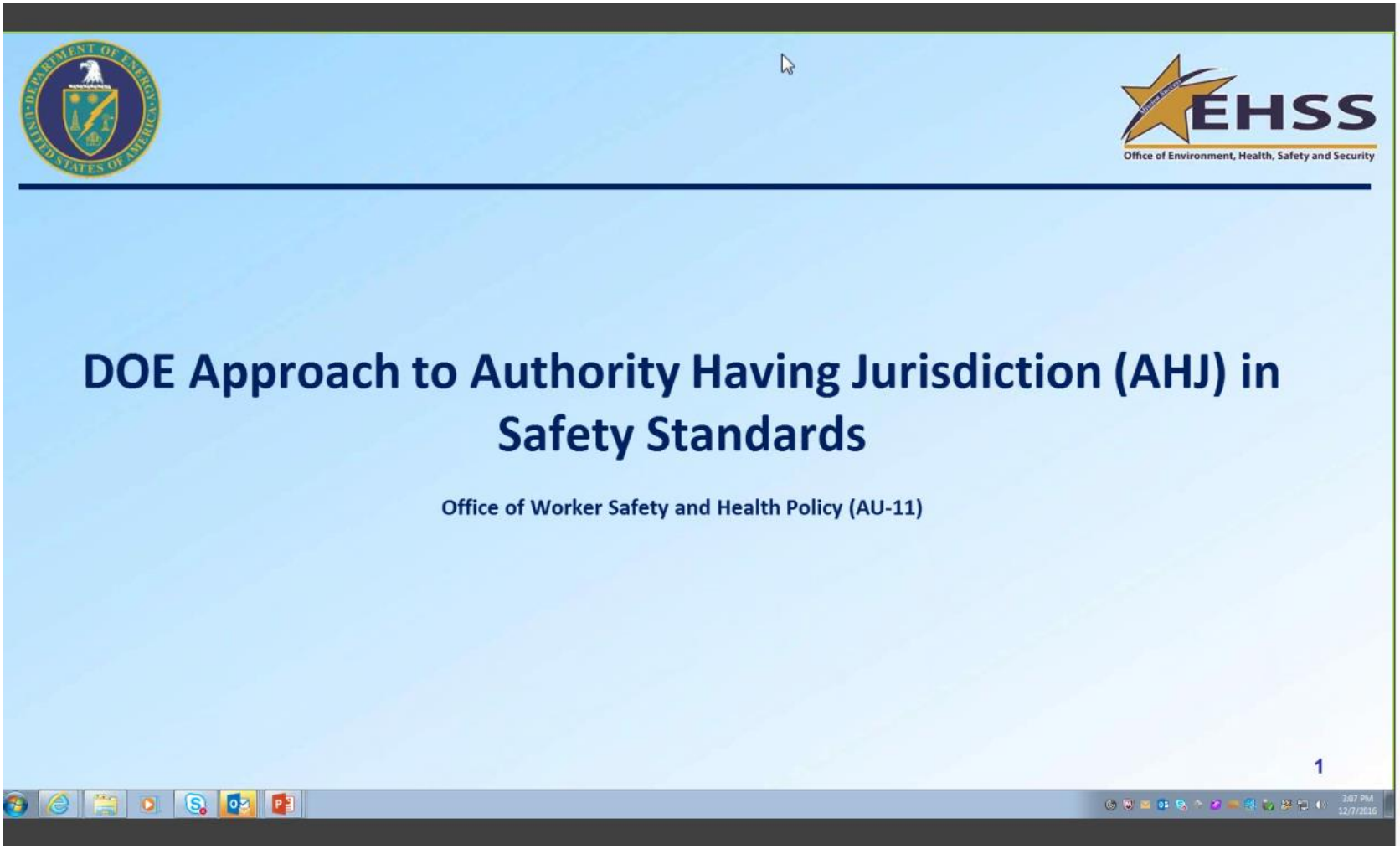
Element 1 - The Electrical Authority Having Jurisdiction

Authority Having Jurisdiction (AHJ)

- Competency is key – increase federal competence and define relationship to engage with site SMEs
- NEC - The AHJ is the organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

- This simple and broad definition will be expanded to cover typical responsibilities of DOE contractor AHJs.

The following slides are from a webinar hosted by DOE EHSS on December 7, 2016



Authority Having Jurisdiction (AHJ)

EHSS
Office of Environment, Health, Safety and Security

- **DOE is the AHJ**
  - DOE can delegate the authority to DOE Head of the Field Element
  - DOE Head of the Field Element can further delegate this responsibility to a Federal employee or a contractor employee with the requisite safety knowledge, skills and abilities for a specific technical area.

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Authority Having Jurisdiction (AHJ)

EHSS
Office of Environment, Health, Safety and Security

Guidance on AHJ provided in Position Paper

- *Guidance on Application of Consensus Safety and Health Standards Adopted in Part 851*

DOE G 440.1-1B, Worker Safety and Health Program for DOE (including the National Nuclear Security Administration) Federal and Contractor Employees

- *2.1 Closure Facilities*
- *6.2.1.5 Evaluate Operations, Procedures and Facilities*
- *6.4.1 Authority Having Jurisdiction (AHJ) and Equivalencies*
- *7.1 Flexibility in Codes and Standards*
- *8.2.1 Fire Protection and 8.10.1 Electrical Safety*

AHJ- Authority

- AHJ will vary based on the technical area
- Several different AHJ's can exist for a given technical area, each with different authority
- Authority given AHJ must be formally defined and specific:
  - Official Letter from the Site
  - Worker Safety and Health Program
  - Function, Responsibilities, and Authorities Manual (FRAM)

5

Examples of AHJ components at various sites

- **The top level:**
  - Electrical Safety Committee or Board
  - Chief Electrical Safety Officer or Inspector
- **Lower levels**
  - Inspector or Electrical Inspectors
  - Electrical Safety Officers

AHJ Responsibilities

- Enforce all electrical code requirements
- Clarify electrical code requirements
- Provide advice and consultation on how to meet electrical requirements
- Manage an electrical inspection program
- Approve unlisted electrical equipment
- Perform as the Subject Matter Experts in electrical safety
- Issue formal interpretations
- Final technical arbiter on electrical safety issues
- Approve Energized Electrical Work Permits (EEWPs)
- Assure that employees work freely from unmitigated exposure to electrical hazards

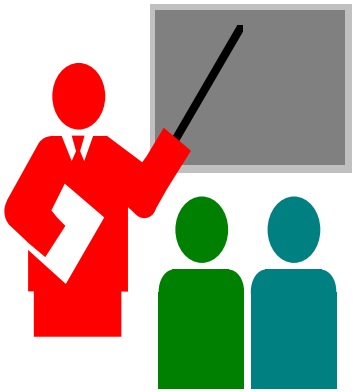
AHJ Responsibilities - cont.

