U.S. Department of Energy

Office of Health, Safety and Security

Office of Corporate Safety Programs

Limited Scope Investigation Report

Limited Scope Accident Investigation of the June 9, 2009, Near-Miss Electrical Accident at DOE Headquarters, Germantown, Maryland

August 2009

Disclaimer

This report is an independent product of the Limited Scope Accident Investigation Board appointed by Glenn S. Podonsky, Chief Health, Safety and Security Officer, Office of Health, Safety and Security, U.S. Department of Energy. The Board was appointed to perform a Limited Scope Accident Investigation of this accident and to prepare an investigation report in accordance with DOE Order 225.IA, *Accident Investigations.*

The discussion of the facts as determined by the Board and the views expressed in the report do not assume, and are not intended to establish, the existence of any duty at law on the part of the U.S. Government, its employees or agents, contractors, their employees or agents, subcontractors at any tier, or any other party.

This report neither determines nor implies liability.

Release Authorization

On June 15, 2009, I appointed a Limited Scope Accident Investigation Board to investigate the June 9, 2009, accident that occurred in an electrical manhole located near the south entrance of the DOE Headquarters, Germantown facility. The Board's responsibilities have been completed with respect to this investigation. The analyses and the identification of the contributing causes, the root cause and the Judgments of Need resulting from this investigation were performed in accordance with DOE Order 225.IA, *Accident Investigations.*

I accept the report of the Accident Investigation Board and authorize release of this report for general distribution.

Glenn S. Podonsky
Chief Health, Safety and Security Officer
Office of Health, Safety and Security
U.S. Department of Energy

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Acronyms

CCTV	Closed Circuit Television
CRD	Contractor Requirements Documents
DOE	Department of Energy
DOE M	DOE Manual
GSA	General Services Administration
HASP	Health and Safety Plan
HPI	Human Performance Improvement
HSS	DOE Office of Health, Safety and Security
HS-1	Chief Health, Safety and Security Officer
HS-1.2	Office of Resource Management
HS-1.31	Office of Security Operations
HS-11	Office of Worker Safety and Health Policy
HS-31	Office of Corporate Safety Programs
HQ	DOE Headquarters
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
IST	Integrated Security Technologies, Incorporated
IWMS	Integrated Work Management System
JHA	Job Hazard Analysis
JSA	Job Safety Analysis
JON	Judgment of Need
LSI	Limited Scope Investigation
MA	Office of Management
MA-40	Office of Administration
MA-42	Office of Administrative Management and Support
MA-64	Office of Headquarters Procurement Services
NFPA	National Fire Prevention Association
OSHA	Occupational Safety and Health Administration
SAACS	Security Alarm and Access Control System
SSHASP	Site-specific Health and Safety Plan
SO	Office of Security Operation

Executive Summary

On June 9, 2009, an Integrated Security Technologies (IST) alarm maintenance technician, under contract to the Office of Health, Safety and Security (HSS), received an electrical shock while performing work in a manhole, approximately 11 feet deep, located near the south entrance to the Germantown facility. The worker was exiting the manhole using an 8-foot, all-aluminum ladder when the electrical shock occurred. The worker was transported to a hospital for evaluation and was released later that day. The worker sustained a minor burn to his hand and was placed on leave for two days.

The work involved replacing damaged fiber-optic cable between the Germantown Main Building and a security camera. The investigation found that workers entered utility manholes without consideration of the confined space hazards associated with dangerous atmospheric conditions or rescuing injured workers. In addition, the workers did not de-energize or control electrical hazards by lockout or tagout before beginning work.

The fiber-optic cable being replaced was located in the same conduit as the 480-volt electric cable that supplies power to the camera transformer. Initially, the old fiber optic cable was used to pull the new cable between two manholes. However, when the old fiber-optic cable broke, the workers disconnected the electrical cable ground wire to use as a "pull string" for installing the new fiber-optic cable. The workers did not de-energize the electrical cable to the camera before disconnecting the ground wire and using it to pull the new cable through the conduit. A separate, 480-volt electrical cable at the bottom of the manhole serviced the radio building, and that electrical cable also was not de-energized before the worker entered the manhole.

The direct source of the electrical current that resulted in the electrical shock to the worker may have come from one of the following: (1) contact with an exposed energized conductor; either one of the three-phase (480-volt) electrical cables or the single phase (480-volt) electrical cables located in the manhole; (2) damage to the single-phase, 480 volt cable by the ground wire; or (3) disconnecting the ground wire. A more definitive determination of the direct cause is not possible at this time as the manhole is not safe to enter. The manhole has been secured to prevent unauthorized entry until the electrical hazard can be abated.

This accident is significant in that the worker who received the shock could have been seriously injured or killed. There were no danger signs or alternative measures used to identify the two manholes as permit-required confined spaces. In addition, there was no confined space rescue equipment at the job site; in many cases, a co-worker has been injured or killed when attempting a confined space rescue without proper equipment.

This accident is also significant because the Board identified major gaps in how work is routinely executed as compared with how work is required to be executed at Department of Energy (DOE) Headquarters (HQ) facilities. HSS line management did not ensure that effective Integrated Safety Management Systems (ISMS) were in place for this work or that IST was in compliance with Title 10 of the Code of Federal Regulations Part 851 (10 CFR 851), *Worker Safety and Health Program*. IST did not have an effective Worker Safety and Health Program in place, and the existing IST Worker Health and Safety Plans (HASP) were not followed.

Finally, the accident is significant because it reflects the gaps in coordination of work at DOE HQ facilities. Construction and maintenance work may occur without coordination with the Office of Management (MA), and thereby created the potential for putting other support service contractors at risk. Secretarial Offices, such as HSS, independently contract support services that involve maintenance and construction work. This work may involve electrical or confined space hazards. The Accident Investigation Board determined that there is no overarching agreement or work control process at DOE HQ facilities to ensure that work is adequately reviewed, approved, coordinated, and overseen.

The results of this investigation represent an opportunity to comprehensively implement Integrated Safety Management (ISM) at DOE

HQ facilities. Corrective actions should be developed to address short-term needs and the longer-term efforts to establish management systems. Commitment to feedback and continuous improvement systems will be needed to sustain the effort. This Accident Investigation is not meant to be punitive or to assign blame. HSS and MA must encourage event reporting in a culture that fosters worker feedback about needed safety improvements.

Table ES-1 summarizes the Investigation Board's conclusions and Judgments of Need (JON).

Table ES-1. Conclusions and Judgments of Need

Conclusion	Judgment of Need
The same management system and work control weaknesses that contributed to this accident may exist within other Secretarial Offices conducting work at DOE HQ.	**JON 1** HS-1 and MA-1 need to establish a formal agreement that is implemented with ISM as the overall framework. The agreement must provide specific implementing mechanisms for establishing a uniform work-control process for all contractors performing work at DOE HQ.
HSS line management did not fulfill its responsibility to institute a process to monitor the worker protection performance of its support service contractor, IST. HSS line management has not established a mechanism to provide the necessary safety competencies to oversee IST work. The Office of Security Operations (HS-1.3) has not defined the roles and responsibilities or established the mechanisms needed to oversee the safety of IST work. HS-1.3 and IST have not implemented a feedback and improvement process as required by ISM.	**JON 2** HSS line management needs to develop, allocate resources for, and implement a formal program to review the safety requirements of contracted work. **JON 3** HS-1.3 and IST need to develop and implement an integrated feedback and continuous improvements program. This program should be integrated with the Office of Administration (MA-40) as necessary to ensure that corrective actions are coordinated with facilities operations.
The IST Health and Safety Plan (HASP) provided to HSS does not fully meet the requirements of 10 CFR 851. IST has not established an effective and compliant work control process. IST did not demonstrate its commitment to provide a supervisor for the fiber-optic replacement task who could adequately perform the role of Competent Person as described in the IST HASP. IST did not adequately perform a hazard analysis as required by 10 CFR 851, Title 29 Code of Federal Regulations Part 1910 (29 CFR 1910), National Fire Protection Association (NFPA) 70 E, and the IST HASP.	**JON 4** IST needs to develop, submit for approval, and implement a worker health and safety program per the requirements of 10 CFR 851. **JON 5** IST needs to develop and implement a work control process meeting the requirements of 10 CFR 851. The process must be integrated with MA-40 work controls, specifically as related to lockout/tagout and confined space hazards controls.

Conclusion	Judgment of Need
The electrical hazard that caused the accident has not been positively identified and abated.	**JON 6** MA-40, in coordination with HS-1.3, needs to conduct an electrical safety and engineering inspection of Manhole 1 (the accident location) to ensure that all electrical hazards are abated to prevent another accident.
The confined space hazard associated with work performed in manholes was not identified and mitigated.	**JON 7** MA-40 needs to conduct an assessment of the extent of condition of hazards in all confined spaces, identify the spaces, and implement confined space entry requirements.

Introduction

1.1 Facility Description

The Department of Energy (DOE) Germantown facility was dedicated by President Eisenhower in 1957. The 618,852-square-foot facility is situated on approximately 98.6 acres in Montgomery County, Maryland. The facility includes office space, an auditorium, heating and refrigeration plant, radio building, equipment sheds, and garages.

The Germantown Main Building holds office space, a cafeteria, various data centers, a warehouse, and a computer center. Figure 1-1 shows the Germantown facility, surrounding roadways, and location of the accident.

