Electrical Safety Implementation Plan

This plan documents Ames Laboratory's efforts to improve electrical safety performance and includes taking a critical look at operations and improving physical conditions.

Comments and questions regarding this plan should be directed to the contact person listed below:

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Sign-off Record:

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Reviewed by: _____ Date: 7-21-04
Chair, Electrical Safety Committee

Reviewed by: _____ Date: 7/21/04
Manager, Facilities Services

Reviewed by: _____ Date: 7/21/04
Manager, Environment, Safety, Health & Assurance

1.0 Revision/Review Log

This plan will be closed upon completion of identified actions.

Revision Number	Effective Date	Contact Person	Pages Affected	Description of Revision
0	8-1-04	S. Nelson	All	New Plan

2.0 Introduction

The Department of Energy (DOE) Office of Science (SC) Laboratories have exhibited unacceptably high electrical occurrences. In addition, nearly 50 percent of the instances identified by the Occupational Safety and Health Administration (OSHA) inspection during 2003 of the Office of Science Laboratories were related to electrical safety standards. Ames Laboratory had electrical instances similar to those identified at other laboratories however electrical concerns only accounted for 25% and no instances were identified as Immediately Dangerous to Life and Health (IDLH).

3.0 Purpose and Scope

This Electrical Safety Improvement Plan is Ames Laboratory's response to the DOE request to:

- Take a critical look at operations and apply lessons learned to improve performance.
- Improve the physical condition of the Laboratory by correcting electrical hazards recently identified by OSHA.
- Develop and evaluate existing processes to sustain electrical safety improvement, compliance and hazard reductions.

This plan applies to all electrical work performed by Facilities Services, Engineering Services and Qualified Electrical Workers. The Facilities Services Manager, the Laboratory Electrical Safety Inspector and the Industrial Safety Specialist are responsible for the development and implementation of the Electrical Safety Improvement Plan.

4.0 Responsibilities

Program Director / Department Manager and /or Person-in-Charge (PIC)
The program director / department manager and/or PIC are required to ensure that necessary resources are provided to comply with the electrical safety requirements of the Electrical Safety Manual and the Environment, Safety, Health and Assurance Manual. The areas of compliance include: practices and procedures; instructions; new employees; workplace personal protective equipment; standard operating procedures; administrative authority; record; knowledge and devices.

Group / Section Leader and/or Person-in-Charge (PIC)

The group / section leader and/or PIC are required to operate their units in compliance with the electrical safety requirements of the Electrical Safety Manual and Environment, Safety, Health and Assurance Manual.

Engineering Services

Engineering Services (ES) provides expertise on electronic systems for the entire Laboratory including a staff person acting as a certified Electrical Safety Inspector. Engineering Services also has the following responsibilities:

- Provide assistance to group / section leaders in the design, installation and documentation of electrical / mechanical systems and equipment;
- Provide training in coordination with Environment, Safety, Health and Assurance (ESH&A) to authorize designated group / section members in electrical safety, signal wiring, system wiring and equipment wiring;
- Provide direct assistance to the Ames Laboratory Electrical Safety Committee (ESC) with the management and maintenance of the Ames Laboratory Electrical Safety Manual (46200.001);
- Review requisitions for purchase and identify when inspection is required per Ames Laboratory Procurement Quality Procedure (46200.003); inspect identified items of electrical equipment upon receipt.
- Operate in compliance with the electrical safety requirements of the Electrical Safety Manual and Environment, Safety, Health and Assurance Manual.

Facilities Services

Facilities Services (FS) is responsible for the maintenance of Ames Laboratory including buildings and utility systems and has sole responsibility for the electrical distribution system and all modifications to buildings. These responsibilities include:

- Modification and maintenance of building supply of electric power to each receptacle;
- Maintenance of the Laboratory Standby Power Service;
- Installation of structurally supported equipment and raceways.
- Operate in compliance with the electrical safety requirements of the Electrical Safety Manual and Environment, Safety, Health and Assurance Manual.

