1998 DOE ELECTRICAL SAFETY COMMITTEE

Electrical Safety Steering Committee
Monday, June 22

Introduction

At the beginning of the meeting, a brief introduction was held, and people in attendance were asked to introduce themselves. It was noted that the electrical community had lost three people during the past few years--Dale Algrim who passed away just before the annual meeting; Marty Nee who passed away this year; and Jim Garrett who passed away last year. Larry Perkins told the attendees that approximately 75 people attended last year's meeting in Pigeon Forge and that more than 120 people were expected at this year's meeting. The topics from the 1997 annual meeting were reviewed as follows: Approval of Non Listed & Labeled Equipment (Hugh Bundy), ASTM Update & Special Topics (Doug Lovette), Bonneville Accident (Bill Marsh), Electrical Trauma Research (University of Chicago), (Dr. Mary Capelli-Schellpfeffer & Dr. Raphael C. Lee), Electrical Utility (Ed Whaley), Electrical Survey (Jim Craven), Idaho Electrical Accident (J. Jacobson/Wayne Rivers), Grounding of Crane Rails (Arlie Jenkins), Qualifications of Electrical Workers (Del Bluhm), R&D Electrical Work (Ishwar Garg), Special Topics (Doug Lovette), Underground Locating Technology (Jerry Phillips), Electrical Safety Handbook Status (Larry Perkins).

Meeting June 23 - 25 Agenda

The topics to be discussed at this year's meeting were discussed and the agenda follows:

ELECTRICAL SAFETY MEETING
AGENDA

Monday - June 22	**1:00 - 4:00**	**Steering Committee Meeting (Larry Perkins/Pat Tran)**
Tuesday - June 23	**7:30 - 8:00**	**Registration (Janice Nelson)**
	8:00 - 8:15	**Welcome (Pat Tran)**
	8:15 - 8:45	**Electrical Statistics (Jim Craven)**
	8:45 - 9:45	**1000 Volt Insulated Tools (Don Benton)**
	9:45 -10:00	**Break**
	10:00 - 11:00	**Electroshield, PVC, Rubber Blankets (Ben Surbelo)**
	11:00 - 11:30	**FermiLab Accident (Craig Schumann and Rafael Coll)**
	11:30 - 12:30	**Lunch**

	12:30 - 5:00	**99 NEC Code Changes (James Stallcup)**
Wednesday - June 24	**8:00 - 12:00**	**NESC (James Stallcup)**
	12:00 - 1:00	**Lunch**
	1:00 - 1:30	**Extension and Flexible Cords (Chuck Monasmith)**
	1:30 - 2:30	**Electrical Meter Safety (Kevin Kaufman)**
	2:30 - 3:00	**WAPA Electrical Accident (Troy Henry)**
	3:00 - 3:15	**Break**
	3:15 - 4:15	**ASTM Update (Doug Lovette)**
	4:15 - 4:40	**1000 Volt Tools and Testing (Dave Parrella)**
	4:40 - 5:00	**OSHA Update (Jim Craven)**
Thursday - June 25	**8:00 - 12:00**	**Grounding (Mark Regan)**
	12:00 - 1:00	**Lunch**
	1:00 - 1:30	**Load Breaking Receptacles (Ron Hayduk)**
	1:30 - 2:30	**Lightning Protection (Doug Lovette)**
	2:30 - 2:45	**Break**
	2:45 - 3:15	**Hazards of R&D Power Sources (Lloyd Gordon)**
	3:15 - 3:45	**Training the R&D Electrical Worker (Lloyd Gordon)**
	3:45 - 4:15	**Electrical Safety Handbook Process (Janice Nelson)**
	4:15 - 5:00	**Future and Closure (Larry Perkins/Pat Tran)**

What has been accomplished over the last year.

The items accomplished during the past year were discussed. This included surveys on: AHJ, On or Near, Qualified Person, and Line Hose Inspection, Testing and Use. The recent publication of the Electrical Safety Handbook was also discussed, and key contributors to the effort were recognized. Larry explained that 180 CDs containing the document in PDF format had been distributed to people in the complex. The forthcoming DOE Electrical Safety homepage was mentioned as a method for sharing information in the near future.

Future Surveys

A request was made for people to submit topics that they would like to see in surveys during the upcoming year.

Commitments and Assignments

Appendix E of the handbook was discussed. Chairpersons for the possible future chapters were selected and are as follows:

Underground Utilities Detection Equipment During Excavation- Chairman - Larry Perkins
Arc Flash Protection - Chairman - Bill Marsh
Proper Use of Electrical Test Equipment - Chairman - Doug Lovette
Portable and Vehicle-Mounted Generators - Chairman -Chuck Monasmith
Electrical Hazards During Decontamination & Decommissioning (D&D) Activities - Chairman - Orville Paul
Electrical Hazards During Welding Activities - Chairman - Bryan Drennan

Meeting with Team Leads and Time Frames

The proposed time frames for the possible new chapters were established. It was agreed that a rough draft for each possible new chapter would be prepared by October 1998.

The following people attended the Steering Committee meeting:

Paul Goins, John MacMullin, James Delong, Keith Schuh, Jack George, Chuck Monasmith, Ed Henderson, Ken Schriner, Richard Wheeler, Doug Lovette, James Craven, Janice Nelson, Bryan Drennan, Orville Paul, John Scott, Terry Monahan, Wayne Rivers, Larry Moore, Al Roberson, Keith Gershon, Rafael Coll, Terry Fogle, Merl Haldeman, Patrick Tran, Peter Burggraff, and Larry Perkins.

ELECTRICAL SAFETY COMMITTEE MEETING

Tuesday, June 23

Registration (Janice Nelson)

The registration for the Electrical Safety Meeting was held. Approximately 125 people attended the meeting.

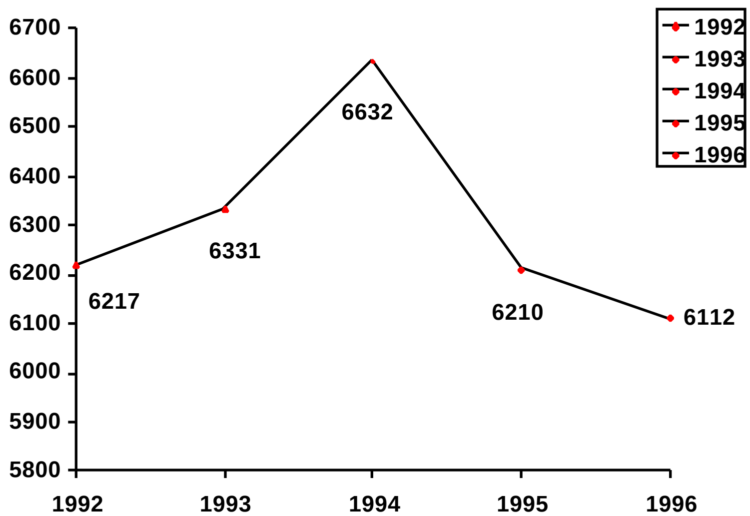
Welcome (Pat Tran)

Pat Tran from EH-51 welcomed the participants to the annual meeting. The attendees introduced themselves and identified the locations they represented. It was also noted that the electrical community had lost three people during the past few years--Dale Algrim who passed away the week of the annual meeting; Marty Nee who passed away this year; and Jim Garrett who passed away last year. The DOE community will miss these people and their contributions to electrical safety.

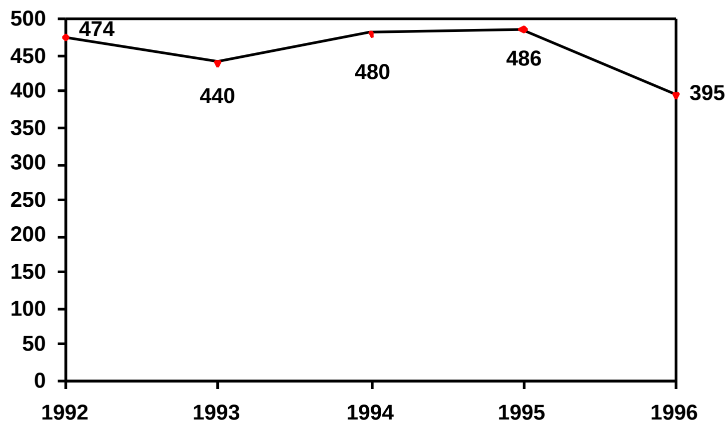
Electrical Statistics (Jim Craven)

Jim discussed the Bureau Labor Statistics related to electrical incidents. The good news was that the numbers of fatalities are on the decrease (both general fatalities and electrical fatalities), but the number of occurrences for DOE are on the increase.

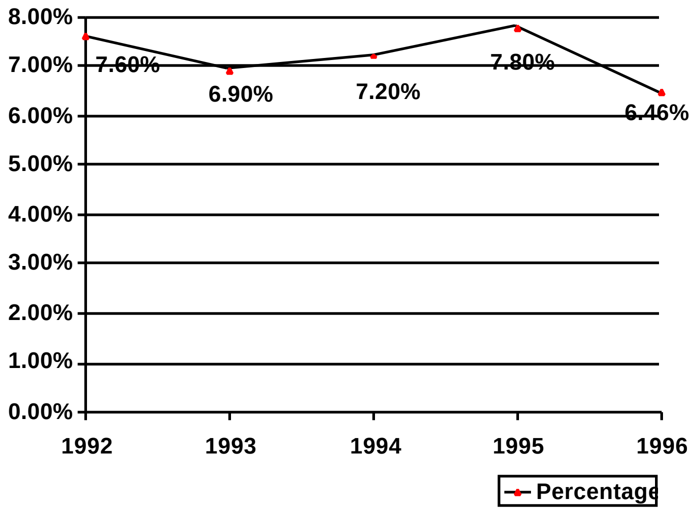
Total Fatilities By Year



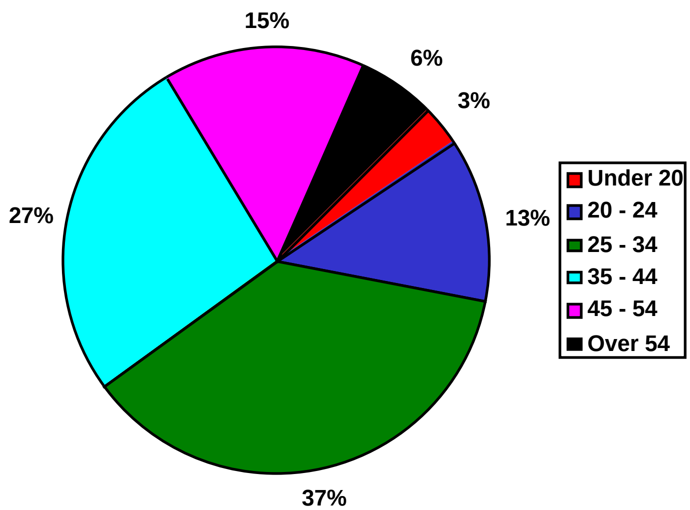
Electrocution By Year



Percent of Total Fatilities By Year



Electrocution By Age



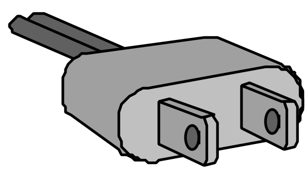
1000 Volt Insulated Tools (Don Benton)

Don gave a brief history of the Klien Tool Company and discussed their recent recall of their 1000-volt tools. He also explained why the recall took place and the impact on the company and the industry as a whole. He also discussed the future of 1000-volt tools and what Klein Tools expected in the near- and long-term.