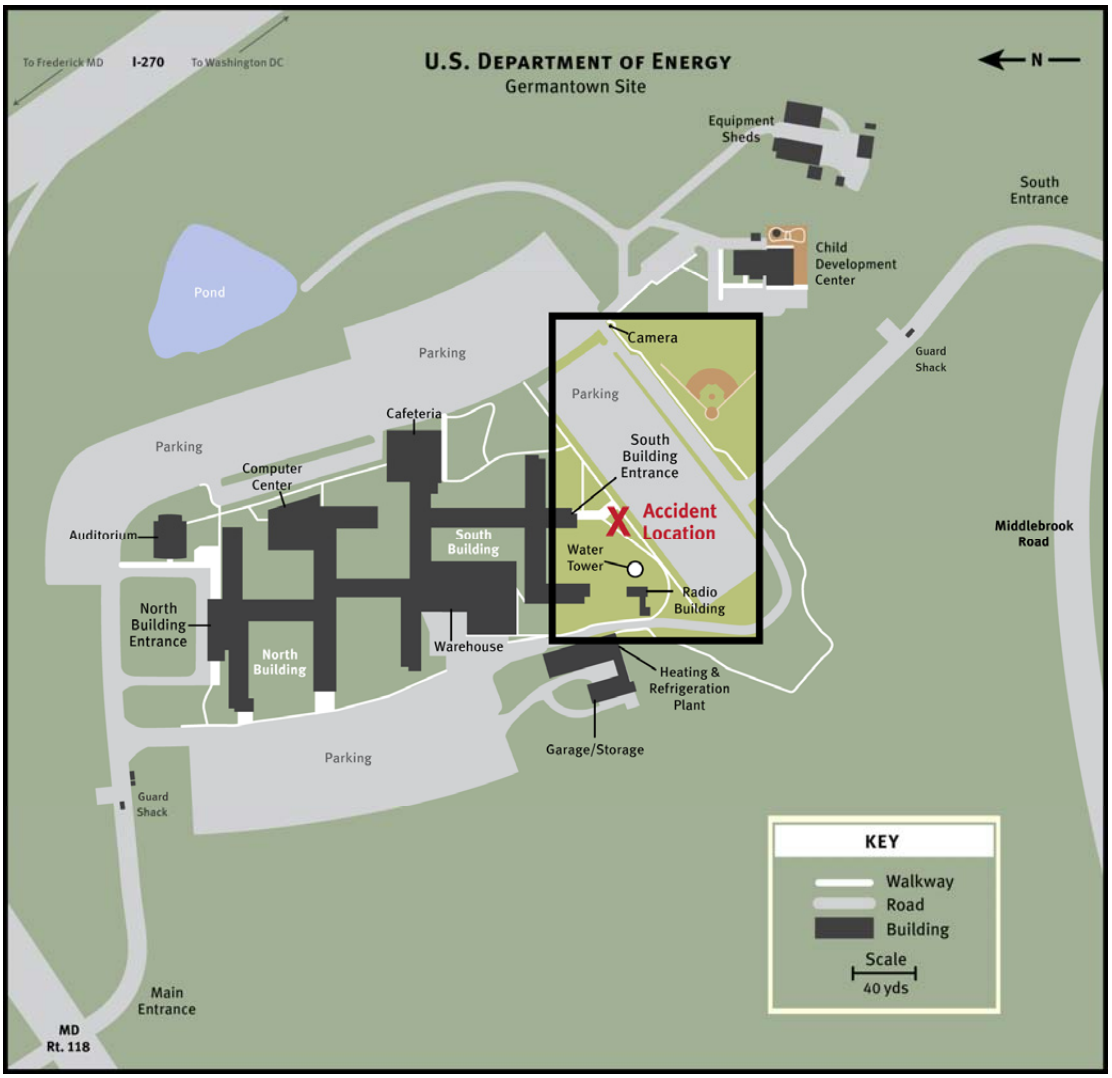

Figure 1-1. DOE Germantown Facility Site Map

1.2 Scope, Conduct, and Methodology

The Accident Investigation Board began its investigation on June 15, 2009, and submitted its final report to Chief Health, Safety and Security Officer (HS-1), on July 24, 2009. The Board's appointment letter is included as Appendix A to this report. The scope of the Board's investigation was to review and analyze the circumstances surrounding the accident and determine its cause. The Board also was tasked with evaluating the following.

- DOE Office of Health, Safety and Security (HSS) line management systems to ensure the contractor's compliance with safety and health regulatory requirements
- Integrated Security Technologies (IST) security systems maintenance contractor safety and health programs and plans including:
  - Work Planning and Control
  - Hazard Analysis
  - Confined Space
  - Electrical Safety
  - Training and Qualifications
  - Internal Safety Supervision, Performance, Feedback and Improvement
- Interface and protocols associated with safety between the Office of Management (MA) and HSS contractors

The purpose of this investigation was to determine the causes of the accident, including deficiencies, to assist the Department in understanding lessons learned, and, in doing so, to reduce the potential for recurrence.

The Board conducted its investigation using the following methodology.

- Facts relevant to the accident were gathered though interviews, document and evidence reviews, and examination of physical evidence.
- Event and causal factor charting, along with barrier analysis, change analysis, and human factors techniques, were used to analyze the facts and identify the cause(s) of the accident.
- Based on the analysis of information gathered, Judgments of Need (JON) for corrective actions to prevent recurrence were developed.

Figure 1-2 shows the terminology applicable to this investigation. Appendices B through G include photographs of the accident scene; a wiring diagram of the electrical cable involved in the accident; human factors indicators related to the accident; and the Board's barrier, change, and events and causal factor analyses.

Accident Investigation Terminology

A **causal factor** is an event or condition in the accident sequence that contributes to the unwanted result. There are three types of causal factors: direct cause(s), which is the immediate event(s) or condition(s) that caused the accident; root causes(s), which is the causal factor that, if corrected, would prevent recurrence of the accident; and the contributing causal factors, which are the causal factors that collectively with the other causes increase the likelihood of an accident, but which did not cause the accident.

Event and causal factors analysis includes charting, which depicts the logical sequence of events and conditions (causal factors that allowed the accident to occur), and the use of deductive reasoning to determine the events or conditions that contributed to the accident.

Barrier analysis review the hazards, the targets (people or objects) of the hazards, and the controls or barriers that management systems put in place to separate the hazards from the targets. Barriers may be physical or administrative.

Change analysis is a systematic approach that examines planned or unplanned changes in a system that caused the undesirable results related to the accident.

Human Factors analysis is a method used to identify organizational and cultural factors that, combined with human actions, can precipitate undesirable outcomes.

Figure 1-2. Accident Investigation Terminology

2. Facts and Analysis

2.1 Accident Description and Chronology

2.1.1 Accident Description

On June 9, 2009, at about 11:00 a.m., an IST alarm maintenance technician (Worker 1) received an electrical shock while performing work in an electrical manhole located near the south entrance to the Germantown facility (Figure 2-1). The worker was exiting the manhole using an aluminum ladder when the electrical shock occurred. Figure 2-2 shows the manhole and ladder. Appendix B includes additional photographs related to the accident scene.

A crew of four IST alarm maintenance technicians, one of whom was the supervisor, was tasked with pulling a length of fiber-optic cable that ran from Electrical Manhole/Vault 2 (Manhole 2), which is located across the south parking lot of the Germantown facility at the baseball field; to Electrical Manhole/Vault 1 (Manhole 1) located near the south entrance of the facility; to the Germantown Main Building. There was no written work plan or confined space permit for this work, and the IST supervisor provided only oral, not written, direction.

Facilities management staff from the Office of Administrative Management and Support (MA-42) was not available to open the manhole covers for the IST workers, so the IST workers obtained crowbars from MA-42 contractor staff to open them. There were no danger signs or alternative measures identifying the two manholes as permit-required confined spaces pursuant to Occupational Safety and Health Administration (OSHA) regulations in 29 CFR 1910.146, *Permit-required Confined Spaces*. The workers used a single 8-foot aluminum ladder to enter Manhole 1, which is approximately 11 feet deep, and Manhole 2 (8 feet deep).

When the IST work crew attempted to use old fiber-optic cable installed in the vaults as a "pull string" for the new fiber-optic cable, the old cable broke. The workers decided to use an existing ground wire (green wire) to pull the new fiber-optic cable (Figure B-2). They disconnected the existing ground wire in Manhole 1 and Manhole 2, and it remained attached to the transformer case; however, the closed-circuit television (CCTV) transformer remained energized. No one locked/tagged out the 480-volt power supply from the breaker in the Germantown Main Building. Figure C-1 shows a diagram of the electrical cable wiring. The Board developed Figure C-1 as a tool for analyzing the potential direct causes of the accident; it is conceptual and may not represent the actual wiring configuration.

At about 9:00 a.m., as the IST workers began to pull the new fiber-optic cable, Worker 1 entered Manhole 1 to pull the new cable through a conduit that held the old cable and a 480-volt electrical line that supplied power to the CCTV security camera (Camera 126). Worker 1 used an aluminum ladder to descend the manhole. After he entered Manhole 1, his co-workers took the ladder to Manhole 2 for use at that location.

Worker 1 completed the new fiber-optic cable pull using the disconnected ground wire (i.e., the green wire) as the pull string. When the cable pull was complete, his co-workers at Manhole 2, reconnected the ground wire and took the aluminum ladder back to Manhole 1 for Worker 1 to use when he ascended the manhole.

At about 11:00 a.m., Worker 1 yelled that he had been shocked while ascending the ladder. Worker 1 stated that, as he stepped off the ladder following the electrical shock, his left hand remained attached to the ladder and he disengaged it with a blow from his right hand. He remained at the bottom of the manhole and performed a cursory examination of the wires and cables to search for exposed electrical conductors.

Worker 2 (the supervisor) removed the aluminum ladder from Manhole 1 using a section of wire insulation. Worker 1 then used his cell phone to call the IST workers at Manhole 2 for help. They placed the aluminum ladder back into Manhole 1, trying to stay clear of any electrical conductors, and Worker 1 used it to exit the manhole without assistance. All appropriate notifications were made to

Office of Security Operations (HS-1.3) personnel, who, in turn, notified the Office of Administration (MA-40).

A co-worker transported Worker 1 to Shady Grove Hospital in Rockville Maryland, in a privately owned vehicle at approximately 11:30 a.m. He was examined for burns to his hand and released later that same afternoon. The following day he complained of soreness in his joints, arms, and shoulders, and was placed on leave for two days.