- Approve alternate methods to a code or standard
- Report to management on the effectiveness of the Electrical Safety Program
- Evaluate and recommend the contractual adoption of new or revised standards, codes, and requirements for electrical work
- Recommend electrical safety training priorities and training technical content
- Provide SMEs for critiques of electrical incidents

AHJ Qualifications

- **There should be qualification requirements for any electrical safety oversight person such as an Electrical Inspector or Electrical Safety Officer (ESO)**
- **For facility inspection/oversight this might include:**
  - journeyman's license
  - inspector's certification or license
  - additional knowledge of applicable electrical safety requirements
  - demonstrated field experience in facility electrical systems
    - design, installation, operation
- **For R&D inspection/oversight this might include:**
  - a qualified electrical worker
  - knowledge of applicable electrical safety requirements based on
    - OSHA, NEC, NESC, DOE
  - demonstrated field experience in R&D electrical systems
    - design, installation, operation

Element 2 - Qualification and Training



Safety training

Training Program at Each Site

- With 851 revision, each site will be required to implement a Risk Management Process and formally train workers to comply with 70E-2015
- Each subcontractor must have a program to assure training and qualification of electrical workers.
- The training may be provided by external sources for smaller sites, but larger sites usually have an in-house training program.
- Training of qualified electrical workers must be documented.

2015 NFPA 70E
Select Training Requirements

- **110.2 Training**
- (B) Type of Training. The training required by this section shall be classroom, on-the-job, or a combination of the two. The type and extent of the training provided shall be determined by the risk to the employee.
- 110.2(D)(1)(d) – Tasks that are performed less often then once per year shall require retraining before the performance of the work practices involved.
- 110.2(D)(3) Retraining – Retraining in safety-related work practices and applicable changes in this standard shall be performed at intervals not to exceed three years.

Comments on Training Method

- Some sites have moved to largely web-based or self study for electrical safety training. This is driven by limited resources and/or researchers.
- 70E requires a live component for instructor/student interaction

2015 NFPA 70E
Training Requirements for subcontractors

- 110.3 Host and Contract Employers' Responsibilities
- Note: "Host" is the site contractor and "contract" is a subcontractor.
- (B)(1) The contract employer shall ensure that each of his or her employees is instructed in the hazards communicated to the contract employer by the host employer. This instruction shall be in addition to the basic training required by this standard.
- The site contractor (e.g., LANL) is responsible per 10CFR851 to assure that the subcontractor (e.g., Eaton) has acceptable training as required by NFPA 70E.

Recent Subcontractor Training Issues

- Recent electrical accidents involving electrical subcontractors have validated that electrical subcontract workers may not be adequately trained to NFPA 70E. Examples include:
- - January 2011 – UPS subcontract worker seriously injured at LANL
- - November 2013 – facility subcontract worker seriously injured at LBNL

Office of Enforcement Investigation of Electrical Subcontractors

- OE investigated two UPS subcontractors at LANL in 2012. Their reports stated that the subcontractors "did not provide adequate electrical safety training"
- In their report on LANL they found that "the contractor did not assure that the subcontractors were adequately trained"

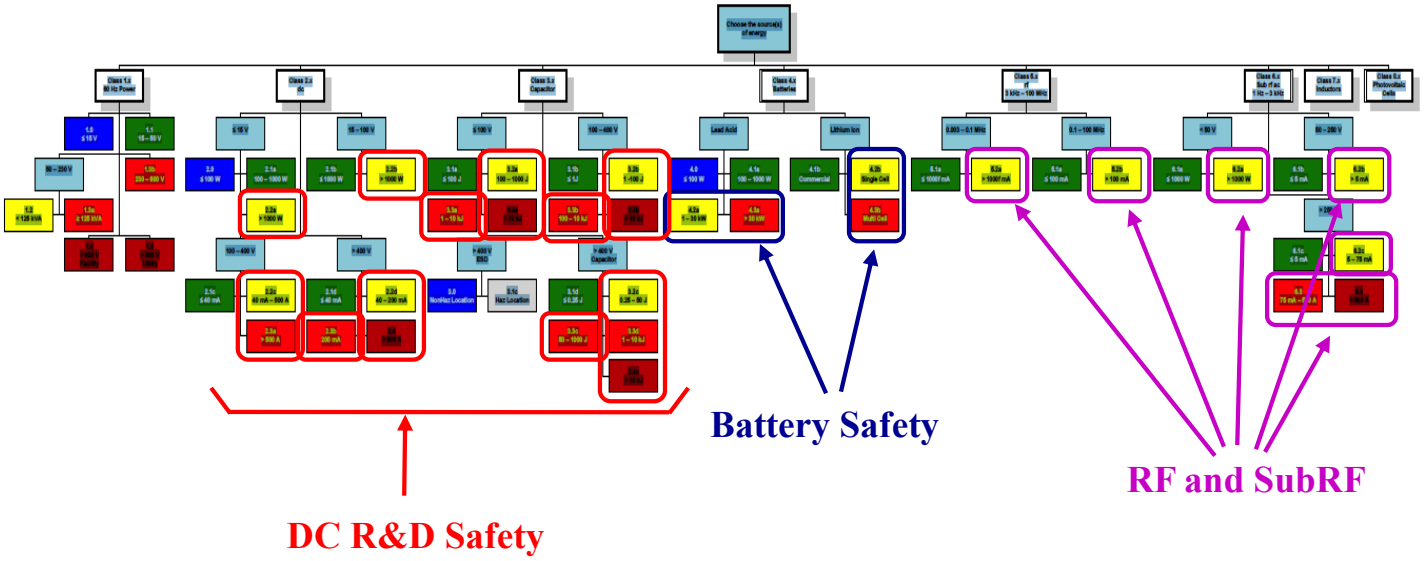
What AHJs require NFPA 70E?

- DOE has the ONLY electrical AHJ in the US that require and enforce NFPA 70E.
- DoD is in the process of requiring NFPA 70E.
- The DOE community can significantly influence the training and qualification of facility electrical workers in the US by strictly requiring NFPA 70E training of all electrical workers supplied by subcontractors
- 70E-2015 universal implementation in DOE will further this cause.