Environment, Safety, Health and Assurance

Environment, Safety, Health and Assurance (ESH&A) is responsible for auditing compliance with the Ames Laboratory Electrical Safety Manual and Environment, Safety, Health and Assurance Manual. ESH&A also coordinates all Electrical Safety Training and maintains the training records via the Ames Laboratory Training Records System (ALTRS).

Qualified Electrical Workers

Qualified Electrical Workers (QEW) are required to comply with all portions of the Electrical Safety Manual and the Environment, Safety, Health and Assurance Manual that apply to their actions and conduct of operations, including the immediate reporting of unsafe conditions to first-line supervisors or activity supervisors. They are also responsible for knowing and following the safe procedures and practices that are specific to their organization and facility.

Contractors / Visitors

Contractors and visitors are required to meet all the safety regulations contained in the Electrical Safety Manual and the Environment, Safety, Health and Assurance Manual including a Qualified Person as an escort, when exposed to electrical hazards. In addition, the Laboratory utilizes the Subcontractor Oversight Procedure (10200.046) and the Visitors Safety Guide (10200.001) to communicate and control work being performed.

5.0 Electrical Safety Programs and Manuals

The Electrical Safety Manual (#46200.001) and the Environment, Safety, Health and Assurance Manual (#10200.002) and are the two main references for Electrical Safety and Electrical Related Work Practices. Both are reviewed on a periodic basis to ensure compliance with the Occupational Safety and Health Administration, the National Electric Code and the Department of Energy.

6.0 Assessments

6.1 OSHA Inspection 2003

An OSHA Inspection was performed September 15 – 18, 2003 in preparation for the potential transfer to external regulations (OSHA). The main goal of the inspection was to determine the cost to bring DOE Facilities into compliance and avoid citations should the transfer to external regulations occur. Although electrical citations accounted for nearly 50% of the instances identified by OSHA at the Office of Science (SC) Laboratories, Ames Laboratory had 42 electrical concerns out of the 170 total, accounting for 25%. The types of concerns identified at Ames Laboratory were consistent with the most common electrical instances identified.

The following are the primary types of electrical concerns identified during the Ames Laboratory OSHA inspection:

- Blocked circuit breaker panels and electrical disconnects.
- Misuse of temporary power taps.
- Improper strain relief on electrical cords, etc.
- Metal knockout boxes intended for fixed application being used as pendants.
- Lack of Ground Fault Circuit Interrupters
- Labeling electrical disconnects to identify purpose.
- Equipment was not provided with an electrical path to ground.
- Guarding of light fixtures

Since the OSHA Inspection, DOE has provided funding for Health and Safety Improvements including the correction electrical concerns. Facilities Services is correcting the electrical concerns identified by OSHA plus concerns that were missed by the inspectors (identified by an Ames Laboratory Task Group including Facilities Services, Engineering Services and Environment, Safety, Health and Assurance). Approximately ninety percent of the total OSHA concerns have been corrected as of 7-12-04. All of the identified concerns will be addressed by 1/1/05.

6.2 Internal Independent Walk-Throughs and DOE Oversight

Independent Walk-Throughs are conducted annually at all Ames Laboratory spaces and spaces leased to Ames Laboratory from Iowa State University. An active participant of the Independent Walk-Through Team is the DOE-Chicago Facility Representative. In addition, the Electrical Safety Committee Chair (a certified Electrical Safety Inspector) participates in all walk-throughs. This DOE Oversight and Electrical Inspector participation provides for a concentrated emphasis towards electrical safety. In addition, the other walk-through specialists (Industrial Hygienist, Environmental Specialist, Health Physicist and Fire Safety Specialist) are all trained to identify electrical safety and compliance concerns. All identified concerns are tracked and trended using the Ames Laboratory Corrective Action Tracking System (ALCATS). The numbers of identified electrical concerns for the last 5 years are:

- 1999 = 211
- 2000 = 153
- 2001 = 131
- 2002 = 112
- 2003 = 107 (51% reduction since 1999)

These concerns are consistent with the type of issues identified during the OSHA Audit.