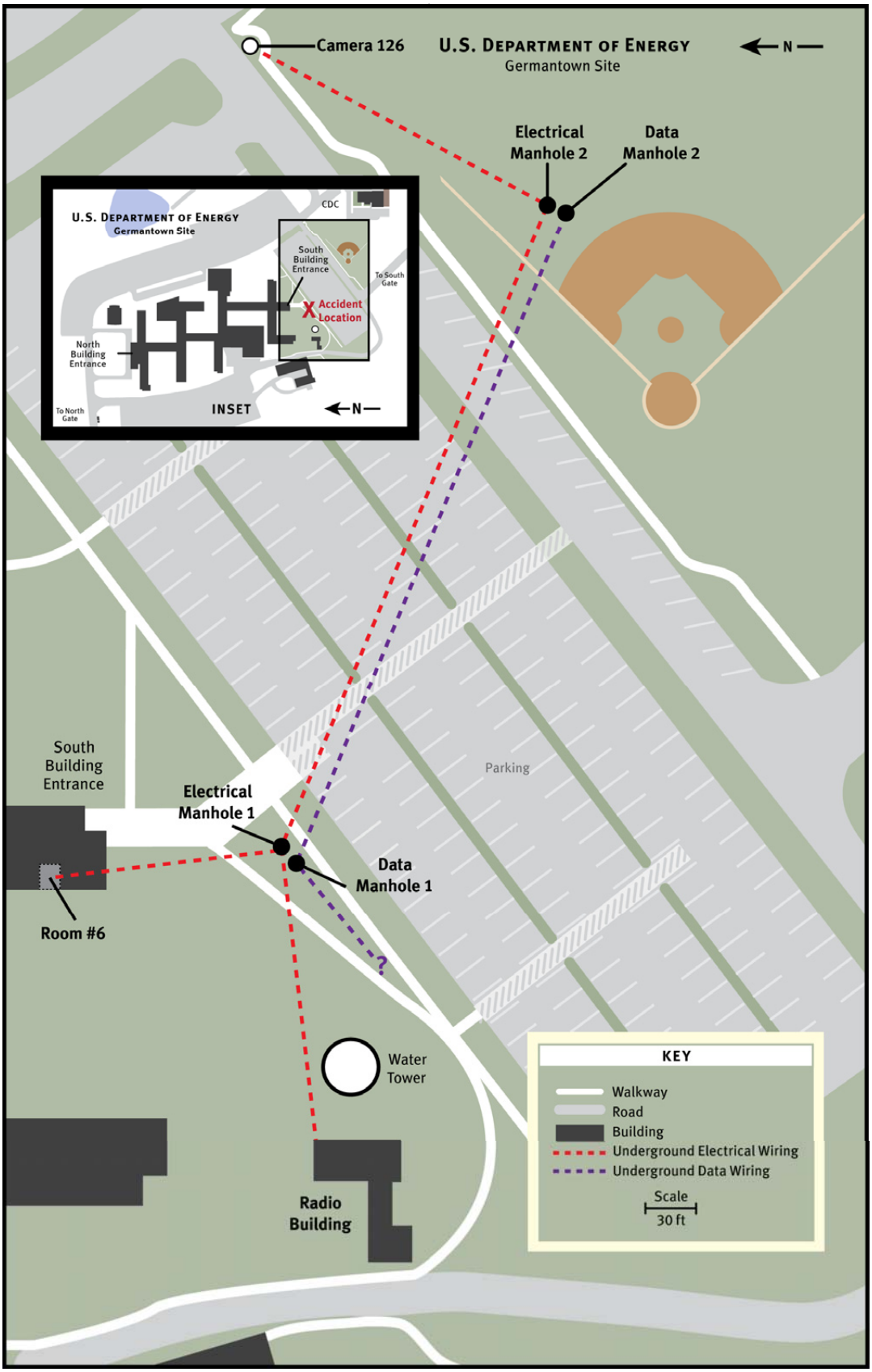

Figure 2-1. Accident Site

Figure 2-2. Aluminum Ladder inside Electrical Manhole 1

2.1.2 Historical Events and Accident Chronology

Table 2-1 shows a list of events that pre-date the June 9, 2009, accident and presents a chronology of related pre- and post-accident events.

Table 2-1. Summary Event Chart and Accident Chronology

Date	Time	Event
Historical Events		
1992		Original CCTV camera cable is routed with 480-volt power cable supplying the camera with power.
04/07/05		Limited Scope Investigation (LSI) of the Germantown Vehicle Barrier System identifies deficiencies in IST and the Office of Security safety programs.
02/09/06		Title10 Code of Federal Regulations Part 851 (10 CFR 851) was published as a final Rule.
Recent Events		
11/06 to 02/07		Discussion occurs on applicability of 10 CFR 851 to DOE HQ contractors. Initially, 10 CFR 851 is not recognized as applying to DOE HQ contractors.
12/08/06		Contract awarded to IST.
02/28/07		MA issues an “Acquisition Letter” to IST that requires submission of a health and safety program in conformance with 10 CFR 851.

Date	Time	Event
03/09/07		IST acknowledges receipt of acquisition letter per email to Office of Headquarters Procurement Services.
04/20/07		IST management signs and submits the IST HASP in response to 10 CFR 851.
04/20/07 to 07/18/07		IST HASP is received and is in HSS possession for review and approval.
05/25/07		Date by which DOE contractors must have an approved health and safety program pursuant to 10 CFR 851 to continue working on DOE sites.
07/18/07		End of 10 CFR 851 90-day review for the IST submittal.
Events Leading up to the Accident		
02/23/09		IST construction group, upgrading the CCTV system at the baseball field, discovered there was a break in the fiber-optic cable. The construction group relayed the information to the IST project manager. The IST project manager tasked the IST maintenance group with replacing the cable.
06/08/09		IST maintenance personnel began replacing the CCTV fiber-optic cable. Fiber-optic cable is run from camera to Manhole 2.
06/09/09	~ 09:00 A.M.	Four IST workers begin work at Manhole 1 (near the south entrance) and Manhole 2 (at the baseball field).
06/09/09	~ Between 11:00 and 11:30 A.M.	**ACCIDENT** **IST Worker 1 receives electrical shock while ascending ladder to exit Manhole 1.**
Post-Accident Events		
06/09/09	~11:30 A.M.	IST Worker 1 transported by co-worker to Shady Grove Hospital Emergency Room, Rockville, Maryland. IST notifies HS-1.3 personnel of accident; they, in turn, notify MA-40. MA-40 initiates investigation.
06/09/09	~ 02:30 P.M.	MA-40 notifies HSS Office of Corporate Safety Programs (HS-31) and requests investigation assistance.
06/09/09	~03:00 P.M.	The HS-31 investigator meets IST Worker 2 and the IST safety officer at Manhole 1. Two other IST workers arrive at the scene with crowbars and open the cover. Upon completion of the inspection the cover is closed.
06/09/09	~4:00 P.M.	The HS-31 investigator contacts the HQ MA Safety Director and relates what was observed.
.06/09/09	~5:00 P.M.	IST implements safety stand-down of all work pending a review.
06/10/09	~09:00 A.M.	HS-31 initiates initial interviews with IST.
06/10/09	~03:30 P.M.	IST reports safety stand-down release, but no access to Manhole 1 will be allowed.
06/15/09		Letter from Glenn Podonsky, HS-1, to Charles Lewis, HS-31, appointing the LSI Board.
06/15/09	10:00 A.M.	LSI begins.

2.2 Management Systems

Integrated Safety Management (ISM) establishes the overall framework and specific guidance for ensuring that the protection of workers, the public, and the environment is fully and effectively incorporated into all work and operational activities. Key aspects of ISM beyond those explicitly associated with the core functions and relevant to the circumstances surrounding the accident are discussed in this section.

In August 2007, HSS established an Integrated Work Management System (IWMS) description, the purpose of which was to provide an overview of the general functions of HSS and the implementing mechanisms used to accomplish these functions effectively and efficiently. Moreover, this description was intended to clearly communicate the HSS integrated approach for performing work to its employees and to other DOE and external organizations. Multiple existing DOE programs and directives drove HSS to develop this IWMS, including DOE Manual (DOE M) 450.4-1, *Integrated Safety Management System Manual*, which requires HSS to establish and maintain an ISM system description and implementing mechanisms to implement HSS work activities.

ISMS—Seven Guiding Principles

The guiding principles are the fundamental policies that guide actions, from development of directives to performance of work.

- Line Management Responsible for Safety
- Clear Roles and Responsibilities
- Competence Commensurate with Responsibility
- Balanced Priorities
- Identification of Safety Standard and Requirements
- Hazard Controls Tailored to Work Being Performed
- Operations Authorization

Five Core Functions

These five core safety management functions provide the necessary structure for any work activity that could potentially affect the public, the workers, and the environment.

The August 2007, IWMS applies to all work activities conducted by HSS. HS-1.3 has the responsibility for protecting personnel, facilities, property, classified information, and sensitive unclassified information for DOE Headquarters (HQ) facilities and performs work activities in the HSS assistance function related to Department operational activities. Although the use of ISM in ensuring safety and security operations at DOE HQ facilities is a primary responsibility of HSS, the HSS IWMS description does not address the interfaces with the Office of Management (MA) as related to safe facility operations.

It is important to note that, although MA is responsible for operation, maintenance, and construction at DOE HQ, General Services Administration (GSA) -owned facilities, several Program Offices, including HSS; Office of Chief Information Officer; Office of Science; and Office of Energy Efficiency and Renewable Energy, hire their own support service contractors to independently perform work. MA stated that of the 70 to 80 support service contractors at DOE HQ, only half are MA contractors; thus, there are potentially 35 to 40 support service contractors directly contracted by other DOE HQ program offices working in HQ buildings at any given time. The Board's review of Office of Worker Safety and Health Policy (HS-11) records found 139 DOE HQ support service contracts, and 47 of those contractors were required to submit their own worker safety and health programs pursuant to 10 CFR 851.

These support contractor services vary and may include administrative support, construction, maintenance, or the facility guard force. These contractors perform maintenance and construction activities without the knowledge of MA

facility managers. As a result, work controls for electrical safety lockout/tagout and for confined space entry permitting is not coordinated under a common set of work controls to protect workers.

The Board concludes that the same management system and work control weaknesses that contributed to this accident exist within other Secretarial Offices conducting work at DOE HQ. Unless MA is afforded the authority, and allocates commensurate resources to review and approve the safety implications of work, the conditions contributing to this accident cannot be fully corrected.

2.2.1 Line Management Accountability, Roles, and Responsibilities

Line management accountability for worker, public, and environmental protection is an essential part of the successful implementation of ISM. Line management accountability involves establishing clear priorities for worker, public, and environmental protection; ensuring an understanding of roles and responsibilities in achieving safety and environmental objectives; allocating sufficient resources; ensuring the existence of appropriate mechanisms for safe conduct of work activities; and rigorously monitoring performance and promoting enhanced performance. In this case, the Board defined HSS line management as those organizational elements responsible for ensuring the safe implementation of security operations, including HS-1; HS-1.2 (Office of Resource Management); HS-1.3; and IST.

IST was required to submit a Worker Safety and Health Program for DOE approval in accordance with 10 CFR 851.11(a)(3), which integrates the requirements that are applicable to the workplace with other related site-specific worker protection activities and with the Integrated Safety Management System (ISMS).

On April 20, 2007, IST submitted a corporate health and safety plan to HSS, rather than the Worker Safety and Health Program required by regulation. Interviews with HS-1.2 revealed that the IST HASP was never officially reviewed and approved by HS-1. There was an informal note in Office of Worker Safety and Health Policy (HS-11) records indicating that the IST plan was "incorrect"; however, that information was never communicated to HS-1.2, HS-1.3, and IST. Since HSS did not complete its review, the IST document was deemed approved after the 90-day review period elapsed, in accordance with the Rule.

Principles of clear roles and responsibilities establish a framework for ensuring that each departmental element, prime contractor, and subordinate contractor organization clearly understands and readily accepts their safety management function and that they recognize how their role supports the overall mission of worker, public, and environmental protection.

On December 8, 2006, a Master Task Order under Contract GS-07F-9158S was put in place. The contract establishes HS-1.31 as the Contracting Officer's Representative for technical matters. The Board notes that in this GSA contract the term Contracting Officer's Technical Representative is abbreviated as COR. This caused confusion during the investigation as COR is typically used to refer to the MA role as Contracting Officer. The Board used the term technical monitor to identify this position and function in HS-1.31.