Electrical Training for R&D to meet 70E intent

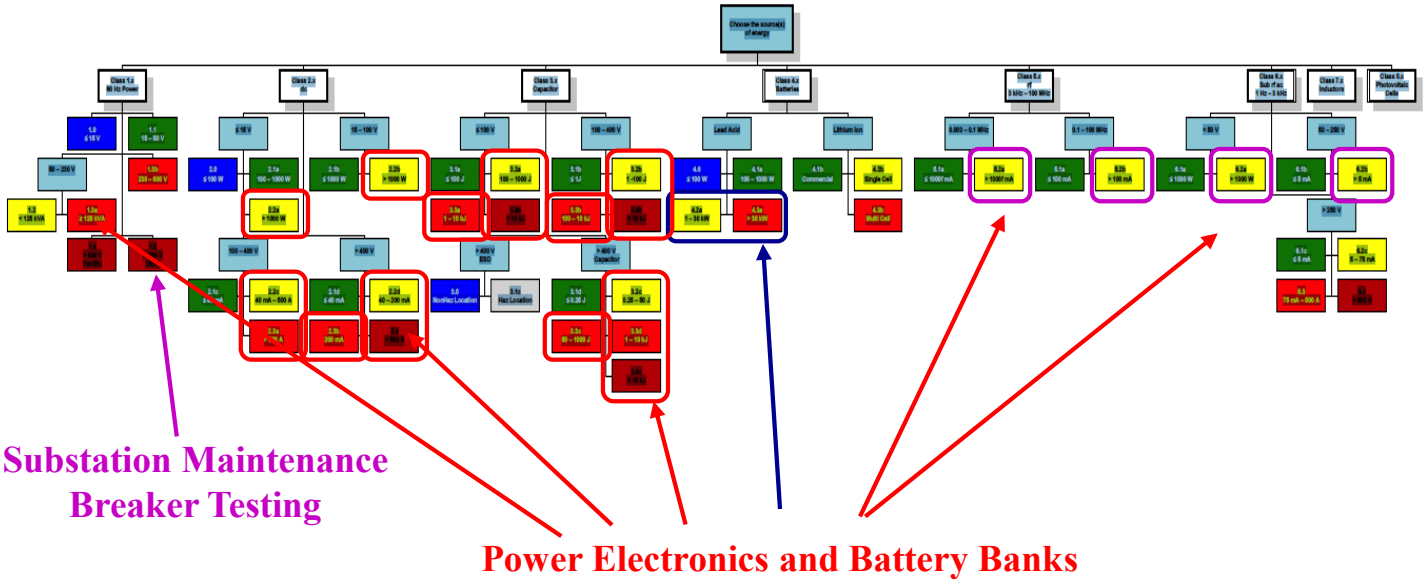
- **R&D workers who work on or near electrical hazards, including opening R&D equipment must be appropriately trained and qualified**
- **R&D workers working on or near unique R&D electrical hazards must be trained for those hazards. Examples include**
  - High voltage, capacitor, and pulsed power hazards
  - High current, high power hazards
  - Radiofrequency and microwave hazards
  - Batteries and battery bank hazards
- **AHJ persons who inspect and approve unlisted R&D equipment must be appropriately trained**

Example Focus Courses for Special Hazard Classes for R&D workers



Specialty classes are required if the workers work in the above hazard classes

Example Focus Courses for facility workers for Special Facility Equipment

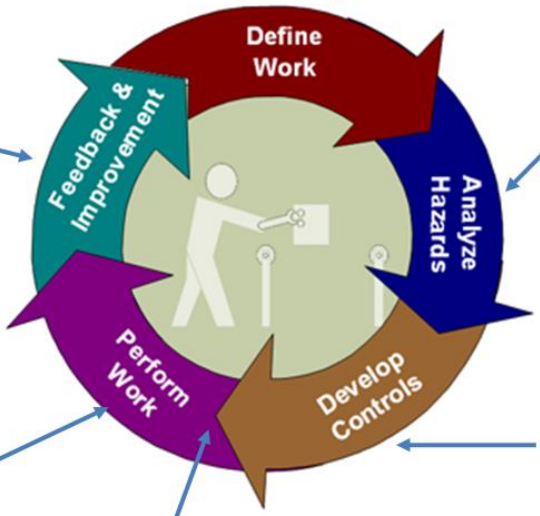


Specialty classes are required if the workers work in the above hazard classes

Element 3 - Performing an Electrical Risk Assessment

Integrating ISM and Risk Management

The ISM (Risk) Model



Task-based Risk Assessment

Risk Assessment

1. **Hazard ID**
2. **Risk Analysis and Estimation**
   - ***likelihood*** *of harm occurring*
   - ***severity*** *of that harm*
3. ***Risk Evaluation***
4. ***Document***

Identify and Document Risk Control Measures

- Elimination
- Substitution
- Engineering controls
- Warnings
- Administrative controls
- Personal protective equipment

Verify and Validate Risk Assessment & Control Measures

- Update and Document as necessary

Continue Real-Time Reevaluation of Risk Assessment & Control Measures

Measure and Monitor

- Lessons Learned
- Near Misses
- Latent (unidentified) Hazard
- Improvement

4 Modes of Electrical Work

Modes of work exist when the cover has been removed, or engineering barriers are not yet in place.
Modes of work map onto work conditions described in NFPA 70E