<u>Electroshield, PVC, Rubber Blankets (Ben Surbelo)</u>
Ben discussed electrical blankets--the purpose and need for these products. He also discussed the progress that ASTM was making in the development of a standard for this type of product. Samples of the product and test results were also supplied. He then answered questions about some of the uses and how the products were designed to protect the user. People interested in learning more about these products can access the company's homepage at "www.aldan.com."

<u>FermiLab Accident (Craig Schumann)</u>
Craig discussed the FermiLab accident. Raphael Coll discussed the progress that the Lab has made since the accident.

DOE Electrical Safety Committee Meeting
Las Vegas, Nevada
June 23, 1998



Craig Schumann
DOE-Argonne Group Office
630-252-9176

TOPIC: Electrical Accident at Fermilab

<u>Background</u>

- Two subcontractor electricians were attempting to provide temporary power for lighting and heat.
- They were removing the upper bus cover of a motor control center that shields the line side connections in the panel.
- The cover was being removed to connect the neutral line associated with the temporary power connection.

- While removing the cover, it contacted the “C” phase of the bus bar causing a short to ground and a subsequent arc blast.

APPLICABLE OSHA REGULATIONS

- Fermilab is under the work-smart standards.
- By contract, have incorporated OSHA regulations
- The Board reviewed the applicable standards
- Determined that due to the limited duration of the wiring and that it would be removed immediately upon completion of the work
- Then the 1910 standards were applicable (i.e. safety-related work practices found in 1910.331-335)
- Failure to lock-out the system
- Failure to have a qualified person verify that the system was deenergized
- A qualified person as defined by 1910.399 is “One familiar with construction and operation of the equipment and the hazards involved.”
- Neither electrician had ever removed this type of cover before

CONSTRUCTION REGULATIONS

- 1926.416 and 417 Standards (dated July 1, 1996 back to 1993) spell out lockout procedures
- 1926.416 and 417 Standards (dated July 1, 1997) do not spell out procedures
- See Federal Register dated August 12, 1996

NOTE: See Army Corps of Engineers lockout regulations

Root causes:

- Electricians did not understand that there were energized components behind the bus bar cover

- Lack of ISM for electrical work

Contributing causes:

- Procedures did not require the use of electrical engineering drawings or prints
- Due to the size of the job, this was treated routine and informal
- Inadequate training (including no selection criteria)
- No clear understanding of roles and responsibilities
- No review of the electrical safety program was done

MAY 1998 EDITION OF EC & M

- Lack of alertness
- Preoccupation
- Reckless or careless attitude
- Personal factors such as poor coordination and physical disabilities
- Lack of training
- Inadequate techniques
- Lack of experience

"You don't warn if you can guard. You don't guard if you can eliminate the exposure."

FermiLab's Progress Since The Accident (Rafael Coll)

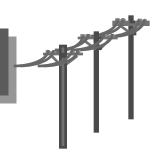
Construction Safety Program

- Complete change in the way Fermilab conducts business with subcontractors.

Construction Safety Program

- Six Step Process:
  - 4 Contractor List
  - 4 Pre-qualification
  - 4 Evaluation
  - 4 Oversight
  - 4 Disciplinary Program
  - 4 Post-contract evaluation

Electrical Safety



- Work on distribution systems tightened
  - 4 work on electrical systems requires a permit.
  - 4 work on energized systems requires a permit, JHA and an on-site briefing.
  - 4 Only journeyman electricians (IEC).
  - 4 line managers to monitor.

Electrical Safety

- Electrical equipment markings and ID
- ID and markings for dual powered equipment.
- Preventive Maintenance

Electrical Safety

Protocol for designating qualified electrical workers.

- Development of a training track
  - 4 academic requirements (general)
  - 4 specific requirements (equipment)
  - 4 Practical factors (observations)

99 NEC Code Changes (James Stallcup)

James discussed the top 100 changes in the 1999 NEC Code and how these changes would affect DOE and its contractors. James provided a great deal of insight into the changes for the upcoming 99 NEC.

Wednesday June 24

NESC (James Stallcup)

James explained that the NESC references many other documents as guidance, such as IEEE. He also explained how 29 CFR 1910.269 ties with the NEC.

<u>Extension and Flexible Cords (Chuck Monasmith)</u>
Chuck discussed extension cords, flexible cords, relocatable power taps, and transient surge suppressors as they pertain to operations at the Hanford site.

Compliance Guidance for the
Proper Use of Extension Cord Sets, Flexible Cords,
Relocatable Power Taps and Transient Surge Suppressors

Hanford Workplace Electrical Safety Board
June 4, 1998

Introduction

The continuing evolution of the work place and the proliferation of computers on nearly every desk, has created an increasing need for more receptacles and a way to reach longer distances to the existing electrical outlets. As a result of the perception there may be problems associated with the increased use of extension cords, the Hanford Workplace Electrical Safety Board has been requested to review the application of extension cords and multiple tap outlets office environment and to provide a recommendation.

This document provides guidance for the proper application of safety requirements and the actions required for compliance with the appropriate safety requirements regarding the use of extension cords, flexible cords, relocatable power taps, and transient surge suppressors. Note that flexible cords are addressed only in the interest of distinguishing them from extension cords and the appropriate applications for each. It is intended that this document be the definitive applications guideline for the use of these devices on the Hanford Site.

Definitions and Discussion
Extension cords (or cord sets) are defined by Underwriters Laboratories as a length of flexible cord with an attachment plug for connecting to a power source at one end, and a cord connector at the other end for connection to a load. Note that this includes both factory assembled units as well as field constructed assemblies, providing that all components are UL Listed for the environment and the application. **An extension cord is considered to be portable equipment.** Extension cords may be used to extend a receptacle for temporary use. When used in this manner, the cord cannot be secured to the building surfaces, and should be removed when not in use. As portable equipment the NEC does not specifically address the use of extension cords beyond stating allowable ampacities for flexible cords used in the construction of extension cords sets. (Section 240-4 Ex. 3) and specifying GFCI requirements and testing for personnel safety (Section 305-6). NEC/NFPA=s concern with extension cord use relates to the fact that an extension cord is inherently more susceptible to damage and misuse than fixed wiring. NFPA 70E, Part II Chapter 4, paragraph 4-3.3, 29 CFR 1910.334 (a)(2) and the DOE Electrical Safety Handbook all require a daily inspection of extension cord sets. However, these standards also allow extension cord sets used in

extended service, where not exposed to physical damage, to be visually inspected only when relocated. 29 CFR 1910.334(a)(2) also removes the daily inspection requirement not only for extension cords but also for cord and plug connected equipment such as computers and other appliances. Included in this exception are power taps and surge suppressors. Safety requirements for the use of extension cords are found in 29 CFR 1910.334 (a).

It is expected that users of extension cords will use the appropriate cord for the application. For example, an extension cord used outdoors must be rated for outdoor use. This rating is marked on the outer jacket every 12 inches. The attachment plug and cord connector must have waterproof covers if the cord is to be used in a wet location. GFCI protection is not a substitute for the proper cord ends. The user is responsible for determining if the cord is capable of handling the current used by the load. Consulting an electrician is recommended for those users who are not certain ampere rating of the load or the rating of the cord. There is no prohibition on plugging an extension cord into another extension cord (daisy chaining) unless specifically prohibited by the manufacturers instructions. However, the user must also consider the distance needed and select the proper cord length as well as the proper conductor size.

Some applications of extension cords such as routing through doors or windows require additional physical protection for the extension cord to prevent damage to the cord.

Flexible Cord

Article 400 of the National Electrical Code requires that flexible cords and cables and their associated fittings be suitable for the conditions of use and location and it allows that flexible cords and cables may be used for the connection of portable lamps or appliances. The Code states specifically that flexible cords and cables shall not be used as a substitute for fixed wiring of a structure, shall not be run through holes in the structure, attached to building surfaces, nor concealed behind building walls, ceilings, or floors.

Flexible cords and cables, if used for connection of portable lamps or appliances, connection of stationary equipment to facilitate their frequent interchange, or appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair are required to have attachment plugs. In these instances there is also a requirement in both 29 CFR 1910.305(g)(ii) and NEC Article 400-8 for these attachment plugs to be supplied from an approved receptacle outlet. The intent of this requirement is to prevent direct connection of the flexible cord into a power source. Requiring connection to an approved outlet permits the utilization equipment to be disconnected at the outlet.

Applications

It is important to distinguish between Aextension cord sets@ and flexible cord purchased in bulk without fittings, and sometimes solidly connected to its supply point rather than plugged into a receptacle. An extension cord is considered to be portable equipment. While, flexible cord is considered to be Awiring@ rather than Aequipment@, must be secured in place and is restricted to very few special uses. Examples of special uses of flexible cord are: temporary wiring; and connection to equipment that may vibrate. Flexible cord installations must meet the requirements of NEC Article 400-7 and 400-8. These NEC requirements are restated in 29 CFR 1910.305(g) and 29 CFR 1926.405(g).

It is also important to distinguish between temporary wiring and temporary use. Flexible cord is one of the wiring methods allowed for temporary wiring. Extension cords are designed and built to extend a receptacle for temporary use.