The HSS standard operating procedure for contract technical monitors is silent on the need to monitor contractor performance relating to worker, public, and environmental protection. In addition, the Quality Assurance Program associated with the IST contract states that the contractor's employees will be required to enter confined spaces in the performance of their duties. However, the Quality Assurance Plan does not address the need for environment, safety, and health performance monitoring.

Interviews with HS-1.3 staff indicated that there was no structured oversight of the IST contract with regard to safety and health performance. As in the case of this accident, work orders for performing maintenance tasks are sometimes made by oral request under a broadly worded scope of work. On February 23, 2009, while performing an upgrade project on the video feed to Camera 126, IST personnel identified a broken and unrepairable fiber-optic connection. IST determined that there was not a spare fiber

in that location, which necessitated replacement of the entire fiber-optic cable from Camera 126 into the Germantown Main Building. An IST Program Manager assigned the IST Security Alarm and Access Control System (SAACS) maintenance crew (orally, but not in writing) the task of removing the old fiber-optic cable and replacing it with new fiber-optic cable as being within the scope of general maintenance. Poor weather and competing priorities delayed the project until Monday, June 8, 2009. HS-1.31 technical monitors for the contract stated that they were unaware that IST workers had entered the manholes on the day of the accident. An HS-1.31 staff member who oversees the Germantown facility stated that he does not review IST work areas, nor is he familiar with the hazards associated with this work. His safety oversight duties focus on the guard force in areas such as firearms safety.

The Board concludes that HSS line management did not fulfill their responsibility to institute a process to monitor the worker protection performance of its support service contractor, IST. HSS line management has not established a mechanism to provide the necessary safety competencies to oversee IST work.

2.2.2 Requirements Management

Effective requirements management mandates that DOE Orders (DOE O), regulations, or expectations governing conduct of a project or work activity be systematically identified. Establishing clear expectations and requirements ensures that all hazards have been properly and thoroughly considered, that appropriate controls have been developed, and that implementation of the identified hazard controls will enable protection of the worker, the public, and the environment.

On December 8, 2006, a Master Task Order under GSA-schedule Contract GS-07F-9158S was put in place. The IST contract for Facilities SAACS maintenance covers a clearly defined list of systems and work areas. The GSA-schedule contract has provisions specific to the work for HSS. However, the contract documents do not specify the worker safety and health standards that are required to be followed. For example, the contract does not incorporate by reference the latest version of DOE M 450.4-1, *Integrated Safety Management System Manual*, or Department of Energy Acquisition Regulation (DEAR) Clause 970.5223-1, "Integration of Environment, Safety, and Health into Work Planning and Execution."

The IST contract awarded by MA and approved by HSS, did not directly identify specific applicable safety and health regulations and standards. HSS line management was not aware of the hazards and associated safety and health requirements for the scope of work performed under the contract.

2.2.3 Competence Commensurate with Responsibility

The third principle of ISMS is "Competence commensurate with responsibilities," which requires that personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities. Training of personnel is vital to ensuring that they understand and recognize specific job and task hazards, are knowledgeable of the appropriate controls being applied, and are aware of the actions to be taken in a situation where unexpected conditions occur.

In addition, DOE O 226.1A, *Implementation of Department of Energy Oversight Policy*, dated July 31, 2007, requires DOE HQ and field-element line management to maintain sufficient knowledge of site and contractor activities to make informed decisions about hazards, risks, and resource allocation; provide direction to contractors; and evaluate contractor performance. The effectiveness of contractor assurance systems, the hazards at the site or of the activity, and the degree of risk are factors in determining the scope and frequency of DOE line management assessments and operational awareness activities.

The HS-1.2 managers and staff responsible for the review and approval of the IST worker safety and health programs submitted pursuant to 10 CFR 851 have not received formal training in worker safety and health requirements. They have used a summary checklist of the require-

ments to screen worker health and safety program submissions of other service contracts, but did not review the IST HASP. In addition, the HS-1.31 technical monitor and supporting staff in Germantown had not received formal training concerning the safety requirements and oversight expectations for the IST work. They stated that they do not monitor IST compliance with safety and health requirements because they do not know the applicable industrial safety and health hazards.

The competencies required for managing a contract are significantly different than the competencies required to perform work-activity-level oversight to determine compliance with DOE and regulatory requirements. Neither HS-1.2 nor HS-1.3 has established formal mechanisms (e.g., safety expertise from other HSS organizations) that provide for trained personnel to provide Federal oversight at the contract-requirement or work-activity level to assess whether DOE requirements and external regulatory requirements are being met and work is being adequately planned and conducted safely.

The IST HASP indicates that the Project Manager / Supervisor / Foreman, as well as Site Safety Coordinators, are the "Competent Persons" on any IST job site and that these individuals possess the necessary training and experience to recognize and anticipate hazards, as well as the knowledge and capacity to implement the site procedures and controls necessary to avoid accidents and create a safe job site.

The IST supervisor in charge of work associated with Camera 126 that occurred on June 8 and 9, 2009, did not adequately perform the functions of a "Competent Person." Specifically, the IST Supervisor did not perform the following functions.

- Identify the hazard associated with working near energized electrical components or the need to de-energize and lockout/tagout the 480-volt power supply to Camera 126 before performing work in the electrical panels located near Camera 126.
- Recognize the confined space hazard associated with Manholes 1 and 2 or that special precautions and special training were required for entry.
- Recognize the potential hazards associated with working in Manhole 1, which contained two, energized, 480-volt electrical power sources with conductors that were not enclosed or secured.
- Recognize the potential hazards associated with breaking continuity of the ground wire (green wire) and thus allowed the ground wire to be disconnected in two locations and used to pull new fiber-optic cable and a new ground wire between Manhole 2 and Manhole 1.
- Recognize that the aluminum ladder found in Manhole 2 was not acceptable for use near electrical power sources nor should it have been allowed to remain in use at the job site.

The Board concluded the following.

- HS-1.2 and HS-1.3 have not established the necessary competencies and mechanisms to provide effective contract-requirement- and work-activity-level safety oversight.
- IST did not demonstrate its commitment to provide a supervisor for the fiber-optic replacement task who could adequately perform the role of Competent Person as described in the IST HASP.

2.3 Work Control

As defined by DOE Policy (DOE P) 450.4, the objective of ISM is that both the Department and its contractors must systematically integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment. This is to be accomplished through effective integration of safety management into all facets of work planning and execution. The Contractor Requirements Document (CRD) included in DOE M 450.4-1, *Integrated Safety Management System Manual*, states that regardless of the performer of the work, the contractor is responsible for complying with the requirements of the CRD and with flowing down CRD requirements to subcontrac-

tors at any tier to the extent necessary to ensure contractor compliance.

10 CFR 851, *Worker Health and Safety Program*, requires contractors to implement work controls by regulation and, indirectly, by requiring implementation of specific safety and health standards. Specifically, 10 CFR 851.21, *Hazard Identification and Assessment*, requires contractors to establish procedures to identify existing and potential workplace hazards and assess the risk of associated worker injury and illness. In addition, 10 CFR 851.22, *Hazard Prevention and Abatement*, requires contractors to establish and implement a hazard prevention and abatement process to ensure that all identified and potential hazards are prevented or abated in a timely manner. Regulations in 10 CFR 851.23, *Safety and Health Standards*, require contractors to comply with safety and health standards that are applicable to the hazards at their covered workplace, including:

- Title 29 CFR, Part 1910, *Occupational Safety and Health Standards*, excluding 29 CFR 1910.1096, *Ionizing Radiation*;
- Title 29 CFR, Part 1926, *Safety and Health Regulations for Construction*;
- National Fire Protection Association (NFPA) 70, *National Electrical Code* (2005) (incorporated by reference, see § 851.27); and
- NFPA 70E, *Standard for Electrical Safety in the Workplace* (2004) (incorporated by reference, see § 851.27).

2.3.1 Define the Scope of the Work

Effective work execution begins with a well-defined scope of work that translates the mission and requirements of the work into terms that those who are to accomplish the work can clearly understand. The scope of work must provide sufficient detail to identify the resources (e.g., personnel, material, equipment, inter-organizational support) necessary to accomplish the work and support the hazard analysis and associated controls.

The contract requires IST to provide all personnel, equipment, facilities, materials, and technical expertise to perform the effort and to conduct contract operations and services in accordance with all applicable laws, regulations, and Orders. In accordance with the contract, corrective maintenance is initiated by a DOE Security Corrective Maintenance Request as outlined in Chapter II of *Headquarters Security Alarm and Access Control System Operations Manual*. Chapter II of the manual specifies that the SAACS administrators will notify the SAACS contractor alarm maintenance technicians of all requests for maintenance and will prepare and issue all DOE Security Corrective Maintenance Request forms submitted on the SAACS system. The chapter also requires the SAACS maintenance contractor supervisor and alarm technicians to interface with the security area custodians and DOE HQ contractor personnel for maintenance activities. The reference to interfacing with DOE HQ maintenance personnel is not explained further.

On February 23, 2009, while performing work on the video feed to Camera 126, IST personnel identified a broken and unrepairable fiber-optic connection. An IST project manager assigned the IST SAACS maintenance crew (orally, but not in writing) the task of removing the old fiber-optic cable and replacing it with new fiber-optic cable. During interviews, the Board learned that the IST job supervisor knew the scope of work was to remove the old fiber-optic cable and replace it with new fiber-optic cable. The IST job supervisor was also aware that Camera 126 was energized with 480 volts AC and that Manholes 1 and 2 contained energized, 480-volt AC, three-phase and 480-volt AC, single-phase cables. The IST job supervisor stated that he had previously performed work in the same manholes, but he was not aware that they were designated as confined spaces.

The Board concluded that IST neither adequately defined the scope of the work associated with replacing the old fiber-optic cable with new fiber-optic cable nor effectively communicated the scope of the work to the MA facilities maintenance organization. As a result, the method, techniques, and safety aspects associated with performing the task were not adequately determined.

2.3.2 Hazards Analysis

The objective of a hazards analysis is to develop a clear understanding of the task-specific hazards that may affect the worker, the public, or the environment. Hazard identification and analysis occur in preparation for a specific task, and continue throughout performance of the task as conditions change.

10 CFR 851.21 requires contractors to perform routine job activity-level hazard analyses: "Contractors must perform routine job activity-level hazard analyses" [851.21(a)(6)]. *DOE Implementation Guide for Worker Safety and Health Program* (440.1-8, Section 3.3.2.1.6.) provides guidance as it relates to a job activity-level hazard analysis.