Mode 0 – Electrically Safe Work Condition

Mode 1 – Establishing an Electrically Safe Work Condition

Mode 2 – Energized Diagnostics and Testing

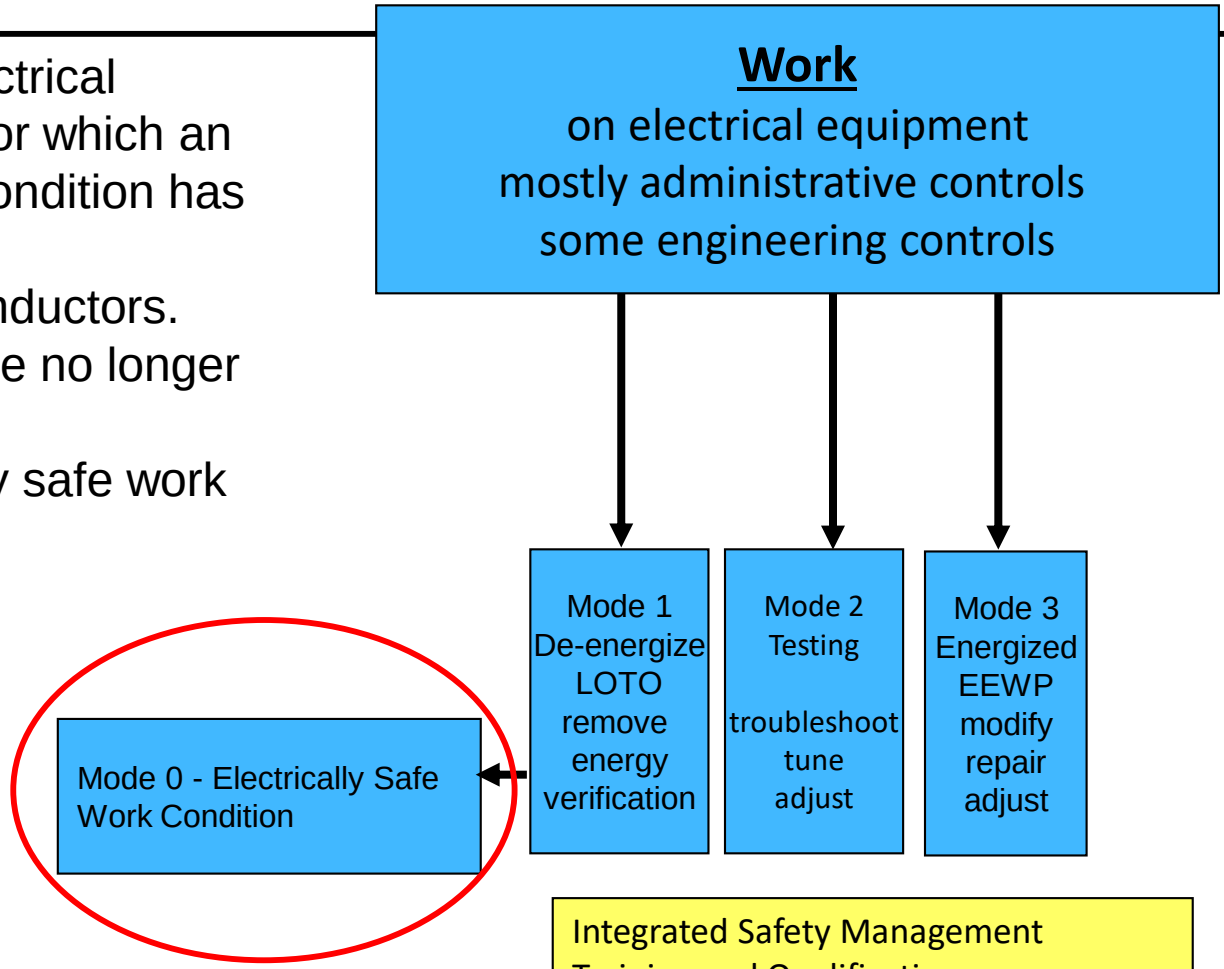
Mode 3 – Energized Work Requiring an EEWP

When work is not a mode of work

- **Operating NRTL or ESO approved, or non-hazardous equipment with all controls in place is NOT a mode of work.**
- **Examples:**
  - Using a computer
  - Using a power tool
  - Turning on a light switch
  - Operating NRTL listed or ESO approved equipment
  - Operating a breaker or disconnect switch
  - ?? Racking out a breaker ??

Mode 0 Work

- Working on or near electrical conductors or circuits for which an electrically safe work condition has been established.
- You are exposed to conductors.
- Engineering controls are no longer protecting you.
- You have an electrically safe work condition
  - Deenergized
  - Verified safe
  - LOTO or plug control

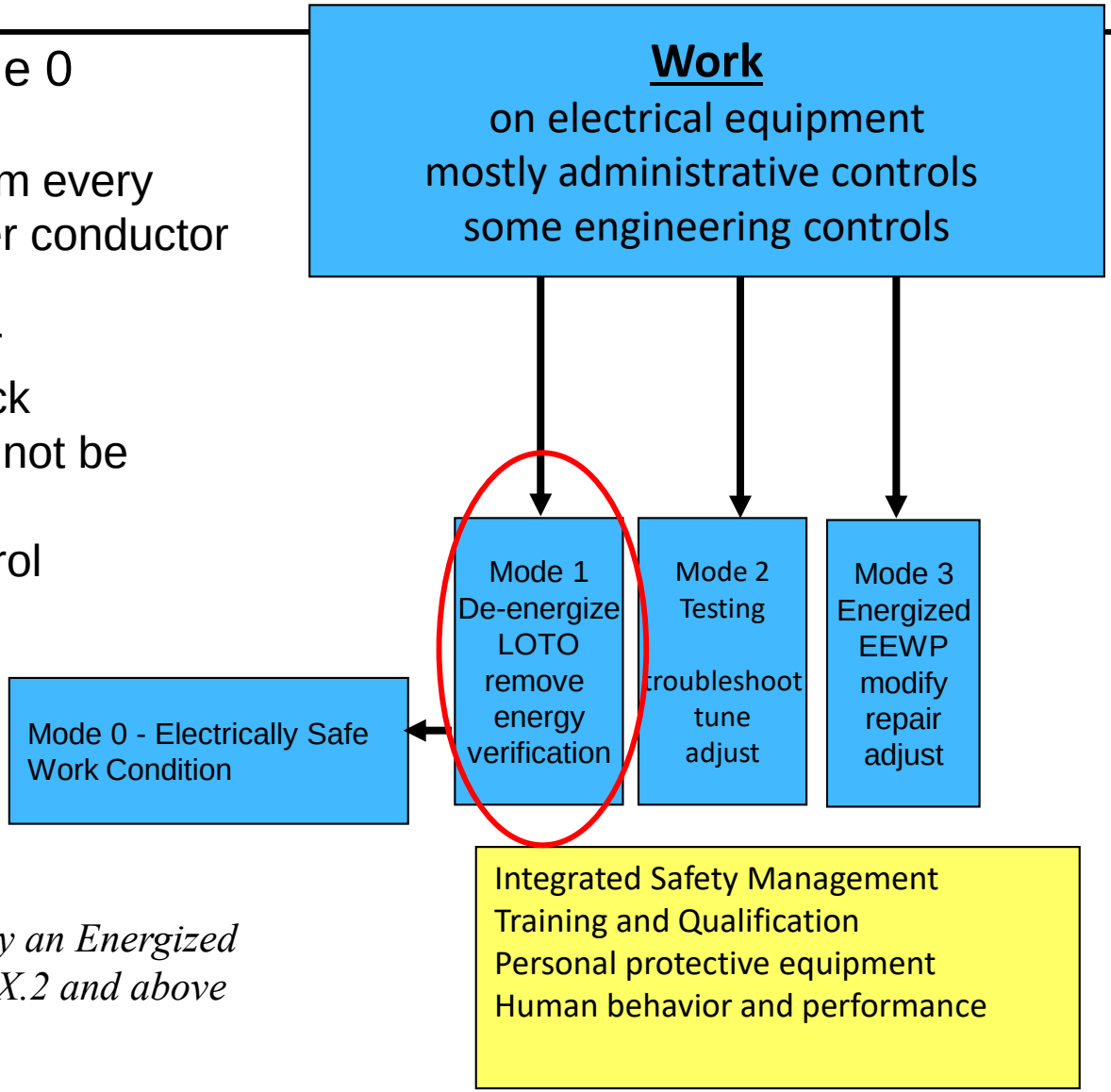


NOTE: This can be performed by a Nonenergized Electrical worker in any hazard class, if Mode 1 was performed by an Energized Electrical worker in Hazard Classes 2,2 and above (yellow and above).