The National Electrical Code includes temporary wiring methods in Chapter three AWiring Methods and Materials@. Chapter three, Article 305, Temporary Wiring, covers flexible cords or cable assemblies, these are mentioned as one of several types of conductors permitted. In this use as temporary wiring the flexible cord must be adequately supported and may be left in place for the duration of the situation which justified the temporary wiring. Temporary wiring is secured from a fixed source to fixed outlets.

There is a requirement in both 29 CFR 1910.305(g)(ii) and NEC Article 400-8 for attachment plugs used with flexible cord to be supplied form an approved receptacle outlet. This requirement applies to flexible cords, not to extension cords. The intent of this requirement is to prevent direct connection of the flexible cord into a power source. Requiring connection to an approved outlet allows the cord to be disconnected at the outlet. This interpretation does not prohibit an extension cord from being supplied from an extension cord.

<u>Relocatable Power Taps and Transient Voltage Surge Suppressors (TVSS)</u>

Power taps and surge suppressors are designed to permit supplying multiple loads from a common group of receptacles. The UL Listing of power taps prohibits their use on construction sites or outdoors.

The user is responsible for determining if his application should use a transient surge suppressor. The user should consult manufacturers instructions for the equipment being used to help determine if surge suppression is recommended.

There is no regulation prohibiting supplying power taps or surge suppressors from another power tap or surge suppressors. However, the user must be responsible to assure that circuit or device overloading does not occur

Conclusion

The use of extension cords and multiple outlet power strips can result in heavier circuit loading. Random or chronic circuit breaker tripping is usually a sign of an overloaded circuit. It is the responsibility of the individuals using the circuit to either reduce the loading or request assistance from the building administrator to resolve the problem.

It is the interpretation of the Hanford Workplace Electrical Safety Board that the risks associated with the use of extension cord sets can be reduced if the above guidance as well as the following is implemented:

Adherence to the Safety requirements for flexible cord are found in NEC Article 400-7,400-8, 29 CFR 1910.305(g) and 29 CFR 1926.405(g). These references shall not be used for extension cord sets.

Compliance with UL application requirements should be determined by information in the manufactures= literature and the, Electrical Construction Materials Directory.

- Multiple outlet power strips (relocatable Power Taps) must be UL Listed. These devices should only be used indoors and are not to be used on construction sites. Reference 29 CFR 1910.303 (b)(1)(I). Note that "Power Taps" do not contain surge suppression circuitry.

- Power may be supplied to an extension cord from another extension cord. Plugging an extension cord into an extension cord is not a prohibited practice unless specified by the manufacturer of the extension cord.

- Power taps and transient surge suppressors have the same utilization requirements. Except that only transient surge suppressors should be applied where the user determines surge suppression capabilities are needed. Transient Voltage Surge Suppressors in compliance with UL Standard 1449 should be used when protection from power surges is required for protection of equipment or data. Use of non Listed devices or equipment is a violation of 29 CFR 1910.303(b)(1)(I)

References

- ***National Fire Protection Association (NFPA) 70,*** A***National Electrical Code (NEC)@, 1996 Edition***
- ***National Fire Protection Association (NFPA) 70E, "Electrical Safety Requirements for Employee Workplaces," 1995 Edition***
- ***29 CFR 1910 Subpart S -Electrical***
- ***William S. Watkins, P.E.,*** A***Questions Frequently Asked About Extension Cords,@ Revised 5/17/89***
- ***UL Directory*** A***Electrical Construction Equipment@ - 1997***
- ***29 CFR 1926 Subpart K - Electrical***
- ***DOE-HDBK-1092-98, Electrical Safety Handbook, Department of Energy, 1998***

The following Points of Contact (POC=s) are available to provide answers if there are any questions concerning this document.

BWHC - Ron Kobelski, Bob Gray, DASH - John Henry, DynCorp - Bert Winschell,
FDH - Ralph Butler, Vern Wolff, FDNW - Chuck Monasmith, LMHC - Bill Pollard
PNNL - Bob Gough, Cliff Wynn, WMH - Paul Case, Brad Graf
FDH Craft - Howard Miura, Clyde Saunders, Steve Bolt, Louis Alcala

Enhancing Electrical Safety Through Proper Voltmeter Selection (Kevin Kaufman)

A discussion of electrical meter safety has held. Kevin talked about the most common problems and limitations of each meter type.

TEGAM

ENHANCING ELECTRICAL SAFETY THROUGH PROPER VOLTMETER SELECTION

T. Kevin Kaufman
Product Manager

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TODAY'S MISSION:

- Provide overview of voltmeter types.
- Discuss benefits and limitations of each type.
- Show how proper selection enhances safety.

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VOLTMETER TYPES:

- Solenoid Type Voltage Testers
- Analog Volt-Ohm Meters
- Non-Contact Type Voltage Testers
- Digital Multimeters
- Safety Voltmeters

SOLENOID TYPE TESTERS:

BENEFITS
- **Inexpensive**
- **Simple to Use & Compact**
- **Vibrates when voltage applied.**
- **No false readings caused by induced voltage.**

LIMITATIONS
- **Doesn't measure voltage less than 50V.**
- **Duty cycle 15 seconds.**
- **Requires current to activate.**

ANALOG VOLT-OHM METERS:

BENEFITS

- Accurately measures voltage and resistance.
- Trusted by electricians.
- No false readings caused by induced voltage.

LIMITATIONS

- Current activated.
- Bulky and fragile.
- Expensive to repair.

NON-CONTACT TESTERS:

BENEFITS

- **Determines presence without physical contact.**

LIMITATIONS

- **Limited to specific voltage levels.**
- **AC voltage only.**
- **May not detect voltage below 50V.**

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DIGITAL MULTIMETERS:

BENEFITS

- **Ability to measure many electrical parameters.**
- **High accuracy.**
- **Audible tones.**

LIMITATIONS

- **Complex to Use.**
- **Limited protection due to multi-function.**
- **False reading when induced voltage present.**

SAFETY VOLTMETERS:

BENEFITS

- **Resistive probes eliminate arc flash potential.**
- **Single function and automatic selection.**
- **Acceptable for both testing and measuring.**

LIMITATIONS

- **Voltage only.**

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TESTING DEFICIENCIES RESULT IN ACCIDENTS:

- Wrong test instrument used for the application.
- Test functions have not been selected properly.
- User does know or understand the limitations.
- Appropriate testing not complete prior to touching.

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PRIMARY INDUSTRIAL APPLICATIONS:

- Voltage Testing
- Voltage Measuring
- Resistance Measuring

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WARNING!

PREPARE for SAFETY
when
MEASURING VOLTAGE!

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PREPARE for SUCCESS:

- Inspect the instrument for defects.
- Check instrument on known live voltage.
- Know manufacturer's instrument limitations.
- Wear appropriate personal protective equipment.

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VOLTAGE TESTING & LINE CLEARING APPLICATIONS:

- Most dangerous because line status unknown.
- Electrician should choose safest voltmeter.

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FOR LINE CLEARING APPLICATIONS INSTRUMENTS SHOULD:

- Clearly indicate zero volts on de-energized lines.
- Detect both AC & DC voltage presence.
- Protect to maximum probable voltage level.

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LINE CLEARING FEATURES:

- Single-function…volts only.
- Clear indication of zero volts.
- Resistive probes to eliminate arc potential.
- Tests for AC & DC volts automatically.

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VOLTAGE MEASURING APPLICATIONS:

- Accuracy is key.
- Ability to measure very low & high voltages.
- Quality of service measurements.
- Control voltage measurements & calibrations.

MEASUREMENT INSTRUMENTS SHOULD:

- Have at least 1V resolution.
- No dead bands.

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A WORD ABOUT COMPLIANCE AGENCIES:

- UL, CSA, MSHA, FM
- Industry defacto standards.
- Does not imply safe for all applications.

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SUMMARY:

- Provide overview of voltmeter types.
- Discuss benefits and limitations of each type.
- Show how proper selection enhances safety.

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<u>WAPA Electrical Accident (Troy Henry)</u>

A recent electrical accident at WAPA was discussed. Troy showed a video and supplied copies of the investigation report. He discussed the causes and what could be done to prevent similar accidents.

Items discussed:

1. **Type B Accident Investigation Report of a Electrical Accident which occurred Jan 20, 1998, at Casa Grande Substation South of Phoenix, Ariz.,**
2. **Description of the victim (Apprentice Lineman)**
3. **Showed a video on Casa Grande Substation Accident (approx 17 min.)**
4. **Discussed Chronology of Events, Root Cause and Contributing Causes**
5. **Discussed the Conclusions and Judgments of Need**
6. **Discussed the Corrective Action Plan from the Construction Managers**

The accident occurred Jan. 20, 1998, at the Casa Grande Substation and resulted from the victim being out of the safe work area of the electrical clearance. The victim, an apprentice lineman, had climbed onto the bus structure and was preparing to remove three sections of rigid-bus stub jumpers from the main bus. The victim moved from an area protected by the clearance and personal protective grounds to an area that was not protected in any way. The victim was beginning to work on the main bus when his right foot contacted an energized 12.47 Kv transfer bus. He suffered burns to his left arm, chest, right thigh and right foot.