It appears that electrical safety concerns are declining in part due to:

- Additional job specific training by Group/ Section Leaders
- Additional electrical safety training to Safety Coordinators / Safety Representatives
- Identification, communication and correction of electrical hazards
- Removal of damaged / obsolete electrical equipment
- Removal of inappropriate Temporary Power Taps (TPT's).

6.3 Program / Department Inspections

Program / Department Walk-Throughs are performed by the Program's and Department's and their Safety Coordinator to look at the organizations spaces and activities to identify, describe and eliminate environment, safety, health and assurance concerns in a timely and effective manner. Training in Hazard Identification and Walk-Through Report requirements provide principles of conducting observations. Electrical safety is a component of both training modules.

6.4 Topical Appraisals

Topical appraisals of the Lockout /Tagout Program were performed August 2000 and the Electrical Safety Program in February 2002. Within each Topical Appraisal, the following were performed:

- Review of the written program in the ESH&A Program Manual.
- Assessed and updated Basic Electrical Safety Training, High Voltage and Lockout / Tagout Training programs (lesson plans, handouts, presentations, multi-media, etc.).

- Analyzed Independent Walk-Through concerns for trends and corrective action effectiveness.
- Review Training Status from the Ames Laboratory Training Records System (ALTRS).
- Examined the injury and illness records for injuries related to electrical hazards.

7.0 Electrical Safety Committee

The Electrical Safety Committee (ESC) is the Authority Having Jurisdiction (AHJ) at Ames Laboratory, which convenes on a quarterly basis or as issues arise. The ESC reports directly to the Safety Review Committee (SRC) and to the Laboratory Director through the (SRC).

The charter of the Electrical Safety Committee defines the structure and function of the Electrical Safety Committee. The ESC establishes policies and procedures related to electrical safety issues in research and operational activities.

The Electrical Safety Committee is comprised of two representatives of the Science and Technology Division (one is the Safety Review Committee Chair Person), the Facilities Services Manager, the Electrical Safety Inspector and the Industrial Safety Specialist and the Institute for Physical Research and Technology (IPRT) Safety Coordinator. The Electrical Safety Inspector is also a member of the DOE Electrical Safety Committee that meets on an annual basis. This membership ensures effective communication between Ames Laboratory and the other DOE Laboratories.

One concern that was addressed by the Electrical Safety Committee is the improper use of Temporary Power Taps (TPT's). Part of the problem has been a lack of power (outlets) due to additional equipment needs. Additional outlets have been installed for equipment that is not considered sensitive such vacuum pumps, furnaces, etc. For equipment that is considered sensitive such as computers, scanners, printers, analytical and ADP Equipment, the Electrical Safety Committee researched the proper type of TPT for use at Ames Laboratory. Isobar is the name (trade name) of an appropriate TPT that has a circuit breaker (12A), 2350 joule rating, metals housing, high quality surge suppression and noise suppression internal to the equipment and hence is considered a device instead of an extension cord. It is OSHA's interpretation that this device is designed for a specific purpose/function and is permissible for the proper application and is not an extension of a circuit (extension cord), which is a violation. The identification of inappropriate TPT's and the availability of appropriate TPT's appear to be resolving the concern.

8.0 Ground Fault / Flash Hazard Analysis

Facilities Services has contracted with consulting engineers to perform a "Ground Fault / Flash Hazard Analysis". As of 2003, Facilities Services received the analysis results for Wilhelm Hall, Spedding Hall and the Technical and Administrative Services Facility.

The Ground Fault /Flash Hazard Analysis for Wilhelm Hall and Spedding Hall indicated that no individual branch circuit panels have a short circuit greater than 10,000A (the minimum rating for a panel). All panels will be able to tolerate the available fault currents. Therefore, no corrective steps

need to be taken. Distribution panels/switches have higher current, but the levels are still below the short circuit rating of the equipment. The incident energy available at each calculated location is less than 1.2 cal/cm^2 (Risk Hazard Category 0). This requires personnel to simply wear untreated cotton clothing.