Mode 1 – Achieving an Electrically Safe Work Condition

Process of achieving Mode 0

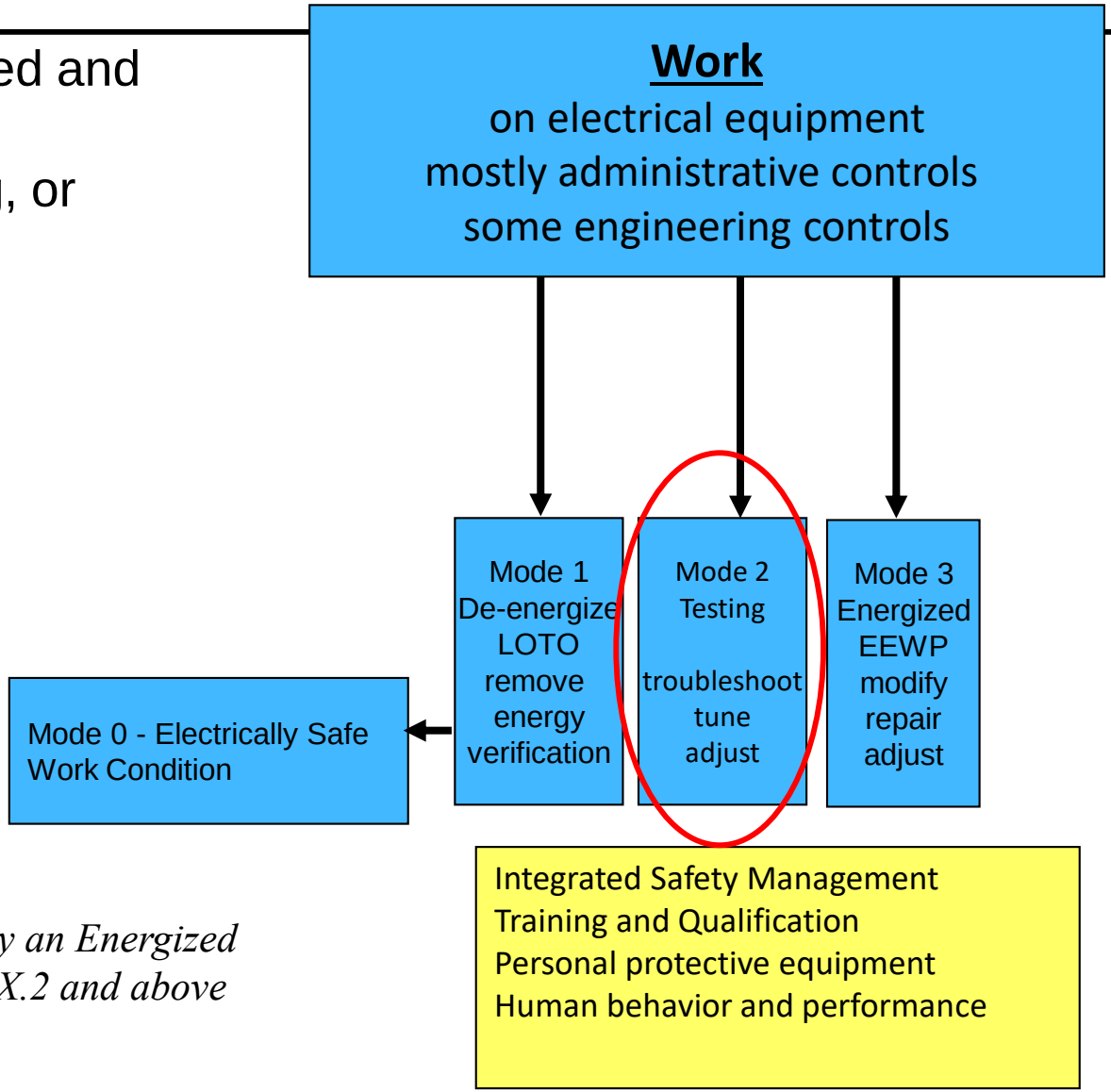
- Deenergize the system
- Verify zero potential from every conductor to every other conductor
  - Using a meter
- Discharging a capacitor
  - Using a ground stick
- Ensure the system can not be reenergized
  - LOTO or plug control



NOTE: This can only be performed by an Energized Electrical worker in Hazard Classes X.2 and above (yellow and above).