Operations and procedures at the activity level should be analyzed and reviewed to identify potential worker protection hazards and deficiencies. A Job Hazard Analysis (JHA), which is also known as a Job Safety Analysis (JSA), is the most basic and widely used tool for identifying hazards associated with jobs at the activity level. JHAs can satisfy a large portion of the worker-protection hazard identification requirements at most workplaces. Affected employees and supervisors should participate in the JHA process, as their knowledge of the tasks and associated hazards and their familiarity with the procedures actually used in performing the work provide information that is more complete during the JHA. In addition, these front-line personnel can assist in determining the feasibility and effectiveness of proposed control measures.

The IST HASP states that the processes and procedures contained within it, combined with Site-Specific Health and Safety Plans (SSHASP), will constitute the overall environment, safety, and health plan for each IST project. The IST HASP includes a synopsis indicating that the Project Manager /Supervisor/ Foreman, as well as Site Safety Coordinators, are the "Competent Persons" on any IST job site and that these individuals possess the necessary training and experience to recognize and anticipate hazards, as well as the knowledge and capacity to implement site procedures and controls to avoid accidents and create a safe job site.

The SSHASP requirements are specified in Section 2.6 of the IST HASP, which states: "A SSHASP will be developed by the Health and Safety Officer or designee based on a review of job-site specifications, site walkthrough, and pre-engineering survey. SSHASP will include activity hazard assessments and site-specific health and safety requirements." Section 2.7 specifies SSHASP field change requirements that may be necessary to ensure that the plan accurately reflects applicable job site conditions and complies with regulatory requirements.

Section 12.0 of the IST HASP provides the IST Confined Space Entry Program to set the standard requirements for practices and procedures to protect employees from the hazards of entry into permit-required confined spaces as outlined in 29 CFR 1910.146. The IST Confined Space Entry Program is a detailed 10-page document that contains information for entering and working in confined spaces, including training, authorized entrants, attendants, entry supervisor, rescue services, atmospheric testing, and the permit system. However, the Confined Space Entry Program was not implemented for the work performed by IST alarm maintenance technicians on June 8 and 9, 2009, at the DOE HQ Germantown facility. In addition, the Confined Space Permit process used by MA-40 at the Forrestal facility is not implemented at the Germantown facility.

Section 14.6.40 of the IST HASP states: "Employees will not work near live parts of electrical circuits, unless the employees are protected by:

- De-energizing and grounding the parts;
- Guarding the part by insulation; or
- Visual airgap."

NFPA 70 E, Article 110.8, "Working On or Near Electrical Conductors or Circuit Parts," requires lockout/tagout devices to be applied before working on or near exposed electrical conductors and circuit parts operating at 50 volts or more. Additionally, it requires the following: "if lockout/tagout devices cannot be applied and if the live parts operating at 50 volts or more are

not placed in an electrically safe work condition, other safety-related work practices shall be used to protect employees who might be exposed to the electrical hazards involved. Such work practices shall protect each employee from arc flash and from contact with live parts operating at 50 volts or more directly with any part of the body or indirectly through some other conductive object. Work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the live parts. Appropriate safety-related work practices shall be determined before any person approaches exposed live parts within the Limited Approach Boundary by using both shock hazard analysis and flash hazard analysis. Additionally, if live parts are not placed in an electrically safe work condition (i.e., for the reasons of increased or additional hazards or infeasibility per 130.1), work to be performed shall be considered energized electrical work and shall be performed by written permit only."

NFPA 70 E, Article 130, "Working On or Near Live Parts," establishes the approach boundaries to live parts for shock and flash protection. Based on the configuration of the lower electrical junction box at Camera 126, the box contained energized electrical terminals with 480 volts electrical phase-to-phase potential. This establishes a Limited Approach Boundary to exposed fixed circuit parts at 3 feet, 6 inches; a Prohibited Approach Boundary of 1 foot, 0 inches; and a Prohibited Approach Boundary of 0 feet, 1 inch.

The IST alarm maintenance technicians were assigned to work in two confined spaces—one a manhole 10 feet, 10 inches below grade and another manhole 8 feet below grade—without following the confined space entry requirements of 29 CFR 1910.146 or Section 12 of the IST HASP. A contributing factor was that MA had not informed exposed employees of the hazard by posting danger signs or any other equally effective means that identified the existence, location, and danger posed by the permit spaces, in accordance with 29 CFR 1910.146(c)(2).

The IST alarm maintenance technicians were assigned to work in two electrical manholes containing energized 480-volt circuits and used a non-electrically-safe aluminum ladder. Section 14.6.25 of the IST HASP states: "Only non-metallic, approved ladders will be used on IST projects. The Site Safety Coordinator will coordinate the approval of ladders with the site manager." However, in this accident, the workers used an aluminum ladder found at the worksite and did not interface with the Site Safety Coordinator.

As their work progressed, IST alarm maintenance technicians independently determined that it would be necessary to use an existing ground wire to remove the failed fiber-optic cable and to install the new fiber-optic cable. As a result, they disconnected the existing ground wire in Manhole 1 and Manhole 2, and were not sure if they could have exposed themselves to a potential energy source. Section 14.6.38 of the IST HASP states: "The path to ground from circuits, equipment, and enclosures will be permanent and continuous." The same section states that electrical safety-related work practices cover both qualified persons (those who have training in avoiding the electrical hazards of working on or near exposed energized parts) and unqualified persons (those with little or no such training).

IST alarm maintenance technicians, who were not trained and were not certified electricians, performed work on an energized 480-volt electrical panel that contained exposed energized components. They also entered two manholes containing energized 480-volt electrical circuits without personnel protective equipment or a full understanding of the potential hazards associated with the work.

The Board concluded that IST did not adequately perform a hazard analysis as required by 10 CFR 851, 29 CFR 1910, NFPA 70 E, and the IST HASP. As a result, IST workers were exposed to significant electrical energy and confined space hazards.

2.3.3 Develop, Implement, and Perform Work within Controls

The objective of developing and implementing controls is to identify and provide a full range of hazard protection (i.e., engineering, administrative, and personnel protective equipment)

consistent with the nature of the hazards to be encountered during task performance. The development and implementation of controls relies on the premise that the hazards associated with the defined scope of work have been adequately and completely identified. IST did not develop a job-specific hazards analysis; therefore, they could not develop and implement adequate controls.

Hazard controls must be properly implemented, and personnel performing work must be fully apprised of the hazards and associated controls before work can be safely performed. Authorization to commence work must be explicit, and associated limits under which work is to be performed should be specific. Deviations to the planned and authorized scope of work are to be analyzed, and appropriate modifications to existing controls implemented prior to executing a scope change.

The Board found that authorization to perform the work was informal and consisted of a telephone call from the IST project manager to the IST SAACS Maintenance Crew. No formal work documentation (site-specific JSA, work "ticket," or work control document) was developed or used to authorize and control the work.

The IST alarm maintenance technicians discussed the original scope of work, which consisted of installing new fiber-optic cable between Camera 126 and the Germantown Main Building using the old fiber-optic cable as the method for pulling the new fiber-optic cable. The original scope of work changed when the IST alarm maintenance technicians determined it would be necessary to use an existing ground wire to remove the old, failed fiber-optic cable and install the new fiber-optic cable and discovered that the old fiber-optic cable could not be used to pull the new fiber-optic cable from Manhole 2 to Manhole 1.

During the interview process, the Board learned that the IST technicians were confident in the ability and judgment of the IST job supervisor and that they believed work was being performed correctly and safely. Based on the number of hazards that were not identified and their significance, the associated controls that were not implemented, and the unsafe work practices used while performing the work, the competence of the IST job supervisor and the alarm maintenance technicians is brought into question. (See Section 2.2.3, "Competence Commensurate with Responsibility.")

2.3.4 Feedback and Improvement

Feedback and improvement processes are essential to understanding safety and operational performance, analyzing trends, identifying essential improvement initiatives, preventing recurrence of events, communicating lessons learned, and promoting improved performance. For these processes to be most effective, workers should be clearly involved in identifying performance vulnerabilities as well as opportunities for improvement.

In 2005, the Office of Security Operations (SO) and IST organizations (line management) were the subject of an LSI concerning multiple events at the Germantown facility involving the malfunction of a vehicle barrier (LSI performed by the Office of Environment, Safety and Health [EH]; report issued for release on July 27, 2005). That investigation resulted in 25 JONs that addressed the improvements needed in SO and IST safety management. The 2005 JONs included the following.

- SO needs to develop and implement a formal process to ensure that essential safety requirements are identified and are incorporated into contractor documents for implementation, according to SO safety expectations.
- SO needs to develop a formal process to ensure that IST and other contractors have established roles and responsibilities for effective hazard evaluation and identification and implementation of hazard controls for SO projects.
- SO needs to develop and implement a formal process for systematically conducting surveillances, inspections, or assessments of all pertinent contractor and subcontractor activities to evaluate the performance of project management, quality assurance, and safety systems, and identify necessary corrective actions.

- IST and other contractors need to formally institutionalize a process for identifying, capturing, evaluating, and translating essential safety requirements into SO project activities.
- IST and other contractors need to develop and implement a formal process to define roles and responsibilities for evaluation of hazards, identification and implementation of hazard controls, and the incorporation of any modifications associated with SO projects.

During the course of this investigation, it was determined that the 2005 LSI report had not been formally transmitted to SO from EH. SO and IST management and staff were aware of the report and had provided factual accuracy comments. Copies of the final report had been provided to SO by the LSI Chairman.

In 2005, neither SO or IST had a formal feedback and improvement process to manage the improvements identified in the JONS from the investigation. The management system weaknesses identified in 2005 were not corrected and became precursors to the 2009 accident.

HSS was formally established on October 1, 2006, by the Secretary of Energy.

DOE M 450.4-1, *Integrated Safety Management System Manual*, requires ISM System Descriptions that explicitly detail how the various ISM guiding principles and core functions are to be implemented. (See Section 2.2, "Management Systems.") HSS implements the ISM guiding principles and core functions for HSS-related security operations at DOE facilities. HS-1.3 is specifically responsible for implementing ISM Core Function 5, "Provide Feedback and Continues Improvement," for DOE HQ security operations.

The investigation found no formal process that has been implemented within HS-1.3 or IST to collect and incorporate lessons learned and other feedback or to manage self-identified or externally identified corrective actions, such as those from the 2005 investigation. The Board concluded that HS-1.3 and IST have not implemented a feedback and improvement process as required by ISM to protect workers.

3. Causal Factors

3.1 Direct Cause

The Board determined that the direct cause of the accident was that IST Worker 1 came in contact with an energized electrical source that was transmitted through an all-aluminum ladder**.**

During the installation of a fiber-optic cable, an IST employee exiting Manhole 1 using an all-aluminum ladder received an electrical shock. The Board took statements from the IST workers to assist in establishing how the shock occurred. Based on the review of the electrical tests run from outside the manhole, review of the 1992 electrical design drawings, and photographs, and interviews, the Board identified three potential causes of the electrical shock.