The analysis for the Technical & Administrative Services Facility indicated that no individual branch circuit panels have a short circuit greater than 10,000A (the minimum rating for a panel). All panels will be able to tolerate the available fault currents. Therefore, no corrective steps need to be taken. Distribution panels / switches also have short circuit currents below 10,000A. The incident energy available at each calculated location is less than 1.2 cal/cm^2 (Risk Hazard Category 0). This requires personnel to simply wear untreated cotton clothing.

Metals Development Building was not included in the initial analysis as the electrical systems are currently being upgraded. When the upgrades are complete, an additional analysis will be performed. Anticipated completion of the Metals Development Ground Fault / Flash Hazard Analysis is the end of calendar year 2004.

Training on Arc /Flash Protection was provided to Facilities Services staff on the results of the analysis and precautions to be taken.

9.0 Training

All of the training programs pertaining to electrical safety were reviewed including the methods used to identify individuals requiring training, content of the training programs, compliance, and course evaluations. The trigger questions on the Training Needs Questionnaire (TNQ) for Basic Electrical Safety, High Voltage Safety and Lockout / Tagout were reviewed to ensure the questions are identifying personnel requiring training correctly. The TNQ trigger questions were determined to be effective in properly identifying employees for training.

The use of electrical gloves is also discussed in the Personal Protective Equipment training module in addition to the three main training models for electrical safety. The electrical gloves for Facilities Services, Engineering Services and the research groups are tested on a 6-month cycle. Gloves are immediately accessible and are maintained in a proper manner. The testing is performed by an accredited testing lab in Ames so turn around time for inspection / testing is minimal and reduces the inconvenience to the users. Engineering Services has loaner gloves that can be used if their gloves are out for inspection.

The following was performed to assess the adequacy of the Basic Electrical Safety, High Voltage, Lockout / Tagout and Personal Protective Equipment Training:

- Attendance and review of Basic Electrical Safety, High Voltage and Lockout / Tagout Training.
- The lesson plans and handouts were reviewed.
- The learning assessments tools (quiz) were reviewed.
- The ESH&A Manager reviews the Course Evaluations completed by the attendees.

Training for all four modules is presented on a monthly basis. The training is effective in communicating the requirements outlined in the OSHA Standard 29 CFR 1910.332:

- Skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.
- Skills and techniques necessary to determine the nominal voltage of exposed live parts and
- The clearance distances specified in 1910.333 and the corresponding voltages to which the qualified person will be exposed.

10.0 Occurrences

A review of the Ames Laboratory Occurrences related to electrical safety for the past eight years revealed one incident. In early 2004, an associate of Ames Laboratory received a shock (CH—AMES-AMES-2004-001). Although the associate does not perform work directly under contract with Ames Laboratory, the research activity is housed in an Ames Laboratory DOE-owned building. The space is rented to Iowa State University and the research group is required to comply with the Laboratory's Safety Program. Contact was made with a 110 VAC lead.

The following corrective actions have been implemented to address the incident:

- Enhance Basic Electrical Safety, High Voltage and Lockout / Tagout Training to emphasis researchers may only work on research equipment, not infrastructure services (circuit breakers, disconnects, engineered services, etc.)
- Add heat shrink insulation to contacts within the laser interlock relay box to avoid contact for authorized personnel.
- Add postings to laser interlock relay boxes to communicate to researchers the need to work only on research equipment, not utility or infrastructure services.
- Issue an associated Lessons Learned.
- Distribute information in the form of a handout at the Safety Coordinator / Safety Representative Meeting.

11.0 Lessons Learned

A review of lessons learned that have applicability to Ames Laboratory has been performed by the Manager of Facilities Services, the Electrical Safety Inspector and the Industrial Safety Specialist. The review specifically examined the five types of issues listed below:

- Personnel errors including working on energized equipment without authorization or personnel protective equipment, wiring mistakes coupled with failure to verify safe-energy conditions and leaving unsafe conditions (e.g. improper grounding).
- Work control problems, primarily mistakes in establishing and clearing lockout/tagouts.
- Configuration management weaknesses, such as inaccurate drawings and failing to verify the as-built conditions.