The official report can be found on the Internet at http://tis-hq.eh.doe.gov:80/web/eh2/acc_investigations2.html

ASTM Update (Doug Lovette)

Doug presented an update on ASTM activities related to electrical safety:

ASTM Update

DOE Electrical Safety Conference

June 1998 - Las Vegas, Nevada

OSHA Update

Proposed Rule for Subpart V - June 1998

Meetings with EEI, IBEW, REA, NECA

Will be changes from draft provided in 1997 Conference

Thermal protection for employee - now no ignition or melting of apparel

Appendix C - Compliance guidelines for apparel - IEEE Draft
There are plans to:

Add Class OO gloves to 29CFR 1910.137

Change 1926.951 to match 1910.137

Not add requirements in Subpart V for line clearing tree trimmers

ASTM F1506 and Rainwear

F1506 has been modified - not for coated fabrics

Failed to include reference to PS 57 and PS 58

New Rainwear Standard - waiting for approval by ASTM Board

Importance of ATPV, HAF, E(btas)

PS 57 and PS 58

Mannequin (ignition) and Panel Tests

Updated to include changes needed as determined by testers

Failed to become permanent standards - 5 negatives

Task Team will address and send out for sub/main committee vote

Faceshields/Safety Glasses

ANSI Z87 Committee - Study UV protection

Requested ASTM F18 to look at doing IR studies

Dyes can be added for IR protection - reduces visible light - Motion to appoint Task Team defeated

Incident energy less than 5 cal/cm2, HAF is approximately 20%

Incident energy of 20-30 cal/cm2, HAF of 65-70% probably due to charring

Dielectric Overshoes

Discussion on need of standard for "Electricians Boots"

Most users see these shoes as secondary protection

There is no in-service test method for dielectric overshoes

Misunderstanding about purpose of these overshoes

They protect against step potential

The sole has a dielectric rating, not entire overshoe

Task Team set up to review need for:

In-service test method for dielectric shoes

Feasibility of fully dielectric shoe

Review F1116 and F1117 language on step potential

Non-PVC Sheeting

Draft standard under development by Task Team

Material from Alden Rubber is widely used as matting per ASTM Standard

Also being used as protective sheeting but no standard exists

Already a standard on PVC (clear) sheeting made by Safety Line

Live Line Tools

Two new standards were approved

F1825-97, "Standard Specification for Fixed Length Clampstick Live Line Tools"
F1826-97, "Standard Specification for Telescoping Live Line Tools"

Task team will look at adding telescoping measuring sticks to reply to a negative response.

Task team working on draft of document to address:
manufacture and use of portable live line tool testers
user electrical integrity acceptance test on new live line tools
feasibility of adding a pictorial section for fiberglass visual inspection

Discussed wet versus dry testing of fiberglass
tool that has lost its gloss may not pass the wet test, some tools that passed the dry test, failed the wet test application of silicon to tool before testing may mask problems

Gloves and Sleeves

Reviewing both D120 and F496, standards on gloves and sleeves

Task group will look at adding a DC maximum use voltage, only AC maximum use voltage now

There is some conflicting language in D120 and some are questioning the basic engineering data that the test voltages and flashover distances were derived

Line Hose

Reviewed data from 35 companies covering 150,000 line hose

Average visual/electrical failure rate is approximately 2%

Task Team looking at need to require an electrical in-service test for line hose

Protective Grounds

Draft was sent out for sub-committee ballot on the testing of protective ground clusters

Covers the use of portable protective ground testers

Twelve negatives were extensive

The negatives were covered and it was voted to withdraw the ballot

1000-Volt Tools and Testing (Dave Parella)

Sonny Trenti introduced Dave Parella, who discussed discrepancies related to 1000-volt tools. Dave discussed recent tests that he had conducted on these tools and the problems he identified.

OSHA Update (Jim Craven)

A discussion of the proposed new OSHA rule was held and how this construction standard would change other electrical standards.

OSHA UPDATE

PROPOSED RULE FOR SUBPART V - 1998

- **OVER 25 YEARS OLD**
  - **DRAFT RULE PUBLISHED JANUARY 31, 1994**
  - **DRAFT FEBURARY 8, 1996**
    - **OSHA HAD A MEETING WITH EEI (EDISON ELECTRIC INSTITUTE), IBEW (INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS), AND UWOA (UTILITY WORKERS UNION OF AMERICA)TO DISCUSS RULE**
  - **ESTIMATED PROPOSED RULE BY JUNE OF 1999**
- **CHANGES IN RULE**
  - **NEW SECTION 1926.97 - COUNTER PART TO 1910.137**
  - **UPDATE TO CURRENT NESC & ASTM**
  - **REVISE 1910.136 - REMOVE REQUIREMENT FOR ELECTRICAL PROTECTIVE FOOTWEAR**
- **CHANGES IN RULE**
  - **REVISE 1910.137**
    - **INCLUDE CLASS "OO" GLOVES**
      - **ASTM D120-95 & F496-96 REVISIONS RECOGNIZE CLASS "OO" GLOVES FOR A MAXIMUM USE OF 500 VOLTS BUT OSHA IN 1910.137 DOES NOT.**
      - **IN THE INTERIUM OSHA POLICY ALLOWS EMPLOYERS TO USE CLASS "OO" GLOVES AS A DE MINIMIS VIOLATION. NO CITATIONS OR PENALTIES WILL BE ISSUED**

- **POLICY STATES YOU CAN FOLLOW A NEWER EDITION OF A NATIONAL CONSENSUS STANDARD USED AS THE BASIS OF THE OSHA STANDARD AND IF THAT CONSENSUS STANDARD PROVIDES A BETTER PROTECTION FOR EMPLOYEES.**

- **CHANGES IN RULE**
  - **REVISE 1910.269**
    - **CPL 2-1.18 CHANGED TO CPL 2-1.18A**
    - **TRAINING - REDUCE PAPERWORK**
    - **FALL PROTECTION - UPDATE REQUIREMENTS FOR WORKING POSITIONING EQUIPMENT**
    - **WORK ON OR NEAR - ENSURE THAT RUBBER INSULATING EQUIPMENT IS USED**
    - **MINIMUM APPROACH DISTANCE - MEET NESC**

- **CHANGES IN RULE**
    - **GROUNDING - CLARIFY APPLICATION OF RULES FOR 600 VOLTS AND LESS**
    - **WORK ON UNDERGROUND INSTALLATIONS - APPLY RULES TO VAULTS AND MANHOLES TO PROTECT EMPLOYEES**
    - **UPDATE NOTES REFERRING TO NESC TO THE LASTEST EDITION OF THE CODES**

Thursday June 25

Grounding (Mark Regan)

Because grounding is one of the most misunderstood requirements, this presentation was very useful. The topics that was discussed are as follows: To Ground or Not to Ground, Grounding Electrical Systems, Grounding Electrical Services, Service and Main Bonding Jumpers, Grounding Electrodes, Grounding Electrode Conductors, Bonding Enclosures and Equipment, Equipment Grounding Conductors, Enclosure and Equipment Grounding, Clearing Ground Faults, and Short Circuits, Grounding Separately Derived Systems, Grounding at More Than One Building, Ground-Fault Circuit-Interrupters, Equipment Ground-Fault Protection Systems, Special Location Grounding and Bonding, and Over 600 Volt Systems.

Load Breaking Receptacles (Ron Hayduk)

Ron talked about an incident with load-breaking welding receptacles that occurred at Rocky Flats, as a result of incorrect wiring. He explained the actions they have taken to prevent this from reoccurring.

Lightning Protection (Doug Lovette)
The effects of lightning and the codes that apply were discussed.

Lightning Protection of Commercial and Industrial Facilities

Presented to the DOE Electrical Safety Conference

June 1998 - Las Vegas, Nevada

Lightning Deaths

National Lightning Safety Institute

- **Under trees - 10%**
- **Open water, golf courses, tractors, etc. - 52%**
- **Inside home (telephones, appliances, bath tubs, water faucets) - 38%**

Lightning is only one source of surges

Utility switching and faults

Florida Power study of commercial/industrial facility

- **15% of surges from lightning**
- **5 % from utility grid switching**
- **80% generated inside of facility**

July 1993 IEEE paper

- **Average current due to lightning at facility service entrance - 35,000 amps**
- **2% probability of 100,000 amps**

LPI 175 - Lightning Protection Institute - Installation Standard

UL 96 - Lightning Protection Components

UL 96A - Installation Requirements for Lightning Protection Systems

UL Master Label Service

Installers listed in the Electrical Construction Material Directory

Use materials subject to factory inspection service and bears the UL Mark

Subject to field inspection covering the installation

NFPA 780 - Standard for the Installation of Lightning Protection Systems

Chapter 3 - Protection for Ordinary Structures. Discusses the physical components and installation of lightning protection systems

Material requirements for the air terminals and main and bonding conductors are different for structures </= 75 feet and > 75 feet.

Discusses zones of protection based on the height of the building and the roof pitch.

Discusses different methods of grounding around the facility based on the soil type.

Use of structural steel as the main conductor of the lightning protection system

Bonding of isolated metallic bodies, protection against flashover

Chapter 4 - Protection for Miscellaneous structures and Special Occupancies

Covers masts, flagpoles, metal towers and tanks, air inflated structures, and concrete tanks and silos.

Chapter 5 - Protection for Heavy Duty Stacks

Heavy duty stack is on > 75 feet in height and flue cross-sectional area is 500 square inches.

Material, installation, and bonding requirements.

Chapter 6 - Protection of Structures Containing Flammable Vapors, Flammable Gases, or Liquids that Can Give Off Flammable Vapors

Adds requirements above those in Chapters 3 - 5 for the special protective measures of these structures.

Discusses the use of rods, masts, and overhead ground wires, zones of protection , and sideflashes

Chapter 7 - Protection for Watercraft

Same information as covered in Chapter 7 of NFPA 302, Fire Protection Standard for Pleasure and Commercial Motor Craft.

Appendix A - Explanatory Material

Appendix B - Inspection and Maintenance of Lightning Protection Systems

Appendix C - Guide for Personal Safety from Lightning

Appendix D - Protection for Livestock in Fields

Appendix E - Protection for Picnic Grounds, Playgrounds, Ball Parks, and Other Open Spaces

Appendix F - Protection for Trees

Appendix G - Protection for Parked Aircraft

Appendix H - Risk Assessment Guide

> **Referenced in the DOE Explosives Safety Manual**
>
> **Assists in the analysis of various criteria to determine the risk of loss due to lightning**

Appendix I - Ground Measurement Techniques

Appendix J - Explanation of Bonding Principles

Appendix K - Protection of Structures Housing Explosive Materials

> **DOD 6055.9STD - Ammunition and Explosive Safety Standards, Chapter 7.**
>
> **NAVSEA OP-5 - (Naval Sea Systems Command) Ammunition and Explosives Ashore, Volume 1, Chapter 4**
>
> **AMCR 385-100 - (Army Material Command) Safety Manual, Chapter 8**
>
> **AFR 127 - (Department of the Air Force) Explosives Safety Standards**

Appendix L - Principles of Lightning Protection

Appendix M - Referenced Publications

> **Does not cover surge suppression, or bonding of other grounding systems in any detail.**
>
> **MIL-HDBK-419A - Grounding, Bonding, and Shielding for Electronic Equipment and Facilities - 2 volumes**
>
> **Addresses the practical considerations for engineering of grounding systems and subsystems**
>
> > **Earth electrode system**
> >
> > **Lightning protection system**
> >
> > **Fault protection system**

Signal reference system

Discusses noise reduction as it relates to the proper installation of grounding systems

Discusses power distribution systems to the degree necessary to show the interrelationship between grounding, power distribution, and noise reduction

Excellent discussion of grounding, bonding, and shielding as they relate to communication systems. Theory and application information, although focused on communication systems, is relevant for wide range of equipment

IEEE 142 - Green Book - Recommended Practice for Grounding of Industrial and Commercial Power Systems

Discusses system grounding, grounded versus ungrounded systems, how and where to ground systems, interconnections of system and equipment grounding, generation of static electricity and prevention of sparking, lightning protection of structures, and grounding of sensitive electronic equipment.