1. Contact with an exposed energized conductor; either one of the three-phase (480-volt) electrical cables or the single phase (480-volt) electrical cables located in the manhole. If any of these cables had exposed conductors or if damage occurred while Worker 1 was in the manhole and either Worker 1 or the aluminum ladder came in contact with the conductor, an electrical shock could have resulted.
2. Damage to the single-phase, 480-volt cable by the ground wire. When the workers disconnected the ground wire and used it as a pull string to remove the old fiber-optic cable and install a new fiber-optic cable, the ground wire could have damaged the single-phase, 480-volt cable that was in the same conduit as the fiber-optic cable. This could have resulted in energizing the ground wire used to pull the old fiber-optic cable out and the new one in. This possibility is supported by some of the low megger-ohm readings obtained from the electrical test conducted.
3. Disconnecting the ground wire. Without knowing the origin of the wire that was disconnected from the transformer while still energized or whether the wire was a grounding conductor, ground wire, neutral or similar wire, there is a possibility that energy was transferred to this wire.

The reason for the electrical shock experienced by Worker 1 cannot be determined and abated until the manhole is entered and the area is examined. MA-40 has advised that this will require several weeks for planning and procurement to ensure that electrical service can be maintained to the radio building. This investigation needs to be performed by qualified electrical workers, in proper electrical personnel protective equipment, using proper confined space entry techniques, with a well thought out plan to progress through the troubleshooting process. DOE-contracted work must be conducted in compliance with ISM and 10 CFR 851.

3.2 Root Causes

The Board determined that the root cause of this accident was the absence of clear understanding of the task-specific hazards. At each line management organizational level and functional responsibility there were unclear roles, responsibilities, and imprecise communication of safety and health requirements within and between HSS and IST. Where IST had established safety controls, such as the HASP, those controls were not implemented.

The Board concluded that this accident could have been prevented.

3.3 Contributing Causes

- **Oversight was not effective.**

The IST, GSA-schedule contract did not identify specific applicable safety and health regulations and standards. There was a lack of recognition by HSS line management about the work hazards and safety and health requirements associated with tasks performed under the contract. HSS line management did not fully understand the requirements of 10 CFR 851. In addition, the HSS contract and technical monitors did not have the training, or expertise available to them, to support the responsibilities to oversee or monitor IST work.

- **Work control did not provide for hazards analysis.**

There is an unstructured, informal work control process at the DOE HQ Germantown facility for IST work with respect to JSA conformance to 10 CFR 851. Direction to perform work by the IST supervisor was communicated orally, not in a written form that could have been reviewed for potential work hazards. Although the IST supervisor performed an inspection of the job site before work began, he did not identify the hazards or lockout/tagout requirements or that work was to be conducted in a confined space. The IST supervisors and workers were unaware of the hazards involved in the work to be performed. The supervisor did not recognize the change in scope of work when the decision was made to pull the fiber-optic cable using the disconnected ground wire (green wire) as the pull string.

- **Facility management institutional controls are not in place.**

MA-40 had not identified the manholes at the Germantown facility as permit-required confined spaces under 29 CFR 1910.146, nor had they implemented a confined space permitting process. IST did not plan for a confined space permit for the job and did not coordinate with MA-40. In addition, safety and rescue equipment was not provided at the job site, a confined space permit was not posted, and air monitoring was not performed under 29 CFR 1910.146.

Work proceeded without proper controls for electrical safety, including logout/tagout. Neither the Germantown Main Building 480-volt electrical supply panel nor the CCTV camera electrical 480-panel was locked out before work began. MA-40 has not established a facility-wide electrical safety lockout/tagout program.

4. Conclusions and Judgments of Need

JONs are the managerial controls and safety measures believed necessary to prevent or minimize the probability of a recurrence of the same or similar accident. JONs flow from the causal factors and are directed at guiding managers in the development of corrective actions. The Executive Summary identifies the Board's JONs. The conclusions and JONs are provided in Table 4-1 and in the Executive Summary.

Table 4-1. Conclusions and Judgments of Need

Conclusion	Judgment of Need
The same management system and work control weaknesses that contributed to this accident may exist within other Secretarial Offices conducting work at DOE HQ.	**JON 1** HS-1 and MA-1 need to establish a formal agreement that is implemented with ISM as the overall framework. The agreement must provide specific implementing mechanisms for establishing a uniform work-control process for all contractors performing work at DOE HQ.
HSS line management did not fulfill its responsibility to institute a process to monitor the worker protection performance of its support service contractor, IST. HSS line management has not established a mechanism to provide the necessary safety competencies to oversee IST work. HS-1.3 has not defined the roles and responsibilities or established the mechanisms needed to oversee the safety of IST work. HS-1.3 and IST have not implemented a feedback and improvement process as required by ISM.	**JON 2** HSS line management needs to develop, allocate resources for, and implement a formal program to review the safety requirements of contracted work. **JON 3** HS-1.3 and IST need to develop and implement an integrated feedback and continuous improvements program. This program should be integrated with the Office of Administration (MA-40) as necessary to ensure that corrective actions are coordinated with facilities operations.
The IST HASP provided to HSS does not fully meet the requirements of 10 CFR 851. IST has not established an effective and compliant work control process. IST did not demonstrate its commitment to provide a supervisor for the fiber-optic replacement task who could adequately perform the role of Competent Person as described in the IST HASP. IST did not adequately perform a hazard analysis as required by 10 CFR 851, 29 CFR 1910, NFPA 70 E, and the IST HASP.	**JON 4** IST needs to develop, submit for approval, and implement a worker health and safety program per the requirements of 10 CFR 851. **JON 5** IST needs to develop and implement a work control process meeting the requirements of 10 CFR 851. The process must be integrated with MA-40 work controls, specifically as related to lockout/tagout and confined space hazards controls.
The electrical hazard that caused the accident has not been positively identified and abated.	**JON 6** MA-40, in coordination with HS-1.3, needs to conduct an electrical safety and engineering inspection of Manhole 1 (the accident location) to ensure that all electrical hazards are abated to prevent another accident.

Conclusion	Judgment of Need
The confined space hazard associated with work performed in manholes was not identified and mitigated.	**JON 7** MA-40 needs to conduct an assessment of the extent of condition of hazards in all confined spaces, identify the spaces, and implement confined space entry requirements.

5. Board Members, Advisors, Consultants

Board Members

7/23/2009

Chairperson — Date:

Charles Lewis

DOE Office of Health, Safety and Security

7/23/2009

David Pegram — Date:

DOE Office of Health, Safety and Security

7/23/2009

Joseph Hopkins — Date:

DOE Office of Health, Safety and Security

7/23/2009

Robert Seal — Date:

Office of Nuclear Energy, Idaho

Advisors

Advisor	Dennis Vernon, MAS Consultants
Advisor	Larry Perkins, DOE Office of Science, Oak Ridge Operations

Consultants

Consultant	Susan Keffer, Project Enhancement Corporation

Appendix A: Appointment of Limited Scope Investigation

Department of Energy
Washington, DC 20585

June 15, 2009

MEMORANDUM FOR CHARLES B. LEWIS, III
DIRECTOR
OFFICE OF CORPORATE SAFETY PROGRAMS

FROM: GLENN S. PODONSKY
CHIEF HEALTH, SAFETY AND SECURITY OFFICER
OFFICE OF HEALTH, SAFETY AND SECURITY

SUBJECT: Limited Scope Investigation of the June 9, 2009 Near-Miss Electrical Incident at DOE Headquarters, Germantown, MD

You are hereby appointed Chairperson of a Limited Scope Investigation to determine the events, conditions and causal factors of the near-miss electrical incident that occurred at the Department of Energy (DOE) Headquarters Building, Germantown on June 9, 2009. This event involved a security system service technician, contracted by the Office of Health, Safety and Security (HSS). This event could have resulted in much more serious consequences to one or more workers. It is imperative that HSS and the Office of Management (MA) work together to identify improvements necessary in management systems and safety programs to prevent recurrence of this or similar events.

HSS has ascertained that this incident meets the requirements for a Limited Scope Investigation consistent with DOE Order 225.1A, *Accident Investigations*. The scope of this investigation will include an evaluation of the adequacy and implementation of the following areas:

1) HSS management systems to assure contractor's compliance with safety and health regulatory requirements.
2) Integrated Security Technology (IST), security systems maintenance contractor safety and health programs and plans to include:
    a. Work planning and control
    b. Hazard Analysis
    c. Confined Space
    d. Electrical Safety
    e. Training and Qualifications
    f. Internal Safety Supervision, Performance, Feedback and Improvement
3) Interface and protocols between MA and HSS contractors associated with safety of work preformed.

In addition, the HSS investigation team should work cooperatively and be coordinated with supporting the MA investigation of this event. Specifically, HSS should provide support to MA on the broader extent on facility condition, work control, and safety programs at Headquarters facilities.

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As you deem necessary, other advisors and support personnel may be added to the Limited Scope Investigation to ensure a high quality report is generated in a timely manner. It is anticipated that MA will designate a representative to observe this HSS investigation and, as appropriate, provide assistance to the Investigation Team during their data collection activities.

You are to provide my office with periodic reports on the status and progress of this investigation. Discussions of the investigation and copies of the draft report will be strictly controlled until the final report is accepted and authorization for release has been granted. The final HSS investigation report should be provided to my office by July 17, 2009. The final report will then be provided to MA.

cc:
Ingrid Kolb, MA-1
Brian Costlow, MA-40
William Eckroade, HS-1
Robert Lingan, HS-1.3
William Roege, HS-30

Appendix B: Photographs of Accident Scene

Photographs of Accident Scene

The following figures show the site of the June 9, 2009, accident and related photographs of the accident scene.