Mode 2 – Testing and Troubleshoot

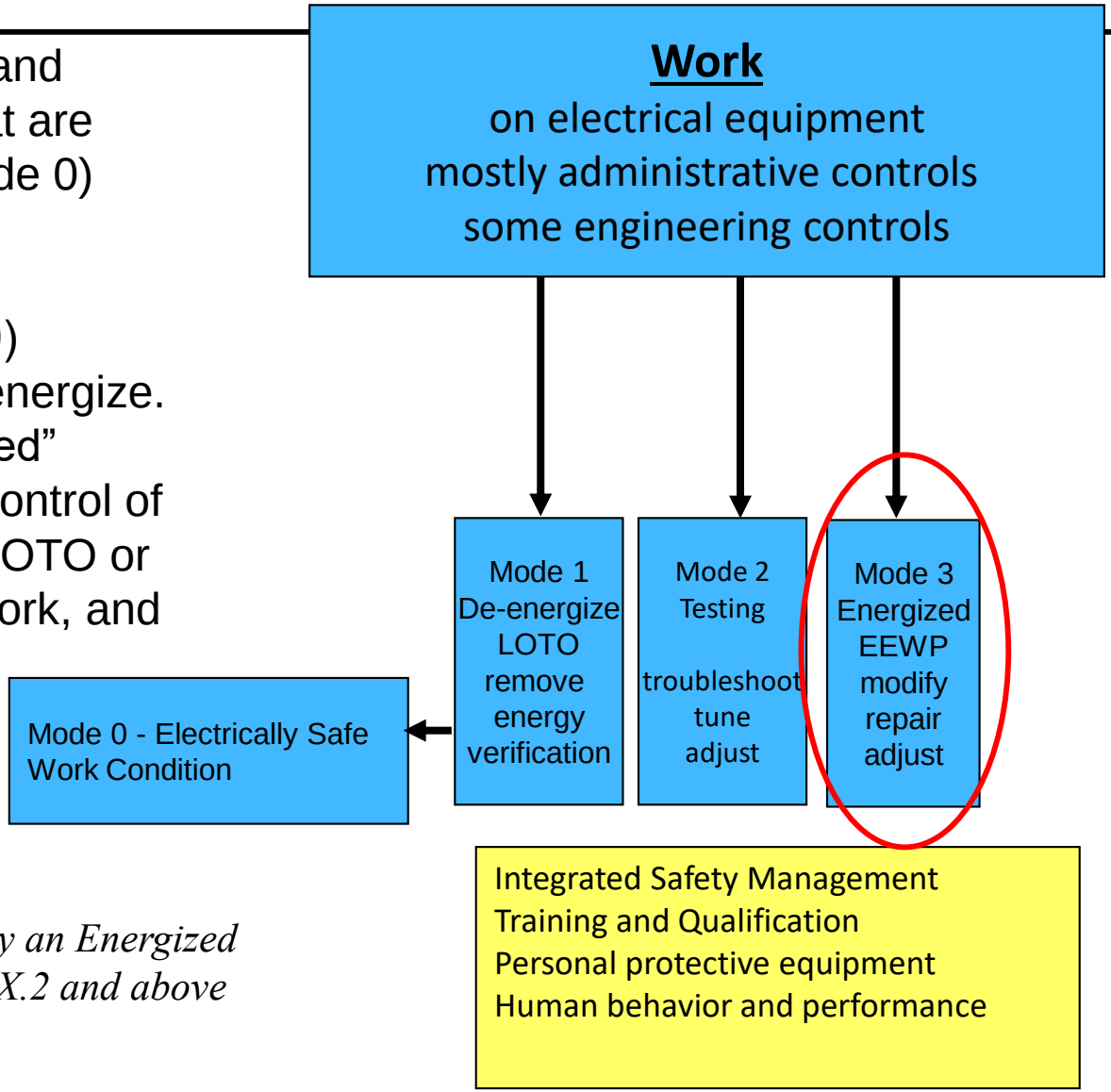
- Conductors are exposed and you are making measurements, testing, or observing.
- The intention is not to deenergize



NOTE: This can only be performed by an Energized Electrical worker in Hazard Classes X.2 and above (yellow and above).

Mode 3 – Energized Electrical Work

- Manipulating conductors and replacing components that are not “electrically safe” (Mode 0)
- Using tools on electrical components that are not “electrically safe” (Mode 0)
- The intention is not to deenergize.
- Working on a “de-energized” circuit (e.g., off), without control of hazardous energy (e.g., LOTO or plug control) IS Mode 3 work, and is NOT allowed.



NOTE: This can only be performed by an Energized Electrical worker in Hazard Classes X.2 and above (yellow and above).

Contrasting the Risk of Modes of Electrical Work

Mode 0 – Electrically Safe Work Condition

- **NO Electrical Risk**

Mode 1 – Establishing an Electrically Safe Work Condition

- **Low to Moderate Electrical Risk**

Mode 2 – Energized Diagnostics and Testing

- **Moderate Electrical Risk**

Mode 3 – Energized Work Requiring an EEWP

- **High Electrical Risk**

Putting Risk and Hazard Assessment Together

- First, from the Model Electrical Safety Program, in HDBK-1092 and the LANL Program – Hazard Assessment and categorization
- Second, Real Time Risk Assessment to ensure work execution is evaluated at the beginning, when conditions change and at the end for LL

Others factors influencing Likelihood

- **Risk Assessment considers many factors**
  - What other conditions could increase the likelihood of an occurrence?
    - Condition of Equipment (unmaintained, damaged, incorrectly installed)
    - Condition of Environment (outdoors, inadequate clearance, clutter)
    - Condition of Work and Worker (time pressure

A Complete Hazard Analysis Process for R&D

- **Determine the waveform of the electrical energy**
  - 60 Hz, other AC, DC, RF, pulsed
- **Determine the source**
  - facility power, DC power supply, capacitor, battery, RF, pulsed source
- **Determine the parameters**
  - voltage, current, power, energy, frequency
- **Determine the need for specific analyses**
  - shock boundaries
  - arc flash boundary
  - arc blast (acoustic, mechanical, electromagnetic, optical)
  - thermal burn
  - rf shock and burn
  - chemical and other secondary hazards

Standard Risk Matrix

Standard Risk Matrix

Severity	Frequent usual occurrence *to* likely occurrence, reasonably expected	Probable likely occurrence *to* irregular occurrence, infrequent	Occasional irregular occurrence, infrequent *to* slight chance of occurrence	Improbable slight chance of occurrence, *to* highly unlikely occurrence	Remote highly unlikely occurrence, *to* extremely unlikely occurrence
	Likelihood of Occurrence				
Catastrophic death, severe injury/ occupational illness, severe environmental harm or liability, or severe property damage	High	High	High	Moderate	Moderate
Critical major injury/ chronic impairment or occupational illness, major environmental harm or liability, or major property damage	High	High	Moderate	Moderate	Low
Moderate minor injury/ temporary impairment or occupational illness, minor environmental harm or liability, or minor property damage	High	Moderate	Moderate	Low	Low
Negligible less-than-minor injury or occupational illness, less-than-minor environmental harm or liability, or less-than-minor property damage	Moderate	Low	Low	Low	Low

Applying Risk concepts to Electrical Work

Risk Matrix For Electrical Work

Severity	Frequent	Probable **MODE 3**	Occasional **MODE 2**	Improbable **MODE 1 & Equipment Operation**	Remote
			Likelihood of Occurrence		
Catastrophic **Class X.4 & X.5**	High	High	High	Moderate	Moderate
Critical **Class X.3**	High	High	Moderate	Moderate	Low
Moderate **Class X.2**	High	Moderate	Moderate	Low	Low
Negligible **Class X.0 & X.1**	Moderate	Low	Low	Low	Low

Human Performance Improvement

- **DOE-HDBK-1028-2009, Human Performance Improvement Handbook**
  - Volume 1: Concepts and Principles
  - Volume 2: Human Performance Tools For Individuals, Work Teams and Management
- **EFCOG ISM & QA, Human Performance Task Group**

Process for Risk Assessment

- **Choose Risk-Based tasks to be done (include Modes)**
- **Perform hazard analysis on all hazards to be encountered**
- **Analyze additional risks (equipment, environmental, etc.)**
- **Perform any individual risk assessments (e.g., thermal, shock, arc flash, etc.)**
- **Use control tables to determine controls**
  - Uses Modes, hazard classes and additional risk factors
- **Prepare Work control package (IWD or DOP)**
- **DURING WORK – real time risk assessment**

Perform the work using “Real Time Risk Assessment”

- **An important concept that is emphasized in Risk Assessment is:**
  - Continue Real-Time Reevaluation of Risk Assessment & Control Measures during work
    - “Real-Time” Risk Assessment
      - As the work is progressing, the worker must take the time to stop and re-evaluate those factors that could increase the likelihood of occurrence
  - Has the condition of the equipment changed?
  - Has the condition of the environment changed?
  - Has the condition of the work and/or worker changed?