FIPS (Federal Information Processing Standards) PUB 94 - Guideline on Electrical Power for ADP Installations

Withdrawn from publication, excellent practical discussion of powering and grounding electrical systems feeding ADP installations

IEEE 1100 - Emerald Book - Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

Brings some order to the power quality field, excellent overall discussion of the problem

Chapter 2 - Definitions - Attempts to bring consistency to power quality terminology

Chapter 3 - Discusses the nature and origin of power supply variations and sensitivities of load equipment

Chapter 4 - Fundamental concepts related to power quality, helps understand the recommended practices of Chapter 9

Chapter 5 - Describes 18 types of instruments useful in power quality surveys, right instrument for the right task, characteristics of the instruments

Chapter 6 - Primer on conducting site power quality surveys

Chapter 7 - Describes 25 problems and solutions

Chapter 8 - Discusses the selection and capability of power conditioning equipment to solve various power quality problems

Chapter 9 - Recommends powering and grounding practices from service entrance to receptacle

Strictly follow the requirements of the NEC

Bond all grounding subsystems together (power, lightning/surge protection, communications)

Use solidly grounded AC power systems

Use dedicated circuits for sensitive equipment

Use a separately derived source close to the load

Discussion of isolated grounding subsystems

Possible means of reducing common-mode electrical noise

Results range from no effect, desired effect, to worsening the noise condition

Only applicable to metal enclosed wiring methods

Limitations

Lack of attention to distributed, interconnected computers

IEEE C62.1 - Standard for Gapped Silicon-Carbide Surge Arresters for AC Power Circuits

IEEE C62.11 - Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits

Discusses the performance characteristics, design, routine, and conformance tests for secondary, distribution, intermediate, and station class arresters

IEEE C62.2 - Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems

IEEE C62.22 - Guide for the Application of Metal-Oxide Surge Arresters for Alternating Current Systems

Discusses overvoltages, protective levels, insulation withstand, insulation coordination of substations and distribution lines using secondary, distribution, intermediate, and station class arresters

IEEE C62.41 (IEEE 587) - IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Systems

Describes the occurrence of surges in low voltage AC power systems, good discussion of the different waveforms used in the testing and specification of equipment

WARNING: If a manufacturer advertises their equipment “meets the requirements of” or “is certified to” IEEE 587 or C62.41, run. This document describes surges, not equipment surge performance.

Provides guidance on the simplification of this information into a limited set of representative surges.

Assists designers in providing appropriate withstand capabilities

Assists users in the specification of appropriate levels of withstand requirements

Assists test equipment suppliers with a recommended practice for well defined waveforms

Standard waveforms discussed by location:

> **Category A - Long branch circuits, receptacles (indoors)**
>
> **Category B - Major feeders, short branch circuits, service panels (indoors)**
>
> **Category C - Outdoor overhead lines, service entrance**

Standard waveforms discussed by exposure:

> **Low exposure - low lightning or load switching activity**
>
> **Medium exposure - medium to high lightning or switching transient activity**
>
> **High exposure - Rare installations beyond medium exposure**

Recommends waveform values, voltage and current amplitude for line-to neutral, line-to-line, and neutral-to-ground configurations

IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Systems

Companion document to IEEE C62.41

Serves as a guide to surge testing methods

Not a specification of performance or acceptance testing

Signal and data lines are not addressed

UL 1449 - Standard for Safety Transient Voltage Suppressors -Updated in 1998

Safety standard, not performance standard

Clamping voltages in UL 1449 are a survival bench mark not a performance indicator

Products that meet the “performance “ requirements of UL 1449, do not pass some of the IEEE C62 testing requirements

There are TVSS that meet the requirements of UL 1449 and tested to verify that voltage surges do not exceed suppressed voltage ratings as specified by the manufacturer when tested using the waveforms in IEEE C62.41-1991

Marked with “Classified in Accordance with IEEE C62.41-1991 Recommended Practice”

UL Construction Materials Directory discusses the details in the listing for “Transient Voltage Surge Suppressors

DOD 6055.9-STD - Ammunition and Explosives Safety Standard - Chapter 7

> **References NFPA 780 and NFPA 70, MIL-HDBK-419**
>
> **System design, surge protection, earth electrode system, inspection, testing, and training**

DOE M 440.1-1 - DOE Explosives Safety Manual, Chapter 2, Section 6.4 and 8.3

> **References NFPA 780 Appendix on Protection of Structures Housing Explosive Materials.**
>
> **References DOD 6055.9-STD, Chapter 7, for examples of acceptable lightning protection systems.**
>
> **Inspection, testing, and service entrance**

Consulting and Specifying Engineer Magazine

Power Quality Assurance Magazine

Electrical Construction and Maintenance Magazine/Books

AB Chance Tips and News Magazine

IAEI News Magazine

Cadweld - Series of articles on grounding for lightning protection

EPRI - Series of articles grounding for lightning protection, testing of surge arresters, and power quality

National Lightning Safety Institute

National Rural Electric Cooperative Association - Lightning Protection Manual for Rural Electrical Systems

Flash Parameters

Initial Path for Discharge - 50 microseconds (us)

Return Strokes/Flash - 1 to 26, (2 to 4)

Peak Current/Return Stroke - 1 to 250 kA, (10 to 20 kA)

Time to Peak Current - .5 to 30 us, (1.5 to 2 us)

Rate of Rise - 1 to 210 kA/us, (20 kA/us)

Thermal and Mechanical Effects

Long Duration Strokes - Melt Metal or ignite solid materials

Short Duration/High Current Stokes - Tear or bend metal, due to electromagnetic forces

Insulating/Semi-insulating materials - Explosive Reaction - Trees, ungrounded poles, flag poles, lighting supports

Masonry - Shattered, broken or explosion where discharge passes through, instantaneous vaporization of water

Electrical Effects

Voltage drop through path to ground (Conductor Impedance)

Magnetic Induction

Capacitive Coupling

Conductor Impedance - Resistive and Inductive

Lightning strike -

20kA, 20kA/us, 30 meter down conductor

$R = 2.88 \times 10^{-4}$ **ohms/meter**

L = 52.5 microhenries

Resistive Component -

$V = 20kA \times 2.88 \times 10^{-4} \times 30 = 173$ **volts**

Inductive Component -

$V = L \times di/dt$

$V = 5.25 \times 10^{-5} \times 2 \times 10^{10} = 1.05 \times 10^{6}$ **volts**

This voltage will cause a flashover in air of 14 inches

Magnetic Induction -

Circuits not in direct contact with lightning discharge

Voltage induced in the loop is dependant on:

Dimensions of the loop (l, r2 - r1)

Distance from the down conductor (r1)

Time rate of change of the discharge current (di/dt)

di/dt can not be controlled but l, r1, and r2 can be controlled

Do not run cables in parallel with down conductors

If cables must be run parallel, make r1 large

r2 - r1 should be as close as possible to zero - ie. twisted pair

Capacitively Coupled Voltage -

$$V = Q/C \times e^{-t/RC}$$

Q = Stored charge in Coulombs, C = Total capacitance to ground in Farads, R = effective resistance to ground in ohms, t = elapsed time from the lightning stroke

Theoretically, if RC is small, capacitively coupled voltage will be small

HOWEVER

Testing performed by EPRI and Power Technologies due to reported failures of cable and transformers.

Rocket-triggered lightning above 15kV class cable, concentric neutral, direct buried and in PVC conduit (3' depth)

Lightning stroke hit cable/conduit due to breakdown of soil.

Failure not always immediate

Punctured cable jacket, allowing water to enter.

Concentric neutral damaged, overloading remaining strands

Damage mainly mechanical, strike within 30 feet can cause damage

Power and Telecommunications industry

Shield wire or sheet of foil buried in soil above cable

Sacrificial shield on the cable

Surge Arrester Lead Length

Due to inductive component, lead length in series with arrester is important.

Power Systems -

Pole-mounted transformer, 13.2kV, 95kV BIL (8us), 110 kV CWW (2us), normal duty 10kV spark gap arrestor, 10 kA discharge, protective margin is 124% at 0' lead length and 1% at 10' lead length

Underground distribution transformer, 13.2kV, 95kV BIL (8us), surge voltage doubled by reflection, heavy duty 10kV MOV arrestor, 10 kA discharge, protective margin is 30% at 0' lead length and -13% at 3' lead length.

Electronic Equipment

Long leads between TVSS and loads affects surge suppressor performance

For a 1.2/50, 8/20 impulse, five feet of lead length increases clamping voltage requirements by 1200 volts.

Hazards of R&D Power Sources (Lloyd Gordon)

The following presentation related to the hazards of R&D power sources was made.

The Other Half of the Hazard
Lloyd B. Gordon
DOE Electrical Safety Meeting
June 24, 1998
Las Vegas, Nevada

Author's comments - The following is a copy of the text shown on the overheads used in the talk. The primary purpose of the talk was to discuss the unique hazards of Low Voltage/High Current, High Voltage/Low Current, and RF/Microwave R&D Laboratory power supplies, as covered in sections 10.8.2, 10.8.3, and 10.8.4 respectively of the current DOE Electrical Safety Handbook. A significant element of this presentation was the oral explanation that goes with these view graphs. This copy is primarily useful as a guide to those who were PRESENT at the talk. If you were not present and read these words you are likely to not understand the key points being made. Be careful in their interpretation. Note: the estimates given in this talk are the author's, and are based on training 15,000 DOE R&D workers over the past 12 years, and in working with the SNL and LANL electrical safety committees. If you have further questions contact the author at email address "L.B.GORDON@IEEE.ORG".