Figure B-1. Data Manhole 1 and Electrical Manhole 1 near South Entrance of Germantown Facility

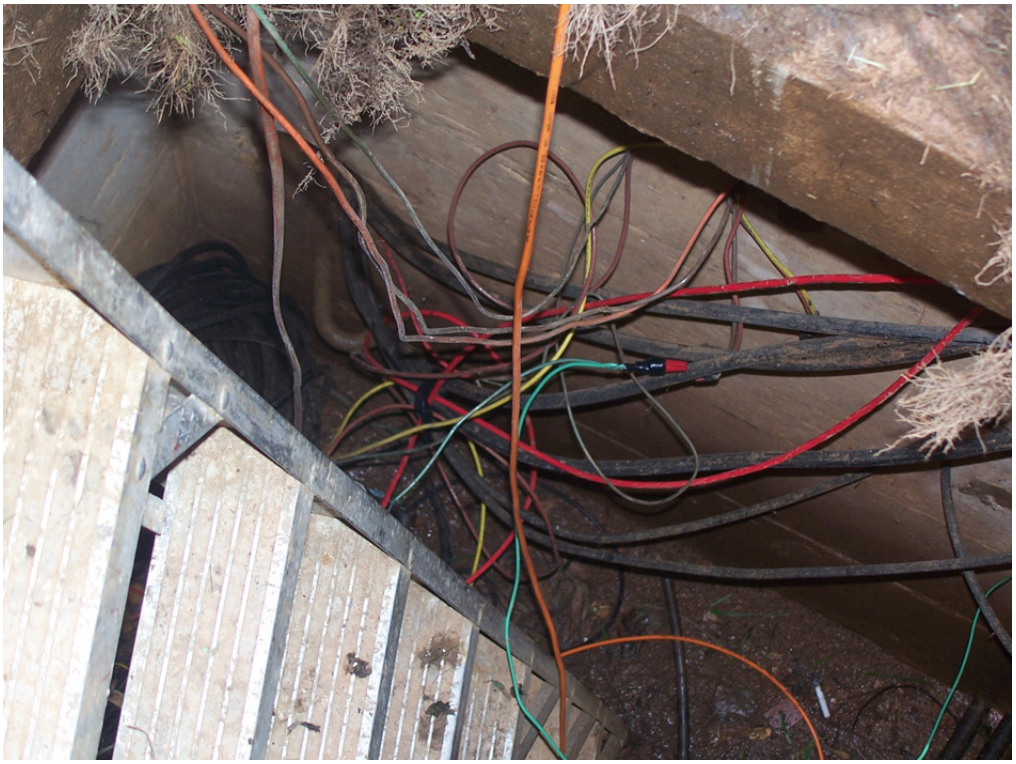


Figure B-2. Manhole 1 Wiring

Figure B-3. Manhole 2 to Manhole 1 Conduit

Figure B-4. Manhole 2 to Camera Conduit

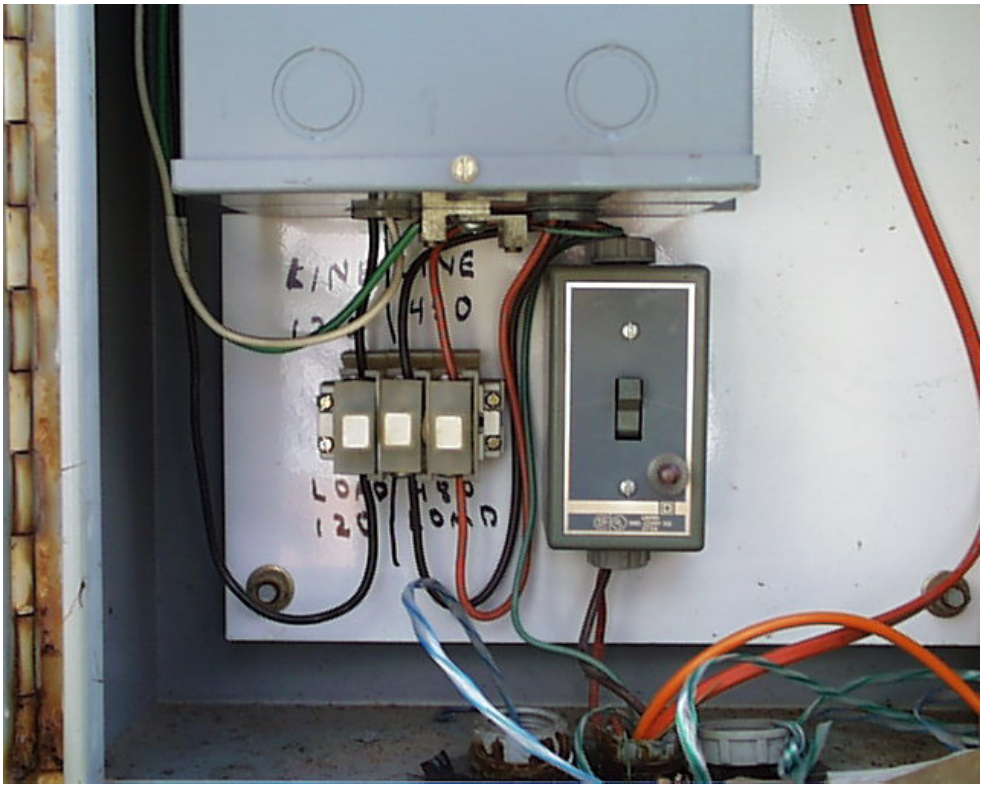
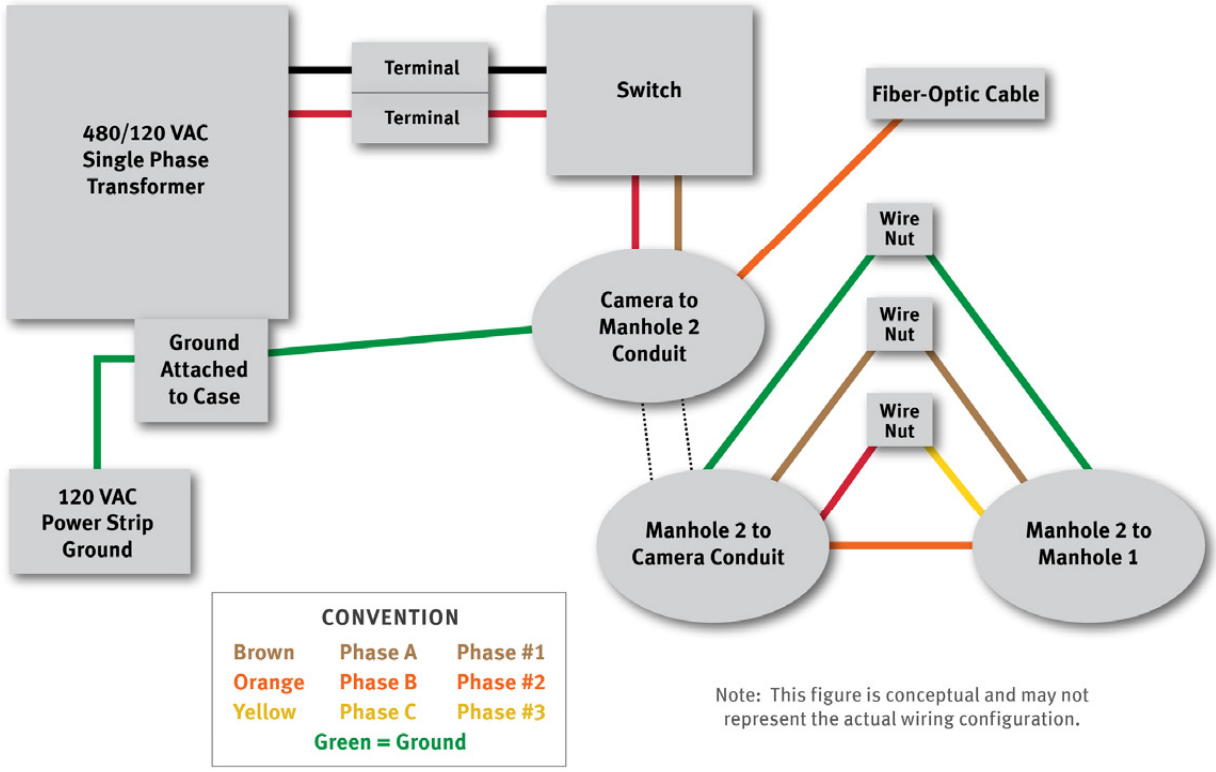


Figure B-5. Camera Lower Junction Box

Appendix C: Electrical Cable Wiring Diagram

Figure C-1. Electrical Cable Wiring Diagram



Notes:

1. Equipment at camera location is not intentionally bonded to earth.
2. Red wire from camera connected to Yellow supply wire (Brown and Yellow 480 VAC supply).
3. Orange line represents fiber-optic cable, not Orange electrical conductor.

Appendix D: Human Factors

Human Factors

The Board considered the concepts of Human Performance Improvement (HPI) in the context of this accident. Within the context of HPI, human error is defined as an inadvertent and, therefore, unavoidable mistake on the part of an individual. The HPI approach is to improve the identification of error-likely situations and to establish additional barriers between the individual and the hazard, such that the individual is protected even if the error occurs. HPI also demonstrates that a large fraction of human errors are due to organizational weaknesses that create situations more likely to lead to error-prone conditions or behaviors.

The Board identified several human performance issues associated with this accident that demonstrated both individual and organizational behaviors that did not proactively or aggressively ensure that work was being conducted safely. Examples of those behaviors included the following.

- **Latent Organizational Weakness—There were unclear goals, roles, responsibilities, and imprecise communication of requirements between the Office of Health, Safety and Security (HSS) and Integrated Security Technologies (IST).**

The IST contract did not directly identify specific applicable safety, health laws, and standards. There was a lack of understanding by HSS and IST about the safety and health requirements associated with tasks performed under the contract, as well as the scope of hazards.

IST acknowledged receipt of an Acquisition Letter per email to the Office of Headquarters Procurement Service (MA-64.1). IST did not fully understand the requirements of Title 10 Code of Federal Regulations Part 851 (10 CFR 851), which includes Integrated Safety Management (ISM). This led to them to submit their Health and Safety Plan (HASP), not a compliant 10 CFR 851, Worker Health and Safety Program.

No documentation was identified to indicate that the Office of Resource Management (HS-1.2) or HS-1.31 formally reviewed or approved the IST HASP. However, a notation made by an Office of Worker Safety and Health Policy (HS-11) industrial hygienist suggests that a cursory review of the IST 2007 HASP was performed and that it was "incorrect." HSS did not adequately review and provide direction to IST regarding the submission. This contributed to IST failing to implement requirements, failing to coordinate with other organizations, and failing to implement ISM.

No documentation was identified to indicate that the IST HASP was finally approved by DOE. HSS failed to understand the requirements of 10 CFR 851, which led to IST continuing to work absent of compliance with requirements. The IST-submitted HASP was accepted by default.

- **Latent Organizational Weakness—Clear accountability for safety oversight was not imposed by HSS or MA on work performed by IST.**

No qualified safety and health professional provided by the Office of Management (MA), HSS, or IST was available at the job site to approve or review work. MA did not provide worker safety and health oversight because they did not view this contract as part of their responsibility. No formal process exists for IST to interface with Germantown MA personnel or to monitor safety.

The Headquarters Security Alarm and Access Control System (SAACS) operations manual does not specify interface requirements between IST and MA Facilities Management on scheduling work, safety reviews, or requirements such as lockout/tagout or confined space. HS-1.31 technical monitors did not follow the SAACS Operations Manual. Use of the manual was inconsistent and informal; the work authorization process was oral, not written; and work performed by IST was not monitored for safety.

- **Normalization of Poor Practices—IST workers had a faulty mental model, inaccurate risk perception and assumptions, and a lack of knowledge about the associated potential hazards and critical parameters involved with the work**.