- Electrical intrusion events, such as contacting underground utilities or concealed utilities within structures.
- Vehicles such as dump trucks, excavators and forklifts striking power lines.

The rigorous and broadly scoped review of Ames Laboratory operations and electrical safety related lessons learned produced the following information:

- Electrical workers at the Laboratory are well trained (See Section 9.0) and conscientious in carrying out their work responsibilities in accordance with the safety envelope defined by the Laboratory's ISM System. Oversight and review of those practices ensures that the Laboratory continues to perform safely in the electrical area. In addition to the formal safety training courses, the Facilities Services has monthly safety meetings with planned topics. Discussion of incidents and applicable near misses either at the Laboratory or other organizations is included at the monthly meeting as well as the daily shop meeting. The daily shop meeting occurs at the beginning of the shift and includes discussion of the day's work assignments, safe working controls required for those tasks as well as discussion of lessons learned from across the DOE complex.
- Oversight activities include topical appraisals by ESH&A of the Lockout/Tagout practices of Facilities Services personnel, including electrical workers. Results from the topical appraisal did not indicate concerns of clearing lockout / tagout devices. ESH&A also does a periodic review of the hazard assessment activities within the corrective maintenance program that rely on the skill of the craft. No corrective actions have been identified from the hazard assessments.
- Facilities Services electricians routinely verify the as-built condition prior to work. Facilities Services maintains building drawings in a central file and the group has excellent knowledge of the electrical infrastructure of the Laboratory. However, that information is used as a starting point for verifying the as-built condition. As a result of the review and development of this safety plan, the Facilities Services plans to review and evaluate new instrumentation for doing circuit and conduit tracing. This instrumentation will further enhance the ability to verify as-build conditions.
- Because of the unique location of the Laboratory on the Iowa State University campus there is very limited potential for electrical intrusion events or for vehicles contacting power lines. There are no overhead power lines on the site. The location of the underground electrical distribution is well documented. Utility locates are confirmed for all utilities prior to digging.

12.0 Implementation Schedule

The following is the implementation schedule for action resulting from this electrical safety improvement review. The schedule presents activities that have been completed in the past and items to be completed in the near future:

Activity	Anticipated Completion	Status as of 7-12-04
Correction of concerns identified by the 2003 OSHA Audit (in preparation for potential external regulations).	1-1-2005	90% Complete
Ground Fault / Flash Hazard Analysis.	1-1-2005	75% Complete
Relocation of electrical disconnects and circuit breaker panels. Funding provided through Health and Safety Improvement Program.	3-1-2005	40% Complete
Correction of electrical supply deficiencies (replace metal knockout boxes used on pendants, replacement of damaged electrical cords, installation of GFCI's, installation of additional outlets, etc. Funding provided through Health and Safety Improvement Program.	3-1-2005	50% Complete
Evaluation of locating equipment for utilities concealed in concrete and walls.	1-1-2005	Open

13.0 Summary

Although there has been significant history of identification and correction of electrical deficiencies throughout the Laboratory, electrical safety deficiencies have continued to surface. A review of the issues identified by the OSHA audit indicates the need for facility upgrades such as additional outlets, clearly marked access perimeters for breaker panel and electrical disconnects, and correction of strain relief on electrical cords. With the help of funding from the Health and Safety Improvement Program a systematic effort has been undertaken to address these causal factors. The planned actions underway will significantly improve the ability to provide a greater level of continued electrical safety compliance.

Additional efforts such as continued improvements and application of electrical safety related training will provide workforce skill adequate to sustain a compliance culture of early identification and resolution of potential concerns due to wear and tear of electrical device components including electrical cords. Communication of the importance of electrical safety for the high turnover work force of students, post docs, and visiting scientists will continue to be addresses through training, distribution lessons learned, the Electrical Safety Committee, the Electrical Safety Manual, the Environment, Safety, Health and Assurance Manual, and walk-through by line management and the Laboratory's Independent Walk-Through Program.