The Other Half of the Hazard
The R&D Environment
June 24, 1998
DOE Electrical Safety Meeting
Lloyd B. Gordon

Outline

- 60 Hz vs. everything else
- The DOE laboratory environment
- Classification of Electrical Hazards in the R&D lab
- Power sources in the R&D lab
- Mechanisms of injury
- How to deal with such hazards
- The DOE Electrical Safety Handbook
- Summary and Discussion

Objectives

- Understand the unique electrical safety environment of the R&D laboratory
- Convince you that there is more to life than 60 Hz!
- Review sections of the DOE Electrical Safety Handbook
- How we deal with such hazards

60 Hz vs everything else

- DOE R&D Laboratories include LANL, LLNL, SNL, SLAC, PNNL, ORNL, etc.
- This represents approximately 30,000 DOE employees
- Perhaps 5% of these DOE employees work regularly with 60 Hz
  - electricians and linemen
  - facility and utility power
- Approximately 50% of these DOE employees work with R&D equipment
  - design and construction, operation, maintenance and modification
  - scientists (physicists, chemists, materials), engineers, technicians, interns

That is 1500 60 Hz workers vs 15,000 R&D workers

Electrical Safety Topics

- 60 Hz
  - rubber blankets
  - sub station accidents
  - insulated and live line tools
  - NEC and NESC updates
  - lightning protection
  - facility grounding
- R&D
  - extension cords and power strips
  - capacitors
  - rf circuits
  - batteries
  - power supplies
  - energized electrical work in the lab
  - diagnostics and controls

Examples not covered by NEC, OSHA

- Capacitors are NOT automatically discharged (NEC 460-6)
- High Voltage can be very low energy, energized work allowed
- Ratings can far exceed NEC for pulsed applications (V, I, P, E)
- Clearances may not be followed (PFN design does not allow), e.g., NEC 384-36
- It may be acceptable to BLOW up the equipment (to meet requirements)
- Grounding requirements are vast and complex

No color codes

Things that R&D workers do
[AUTHORS NOTE - without the oral presentation that followed, do not misinterpret these examples, they were explained in the talk. I have included extra material, a very brief example, in this copy]

- 20 kV, 10 A shocks acceptable - e.g., carpet type electrostatic shock
- use 14 AWG copper wire for 20 kA - e.g., pulsed applications
- work live on 4160 V, no protection - e.g., very low current photo detector bias
- avoid 5 V, very dangerous - e.g., very high current supplies
- 200 mA current through body OK - e.g., 1 MHz rf current, ANSI and IEEE allows

Electrical Shock Accidents and Incidents in 1998

- 60 Hz
  - power cords
  - breakers
  - Lock Out/Tag Out
  - miswired 440 V plug
- R&D
  - several capacitor shocks
  - rf shock and burn
  - other high voltage shocks
- A majority of electrical accidents occur to R&D workers
- Of these, perhaps 40 % are with standard 60 Hz
- Thus, many of DOE accidents are in areas not covered at this meeting

Work Modes

- Mode 1 - De-Energized
  - preferred
  - positively de-energized
  - external electrical energy sources disconnected (e.g., lock and tag)
  - internal energy sources are rendered safe
- Mode 2 - De-Energized to Energized, Diagnostics and Testing
  - confirm successful completion of the electrical work
  - observe functions
  - complete a diagnostics and testing procedure
  - some or all of the protective barriers removed
  - interlocks bypassed
- Mode 3 - Energized
  - physically moving energized conductors and parts
  - moving parts near energized conductors
  - some or all of the protective barriers removed
  - compelling reason necessary

Classification of Hazards by Injury

- sensation or minor injury
  - reflex action or minor burn
- injury or fatality by contact
  - fibrillation, internal or external burns
- injury or fatality due to proximity
  - arc blast, shrapnel, external burns

Classification of Hazards for 60 Hz

- minor, < 50 V

major by contact, from 50 to 600 V
major by proximity, > 600 V
> 5 mA through body

Historical Classification of Hazards by DOE

- > 50 V
- > 10 A
- > 10 J

oral comment - too restrictive or not comprehensive

DOE Electrical Safety Handbook

- 1.0 Introduction
- 2.0 General Requirements
- 3.0 Electrical Preventive Maintenance
- 4.0 Grounding
- 5.0 Special Occupancies
- 6.0 Requirements for Specific Equipment
- 7.0 High-Voltage Work in Excess of 600 V
- 8.0 Temporary Wiring
- 9.0 Enclosed Electrical/Electronic Equipment
- 10.0 Research and Development
- 11.0 References
- App. A - DOE Model Electrical Safety Program
- App. B - Definition of Terms
- App. C - Work Matrices

10.0 Research and Development

- 10.1 Purpose
- 10.2 Scope
- 10.3 Compliance with OSHA and other regulations
- 10.4 Standardized Safety Practices and Procedures
- 10.5 Equipment not listed by an NRTL
- 10.6 Operation and Maintenance
- 10.7 Employee Qualifications
- 10.8 Generic R&D Equipment
- 10.9 Methods
- 10.10 Requirements for Specific R&D Equipment

10.1 Purpose

to maintain workplace free of electrical hazards that can cause injury or death
ensure adequate safety during: design, development, fabrication, construction, modification, installation, inspection, testing, operation, maintenance, decommissioning
to complement existing electrical codes and recognized industry standards in conformance with DOE, OSHA, NEC, NESC, etc.

10.8 Generic R & D Equipment

- 10.8.1 Power Sources
- 10.8.2 Low Voltage and High Current
- 10.8.3 High Voltage and Low Current
- 10.8.4 Radio-Frequency/Microwave Radiation and Fields

Injury Mechanisms for Low Voltage, High Current

conductor or tool can heat up, causing burns

conductive jewelry can heat or melt causing burns
sparks can cause burns
magnetic forces can propel objects

Classification of Low Voltage, High Current Sources
Assume < 50 V
< 10 A or < 1000 W - minor burn injury
> 10 A or > 1000 W - possible serious burn injury
based on LANL recent guidelines

Low Voltage and High Current - Summary
< 50 V AND >10 A or >1000 W
Examples:
power supply: 20 V and 400 A
magnet supply: 40 V and 200 A
magnetron filament supply: 5 V and 8000 A
automobile battery: 12 V and 500 A
hazards
contact burns
mechanical injury
inability to open circuit (voltage buildup on high L circuits)
design techniques
protective covers and/or barriers
identify the hazard at the power source and other places (loads) with appropriate markings consider conductor heating and magnetic forces in normal and short-circuit operation, strength procedures work on such circuits de-energized
when working in Mode 2 or Mode 3 treat as Energized Electrical Work

Injury Mechanisms for High Voltage, Low Current
reflex action or startle effect
falling
dropping object
recoiling into another hazard
minor temporary numbness or tingling

Classification of High Voltage, Low Current
> 10 J or > 5 mA - potential severe injury
between 0.25 J and 10 J or between 0.5 mA and 5 mA - reflex action, possible injury
< 0.5 mA or < 0.25 J - no injury
see Figure 10-1, DOE Electrical Safety Handbook
origins of these thresholds based on late 1950's work, no current work

Example of the origin of our guidelines
Impulse shocks of less than 50 J, although startling and disagreeable, may not be harmful. Both field and laboratory experience with capacitor and inductive types of electric fence controllers indicates that impulse shocks having an energy content of about 0.25 J, while harmless, are definitely very objectionable. It is suggested therefor that an objectionable impulse shock threshold be established at 0.25 J. Such a threshold may have very practicable applications in industry and the laboratory. For example, while it is likely that a technician might tolerate shocks of this magnitude say once a week without comment, it is possible that a daily dose of a half-dozen or

more shocks might produce both violent complaint and possible permanent deleterious nervous effects.
Dalziel, 1956

High Voltage and Low Current - Summary

- **> 50 V and < 5 mA**
- **Examples:**
  - **photo detector bias supplies**
  - **electrostatic charge buildup on dielectric surfaces**
  - **accelerating and deflection fields**
- **hazards**
  - **reflex action (>0.5 mA or > 0.25 J)**
  - **gradual energy buildup (e.g., long cables)**
  - **effect of V squared**
  - **ignition or detonation of explosive or flammable devices**
  - **failure of insulation or low voltage components**
- **design techniques**
  - **adequate warning**
  - **protection if required**
- **procedures**
  - **qualified person**
  - **after careful review this hazard may fall into minor injury**
  - **consider secondary hazard of reflex action**

Radio-Frequency/Microwave Radiation and Fields

- **> 3 kHz, varying powers and field strengths**
- **Examples**
  - **communications equipment**
  - **radar**
  - **rf heaters - materials and plasmas**
  - **dielectric furnaces**
  - **accelerators, klystrons, magnetrons**
  - **medical applications**
  - **effects**
- **Hazards**
  - **burns (different, can be severe even at low voltage)**
  - **Electromagnetic Interference (EMI)**
  - **detonation**
  - **x-rays**
  - **exposure to fields**
- **Unique problems**
  - **shielding, grounding**
  - **reflection**
  - **induced voltages and currents**

Techniques to control RF Hazards

- **shielding**
- **excluding unauthorized individuals, OSHA approved warning symbol for non-ionizing radiation (see 29 CFR 1910.97) or a sign designed per ANSI C95.2-1992.**
- **interlocks**
- **isolate exposed rf components**
- **grounds**
- **clearances**

Summary

- There is more to electrical hazards than 60 Hz in the R&D lab
- High Voltage can be harmless
- Low Voltage can be dangerous
- Each application, system, procedure... must be evaluated for electrical hazards

Training the R&D Electrical Worker (Lloyd Gordon)

The following presentation pertaining to training for R&D electrical workers was made.

"Training" the Researcher
Lloyd B. Gordon
DOE Electrical Safety Meeting
June 24, 1998
Las Vegas, Nevada

Authors comments - The following is a copy of the text shown on the overheads used in the talk. The primary purpose of the talk was to briefly introduce the audience to another critical element of safety, Training. A significant element of this presentation was the oral explanation that goes with these view graphs. This copy is primarily useful as a guide to those who were PRESENT at the talk. If you were not present and read these words you are likely to not understand the key points being made. Be careful in their interpretation. If you have further questions contact the author at email address "L.B.GORDON@IEEE.ORG".