Process to Develop Work Controls

Work

1 - Scope of Work

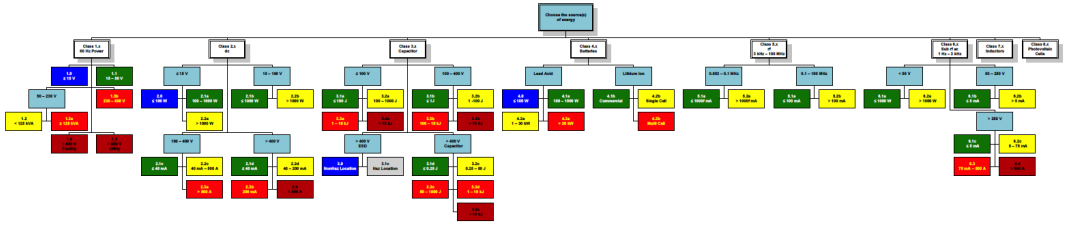
Mode 0

Mode 1

Mode 2

Mode 3

2 - Analyze Hazards

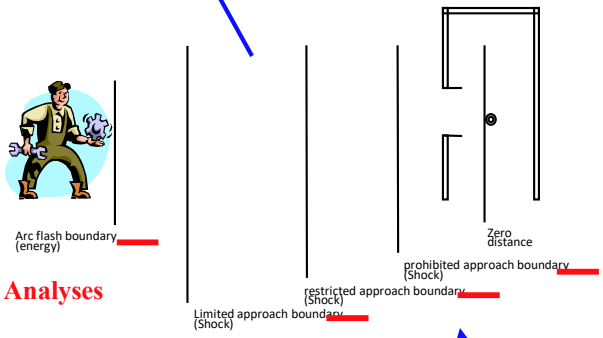


3 - Develop Controls

3a - Choose Controls

3c - Choose PPE and Tools

3b - Shock and Flash Analyses



		3a 1	3a 2	3a 3	3a 4
Class	Mode	Qualified Worker(s)	Training	Work Control	PPE
2.0	ALL	Alone	None	None	None
2.1ALL	ALL	Alone	Non-Energized	None	None
2.2a	0	Alone	Non-Energized and LOTO	None	None
	1	Alone	Energized	IWD	Shock Hazard Analysis
	2	Two person	Energized	IWD	Shock Hazard Analysis
	3	Two person	Energized	IWD	Shock Hazard Analysis
	4[2]	Safety Watch	Energized	IWD, EEWP	Shock Hazard Analysis
2.2b	0	Alone	Non-Energized and LOTO	None	None
	1	Alone	Energized	IWD	Shock Hazard Analysis
	2	Two person	Energized	IWD	Shock Hazard Analysis
	3	Two person	Energized	IWD	Shock Hazard Analysis
	4[2]	Safety Watch	Energized	IWD, EEWP	Shock Hazard Analysis
2.2c	0	Alone	Non-Energized and LOTO	None	None
	1	Alone	Energized	IWD	Shock Hazard Analysis
	2	Two person	Energized	IWD	Shock Hazard Analysis
	3	Two person	Energized	IWD	Shock Hazard Analysis
	4[2]	Safety Watch	Energized	IWD, EEWP	Shock Hazard Analysis
2.2d	0	Alone	Non-Energized and LOTO	None	None
	1	Alone	Energized	IWD	Shock Hazard Analysis
	2	Two person	Energized	IWD	Shock Hazard Analysis
	3	Two person	Energized	IWD	Shock Hazard Analysis
	4[2]	Safety Watch	Energized	IWD, EEWP	Shock Hazard Analysis
2.3	0	Alone	Non-Energized and LOTO	None	None
	1	Two person	Energized	IWD	Shock Hazard Analysis
	2[3]	Safety Watch	Energized	IWD	Shock Hazard Analysis
	3	Safety Watch	Energized	IWD	Shock Hazard Analysis
	4[2]	Safety Watch	Energized	IWD, EEWP	Shock Hazard Analysis
2.4[1]	0	Alone	Non-Energized and LOTO	None	None
	1	Safety Watch	Energized	IWD	Shock Hazard Analysis and Flash Hazard Analysis
	2[2]	Safety Watch	Energized	IWD	Shock Hazard Analysis and Flash Hazard Analysis
	3	Safety Watch	Energized	IWD	Shock Hazard Analysis and Flash Hazard Analysis
	4[2]	Safety Watch	Energized	IWD, EEWP	Shock Hazard Analysis and Flash Hazard Analysis