"Training" the Researcher

- DOE Electrical Safety Meeting
- June 25, 1998
- Lloyd B. Gordon

Topics Today

- the Need
- Such a Diverse Group
- Training Techniques
- the "Training Resistant" Employee
- Transferring Lessons learned

Managing Risk

- Training
- Procedures
- Design

The Goals of Training

- Enhance awareness of employee about the hazard
- Develop proper attitude
- Be able to assess the hazard
- Be involved in mitigation techniques
- Teach some of these techniques
- Meet regulations and requirements

"Easy" Training

some training is for a very specific group of employees, to learn a clear technique

- Lock Out/ Tag Out
- CPR
- Laser Safety

"Hard" Training

R&D Electrical Safety is NOT so easy.

(1) an incredibly diverse group

- in experience and knowledge
- in job responsibilities
- in attitude and awareness

(2) a huge subject

- types of hazards
- environments
- systems, components
- applications

Training Techniques

- presentation methods
- the trainer
- tricks
- changes in DOE

Presentation Methods

- Classroom
- Interactive CD-ROM
- Web-based

The trainer

- "professional" trainer vs a subject matter expert
- knowledge and experience
- credentials and credibility

Tricks

- engaging the class
- defusing the "experts", using their knowledge
- anticipating "negativisms"
- making the training relevant, even if it seems not
- don't require repeating identical material for retraining
- refreshments

Training the "Training Resistant" Employee

- the scientist, or old timer, or immortal
- use relevant examples
- don't threaten with "requirements"
- engage the "resistor"
- credibility of the trainer

Transferring Lessons Learned

- very difficult to do

develop new segments based on needs and accidents
follow up training on the Web

Summary

- Training - a critical component of managing risk, must no be undersold
- Make it relevant
- Credible instruction
- Beware of impersonal training
- Don't just "meet" the requirements
- Revise, incorporate lessons learned

Electrical Surveys (Larry Perkins)

A discussion of the surveys conducted over the past year was held. The purpose of these surveys was explained. Larry also told the audience that the individual and company name were held in strictest confidence. Only the summary results were shared as follows:

Qualified Person

1) Does your site have requirements for an employee to be declared as qualified to perform electrical work?

81% YES

2) Does your site provide electrical training to meet the requirements of 29CFR1910, Subpart S and R?

71% YES

3) Does your site provide training for those employees that are not qualified electrical workers but are exposed to electrical equipment such as welders, riggers, carpenters, painters, etc?

71% YES

4) Does your site require training on the National Electrical Code?

71% NO

5) Does your site offer NEC training?

52% YES

6) Does your site require training on the National Electrical Safety Code?

81% NO

7) Does your site offer NESC training?

86% NO

8) Is there formal update training for each code revision?

67% NO

On or Near

1) What is your sites definition of Near as it applies to electrical work?

63% - 70-E

2) What PPE, clothing, and other equipment does your site have available when employees work on or near energized equipment?

90% - ALL????

3) How is it determined that equipment will be worked on energized?

75% Management

4) Does your site require any paper work to be completed to perform energized work?

75% - YES

5) Does your site have different documentation requirements depending on the type of electrical work to be performed?

75% - YES

6) What are the requirements for some on to work on or near energized conductors?

50% - Qualified

13% - Appropriate PPE

25% - JHA

7) What are the requirements for someone to reset breakers that have tripped? Is this considered on or near electrical work?

50% - No Requirement (Any one can reset one time)

38% - Qualified

AHJ SURVEY RESULTS

1) Is your AHJ chosen by a set of qualifications?

75%   NO

2) Is your AHJ chosen by a position in the company?

65% NO

3) Is your AHJ responsible for only electrical issues?

55% NO

4) Does your AHJ also deal with other issues such as fire protection?

80% NO

5) Does your AHJ attend the DOE sponsored electrical meetings?

50% NO

6) Does your AHJ attend any National meetings, such as the NEC etc?

75% NO

7) Is your AHJ certified by your state?

85 % NO

8) Is your AHJ certified by the ICBO?

50% NO

9) Is your AHJ certified by the IAEI?

75% NO

10) Does your AHJ have the opportunity to review all new installations or modifications prior to installation?

60% NO

Line Hose Inspection, Testing and Use

1. Does your facility use line hose when working on overhead energized conductors?

70% YES

2. Does your facility use line hose as primary protection when placed over conductors?

50% YES

3. Has your facility had accidents/injuries while using line hose?

4% YES

4. Do you periodically inspect your line hose?

60% NO

5. What time period do you require line hose inspections?

21% - 6 Months
14% - 12 Months

6. Do you "fail" line hose due to the visual inspection?

50% YES

7. Do you require line hose to be washed?

75% YES

8. What period of time do you require line hose to be washed?

80% have no set interval

9. Do you test your line hose?

35% YES

10. If you test line hose what period of time do you require the line hose to be tested?

28% - 6 Months
21% - 12 Months

11. For those facilities that require line hose to be tested, how many line hose have failed due to electrical test?

20% had Failures

12. Does your facility use the practice of using higher class line hose than the actual voltage class you are working on?

57% YES

Electrical Safety Handbook Process (Janice Nelson)

The DOE Electrical Safety process was discussed as follows

ELECTRICAL SAFETY HANDBOOK

- **HISTORY**
    - **DECEMBER 1967 - ELECTRICAL SAFETY GUIDE FOR RESEARCH**
    - **AUGUST 1979 - ELECTRICAL SAFETY CRITERIA FOR RESEARCH AND DEVELOPMENT ACTIVITIES**
    - **MAY 1991 - ELECTRICAL SAFETY MANUAL**
    - **AUGUST 1992 - ELECTRICAL SAFETY GUIDELINES**
    - **MAY 1993 - ELECTRICAL SAFETY GUIDELINES**
    - **JANUARY 1998 - DOE HANDBOOK ELECTRICAL SAFETY**
- **DOE-HDBK-1092-98 JANUARY 1998 DOE HANDBOOK ELECTRICAL SAFETY**
    - **REPLACES DOE ELECTRICAL SAFETY GUIDELINES 1993**
- **COMMENTS ON THE ELECTRICAL SAFETY HANDBOOK**
    - **684 COMMENTS FROM THE COMPLEX**
        - **COMMITTEE FROM COMPLEX MEET IN LAS VEGAS TO REVIEW COMMENTS**
        - **AFTER REVIEW AND RECOMMENDATION FROM COMMITTEE ALL COMMENTS RESOLVED**
    - **DNFSB HAD 11 COMMENTS AFTER OTHER COMMENTS RESOLVED (OCT. 7, 1998)**
        - **AFTER SEVERAL MONTHS OF DISCUSSION ALL DNFSB COMMENTS RESOLVED**
- **COPIES ARE AVAILABLE FROM :**

OSTI - FOR DOE AND CONTRACTORS - 423-576-8401
THE DEPARTMENT OF COMMERCE - FOR THE PUBLIC - 703-487-4650

ALSO AVAILABLE ON THE INTERNET AT FOLLOW ADDRESS:

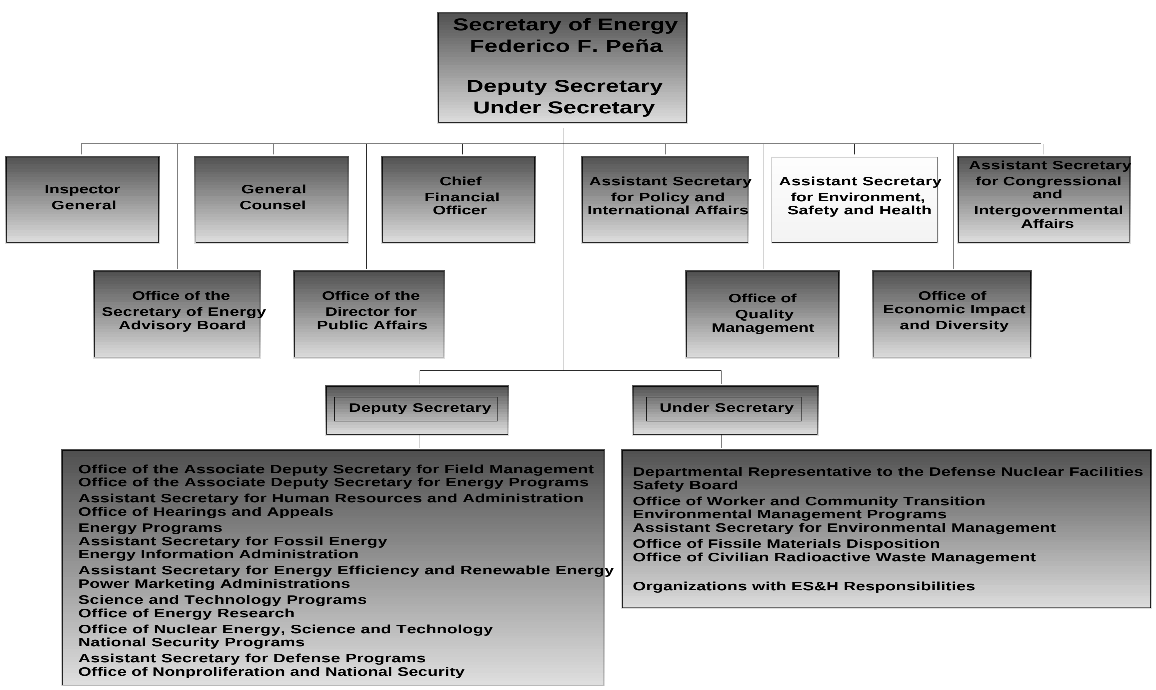
HTTP://APOLLO.OSTI.GOV/HTML/TECHSTDS/STANDARD/HDBK1092/HDBK1092.PDF

DOE ACCIDENT INVESTIGATION (Larry Perkins)