Element 4 - Electrical Hazard Classification

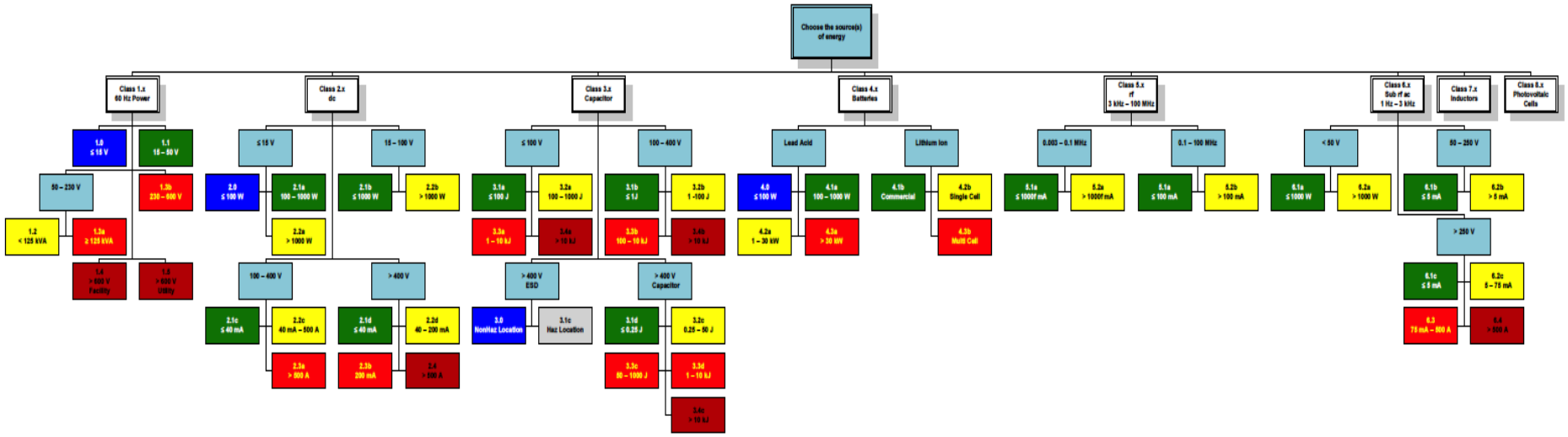
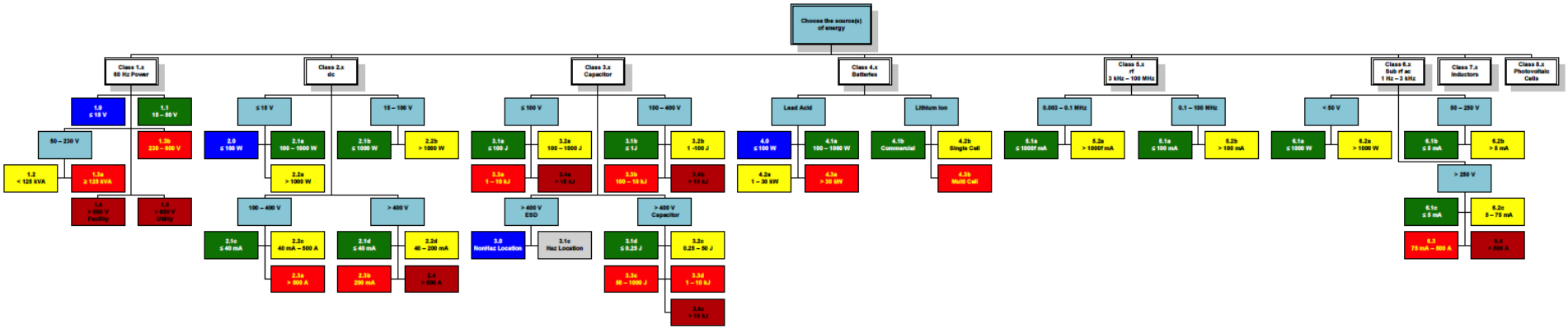


Chart was updated to the 2013 DOE Electrical Safety Handbook

Electrical Hazard Classification Organizational Table

1.x 2.x 3.x 4.x 5.x 6.x



60 Hz DC capacitors batteries RF sub RF

7.x – inductors, 8.x – solar voltaic power

hazards - covers ALL electrical hazards

History of Electrical Hazard Classification

- **1960s - 1990s - Hazard classification focused on 60 Hz hazards. The 50 V rule and the 5 mA rule evolved for safety management (e.g., GFCI)**
- **1990s - The DOE Electrical Safety Handbook added:**
  - capacitor hazards (10 J rule)
  - high current hazards (10 A rule)
  - high voltage/low current not a hazard
- **2000s - R&D electrical hazard classification refined**

Recent Electrical Hazard Classification

- During 2005 - 2007 the most recent electrical hazard classification systems covering DC, capacitors, batteries, and RF were developed.
- These methods are not yet in national codes, but added to the 2013 DOE Electrical Safety Handbook.
- Many elements added to 2018 NFPA 70E
- Sites with R&D should be using the most recent methods

Unlisted Electrical Equipment Approval

- Each site that has unlisted electrical equipment (almost always true in R&D) must have a ESP that includes a process for the AHJ to approve unlisted electrical equipment for use at that site.

Unlisted Electrical Equipment Approval Drivers

- **National requirements**
  - OSHA - 29 CFR 1910-303(a) and (b)
  - NEC Article 110-2 and 110-3
  - NFPA 70E
- **DOE recommendations**
  - DOE Electrical Safety Manual, Appendix C

DOE Electrical Safety Handbook

- **2.5 All electrical equipment, components, and conductors shall be approved for their intended use.**
- **If any electrical system component is of a kind that any Nationally Recognized Testing Laboratory (NRTL) accepts, certifies, lists, or labels, then only NRTL accepted, certified, listed, or labeled components can be used. A nonlisted, nonlabeled, noncertified component may be used if it is a kind that no NRTL covers, and then it shall be tested or inspected by the local authority responsible for enforcing the Code. For example, this would apply to custom-made equipment. The custom-made equipment should be built in accordance with a design approved by the AHJ.**

(6) - Human Performance

Will discuss some,

Also for information

Special Topics in Human Performance

1) Leadership
2) Mixed Crews
3) Hidden Hazards
4) Scope of Work
5) Look Alike Equipment
6) Worker Fatigue
7) Human Error
8) Stop/Pause Work

ASK yourself before touching

- **Before touching an electrical circuit with your hands or tools:**
  - Is MY lock in place? Or do I have control of the plug?
  - Did I perform a zero voltage (with a meter) or zero energy (with a ground stick) test? Or observe someone else perform it?
  - Can there be any other electrical source to this circuit?
  - Is it possible that the configuration has changed since I applied my lock, or unplugged the circuit.
  - Is there any other electrical source (other circuit, battery, capacitor) in this enclosure, rack, or nearby; that could sneak into my work?

How to avoid the “wrong path” in decisions

- Requirements change! If you are unsure what are current requirements, then check!
- If you find yourself suddenly performing work that seems unfamiliar, or that you might not have done before, PAUSE, review your Electrical Worker Qualification Form and the requirements.
- ALWAYS ask yourself, do I need an IWD to do this?
- Be very careful using the term “scoping work”

Element 8 - Assessment

Requirement

- **Each site must have a process for the regular assessment and improvement of the Electrical Safety Program. Components of an assessment could include:**
  - regular inspection of facilities and laboratories for code compliance, listed/approved equipment
  - review of qualification and training of workers
  - analysis of electrical incidents including root causes

Order 226.1B Implementation of DOE Oversight Policy

- **CAS program concepts**
  - Contractor must establish an assurance system that…provides evidence to assure....work is being performed safety, securely and in compliance with all requirements, risks are being identified and managed, and systems of control are effective...