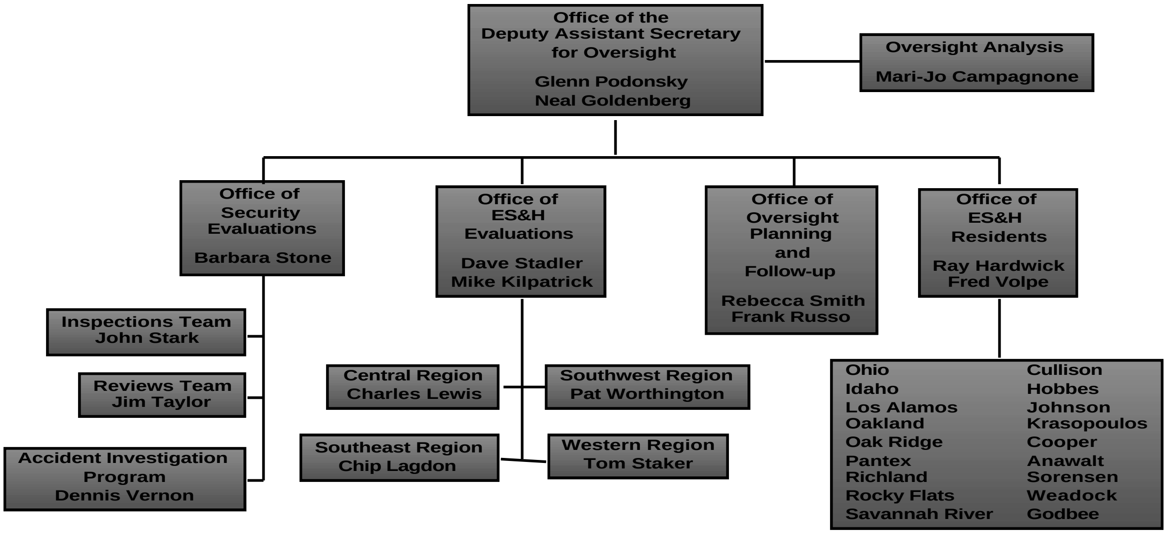
The original presenter was unable to attend, and as a result, Larry discussed the following information related to the accident investigation program. The Type A and Type B Accident Investigations can be located at http://tis-hq.eh.doe.gov:80/web/eh2/acc_inv.html

DOE Accident Investigation Program

Briefing on the DOE Accident Investigation Program



Office of Oversight



Oversight Task

Provide information and analysis needed to ensure that

- **the Secretary of Energy**
- **DOE and Contractor Management**
- **Congressional Committees**
- **and the Public**

have an accurate, comprehensive understanding of the effectiveness, vulnerabilities, and trends of the Department's ES&H and S&S Programs

Oversight Approach

Independent

- **Not tied to mission of DOE line programs**
- **Report results to DOE managers and Congressional Committees**

Balanced

- **Clear and consistent protocols**
- **Stakeholders and regulators involved during process**

Accurate

- **Teams of trained technical and management experts**
- **Information validated with inspected site and Program Office**

Value Added

- **Performance, not compliance-oriented**
- **Focus on effectiveness of management systems**
- **Ratings assigned**
- **Opportunities for improvement**

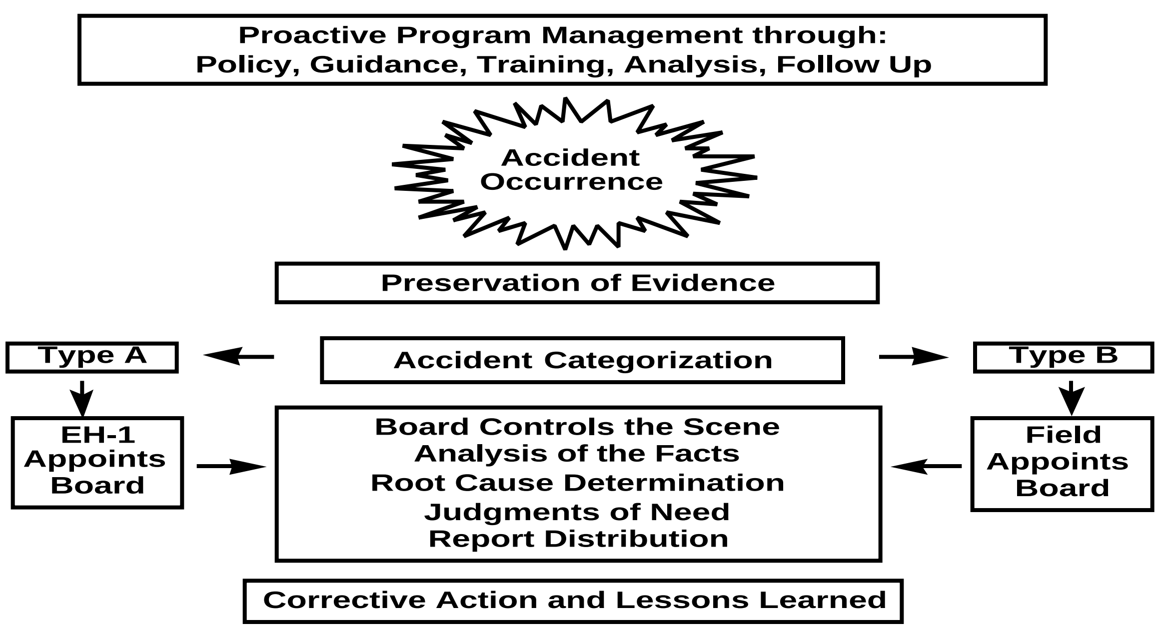
DOE Accident Investigation Program Objectives

- **Prevent the recurrence of accidents**
- **Contribute to improved environmental protection and enhanced safety and health of DOE employees, contractors, and the public**
- **Reduce accident fatality rates and promote downward trend in the number and severity of accidents**

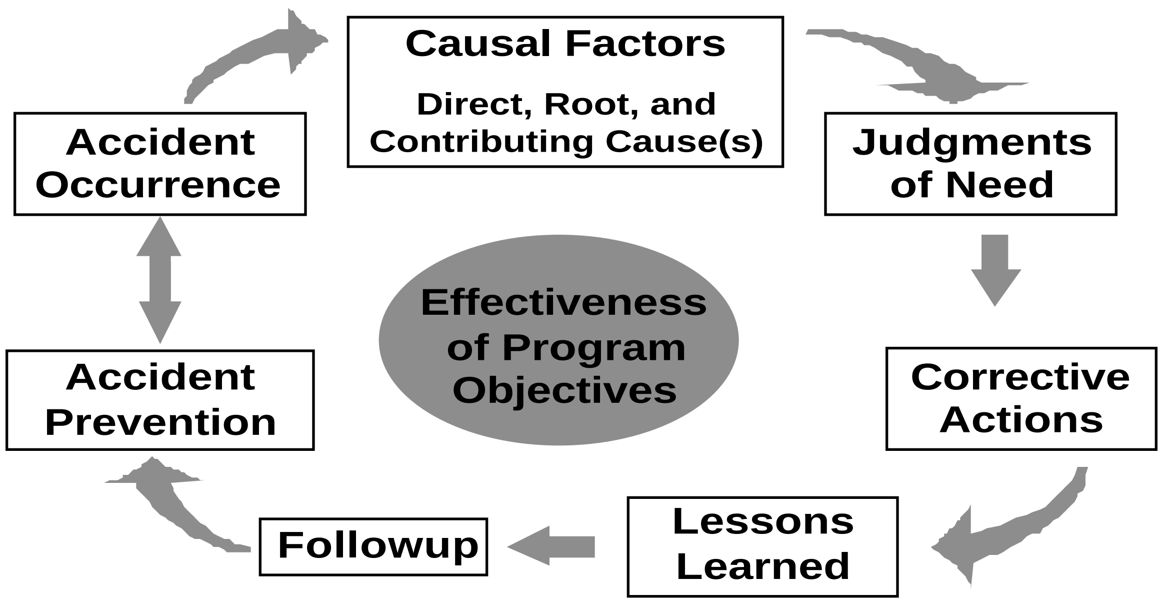
DOE Accident Investigation Program Accidents in 1997

Dec 1997:	Transportation - waste leakage, FEMP, (B)
Nov 1997:	Flooding - chiller line rupture, LANL, (B)
Oct 1997:	Injury - electrical burns, Fermi Lab, (B)
Sept 1997:	Chemical - ruptured waste drum, Paducah, (B)
July 1997:	Injury - electrical shock at BPA, (B)
July 1997:	Injury - lathe operation at Tonopah, NV, (B)
July 1997:	Injury - fall at Windsor, Ct., NR, (B)
July 1997:	Radiological uptake at LLNL, (B)
June 1997:	Fatality - tree clearing at BPA, (A)
June 1997:	Fatality - construction at BNL, (A)
May 1997:	Chemical explosion at Richland, (?)
May 1997:	Injury - steel beam rigging at Richland, (B)
Apr 1997:	Radiological uptake at SRS, (B)
Apr 1997:	Fatality - electrocution at BPA, (A)
Apr 1997:	Injury - ladder fall at LLNL, (B)
Apr 1997:	Helicopter crash at WAPA, (B)
Feb 1997:	Fatality - welding/cutting at K-25, (A)

DOE Accident Investigation Program Concept of Operations



DOE Accident Investigation Program
A Measure of Effectiveness



Future and Closure (Larry Perkins/Pat Tran)

Pat expressed his appreciation for the people attending the meeting. He also explained what he thought the future would hold for this group and what could be done to keep sharing this valuable information. The meeting was concluded.

Information supplied on how to join the email group. (Keith Gershon)

Join The DOE_ESC Electrical Safety Email Group

In October, 1994, Berkeley National Laboratory initiated an email server dedicated to the discussion of electrical safety issues within the DOE complex. With over 60 subscribers, the email server has proven to be a very effective means of sharing information about codes, standards, applications, products, and anything else to do with the topic of electrical safety. This forum is only open to DOE related sites and contractors.

To Subscribe:

To be automatically registered as a participant in the group, simply send an email to

DOE_ESC_Postmaster@lbl.gov

In the Subject header, put “please register”. In the message body, please include your full name, site name, mailing address, email address, phone, fax, and job title. Keith will compile an address book with this information and will periodically send it out to all members so you know who is listening.

To Use The Server:

Once you have registered, you will not need to use the “Postmaster” address again. To send an email to the group, address it to

DOE_ESC@lbl.gov

This is all that is required of you. Your message will be automatically and immediately distributed to every registered participant

Error Message:

When you send an email to the server, you should receive a copy of it back, since you are a member of the distribution list. You may additionally receive an “error message”. This indicates that an individual address within the distribution list had delivery problems. Just ignore these error messages and do not re-send your message. If you get a copy of your own message, then that means the system is functioning correctly, and your message was delivered to the list.

If you have question about this system contact Keith Gershon at kdgershon@lbl.gov.

The following people attended the Electrical Safety Meeting:

ELECTRICAL SAFETY MEETING

JUNE 21 - 25

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