IST workers involved in the accident indicated to the Accident Investigation Board that they had made entry into the manholes involved in the accident to perform similar work six to seven times before without incident. Entering the manhole on the day of the accident without consideration of confined space hazards or electrical hazards was normal operations.

The scope of the work and potential risk changed when the IST workers decided to disconnect the green wire associated with the 480-volt transformer supplying the Closed Circuit Television camera and use it as a pull string for the new fiber-optic cable. There was no "stop point" consideration when the scope of work changed.

Direction to perform work by the IST supervisor was oral, not written. IST supervisors and workers were unaware of the hazards involved in work. IST has an unstructured, informal work control process including the lack of a Job Safety Analysis that conforms to 10 CFR 851. There was no opportunity for a safety professional to review the planned work.

The confined space entry permit was not planned for by IST in coordination with MA. MA at Germantown neither requires nor signs off on confined space permits for IST. An MA confined space program exists at DOE Forrestal, but it is not implemented at the Germantown facility. There were no danger signs or alternative measures used to identify the two manholes as permit-required confined spaces pursuant to Occupational Safety and Health Administration regulations in 29 CFR 1910.146, *Permit-required Confined Spaces*.

Appendix E: Barrier Analysis

Barrier Analysis

Barrier analysis is based on the premise that hazards are associated with all tasks. A barrier is any means used to control, prevent, or impede a hazard from reaching a target, thereby reducing the severity of the resultant accident or adverse consequence. A hazard is the potential for an unwanted condition to result in an accident or other adverse consequence. A target is a person or object that a hazard may damage, injure, or fatally harm. Barrier analysis determines how a hazard overcomes the barriers, comes into contact with a target (e.g., from the barriers or controls not being in place, not being used properly, or failing), and leads to an accident or adverse consequence. The results of the barrier analysis are used to support the development of causal factors. Table E-1 shows the results of the barrier analysis of the June 9, 2009, accident at the Department of Energy Headquarters Germantown Facility.

Table E-1. Barrier Analysis

Hazard: Dangerous Electrical Energy and Confined Spaces		**Target: IST Worker 1**	
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier affect the accident?**
Work Plan/Job Safety Hazard Analysis	Failed	Not Used	Supervision and workers were not aware of the hazards and proper controls.
HSS Contract Award Process: Review and Approval for IST Contract	Failed	HS did not review Health and Safety Plan (HASP) submitted by IST per 10 CFR 851 requirements.	Allowed IST to conduct work using inadequate work controls and procedures relating to work performed at DOE Germantown facility.
Work Planning and Controls	Failed	Non-existent	Lack of IST work planning resulted in failure to recognize hazards and controls. IST failed to fully interface with DOE MA facilities management.
Lock and Tag Out	Failed	Not Used	Allowed dangerous electrical current to flow to IST Worker 1 causing electrical shock.

Hazard: Dangerous Electrical Energy and Confined Spaces		Target: IST Worker 1	
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier affect the accident?**
Oversight	Failed	Non-existent	Neither the HS-1.31 technical monitor, nor MA exercised oversight of IST work activities to ensure performance with standards and requirements.
Work Supervision	Failed	Not Used	Walkdown by IST supervision failed to recognize work hazards as the scope of the project changed. Hazard controls at the job site not provided. No MA safety personnel available to provide supervision of work being preformed.
Configuration Control/Situational Awareness	Failed	Not Used	IST workers did not have knowledge of the configuration of the electrical systems involved, and, therefore, did not have adequate information on the electrical hazards present.

Hazard: Dangerous Electrical Energy and Confined Spaces		Target: IST Worker 1	
What were the barriers?	**How did each barrier perform?**	**Why did the barrier fail?**	**How did the barrier affect the accident?**
Confined Space Safety Precautions	Failed	Not Used	There were no danger signs or any other equally effective means provided on the confined spaces involved, including identifying them as permit-required confined spaces under OSHA 29 CFR 1910.146. IST did not execute a confined space permit in accordance with the IST HASP. MA does not require or sign off on confined space permits at the Germantown location. MA confined space program exists but is not fully implemented in Germantown.
Personnel Protective Equipment (PPE) and Equipment for Electrical Work	Not provided.	Not recognized	An aluminum ladder was used; adequate PPE was not identified or provided for the job.
Competence Commensurate with Responsibility	Failed	Lack of training	Proper electrical safety precautions were not used (i.e., lock-out/tagout, proper PPE, use of a non-conducting ladder).

Appendix F: Change Analysis

Change Analysis

Change is anything that disturbs the "balance" of a system from operating as planned. Change is often the source of deviations in system operations. Change can be planned, anticipated, and desired; or, it can be unintentional and unwanted. Change analysis examines the planned or unplanned disturbances or deviations that caused the undesired results or outcomes related to the accident. This process analyzes the difference between what is normal (or "ideal") and what actually occurred. The results of the change analysis are used to support the development of causal factors.

Table F-1. Change Analysis

Accident Situation	Prior, Ideal, or Accident-Free Situation	Difference	Evaluation of Effect
Inaccurate Mental Model Workers did not recognize the dangers of confined space/electrical hazards present.	IST reported to LSI Investigators that they entered Manhole 1 and 2 previously, approximately seven times, without incident.	None. Workers did not expect or anticipate changes in hazards.	Worker received an electrical shock.
Change of Work Scope Workers failed to stop work until impact of the change of work scope was evaluated.	The potential for contact with hazardous electrical energy would be identified and protective measures taken by IST.	The workers first attempted to pull the new fiber-optic cable using the old cable. The old cable broke, and IST workers decided to disconnect the electrical ground wire (i.e., green wire) from the CCTV transformer and use it as a pull string for the new fiber-optic cable.	Removing the electrical ground from the 480-volt transformer created an electrical hazard that was unrecognized by the IST workers.
Lockout/Tagout Workers disconnected the green wire from the energized 480-volt camera transformer. Workers failed to lock out/tag out 480-volt power to camera.	Power source to the transformer would have been locked out/tagged out before cutting the green wire. IST would have had a lockout/tagout program and would have coordinated lockout/tagout with MA.	If lockout/tagout procedure had been followed, green wire would not have been compromised and energized.	Worker received an electrical shock.
Confined Space Danger of confined space is not identified prior to the accident and permits not formally implemented.	MA would have implemented a uniform confined space program for Headquarters.	If IST had recognized the confined space permit entry, they would have coordinated with MA and may have mitigated the hazards.	Worker received an electrical shock.

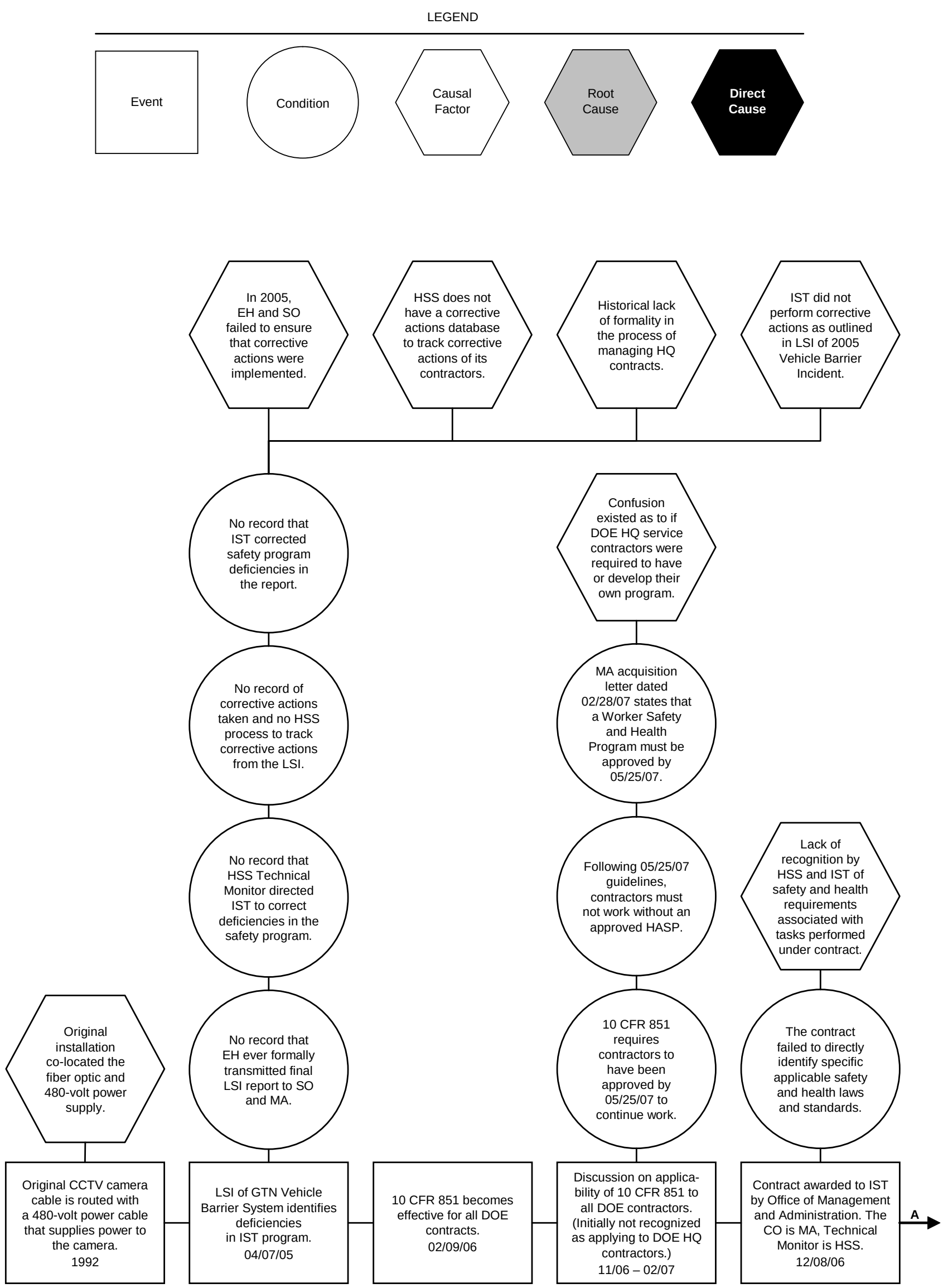
Accident Situation	Prior, Ideal, or Accident-Free Situation	Difference	Evaluation of Effect
Work Planning, Job Safety Analysis (JSA), and Configuration Management Work planning and JSA were not performed; unstructured and inadequate to identify hazards.	Work planning and JSA would have identified the electrical hazards. Would have identified appropriate controls/PPE. If as-built drawings were available, workers would have known of the existence of hazards associated with the 480-volt cables.	Failure to do adequate work planning and specify controls resulted in proper controls or PPE not being implemented. (non-conductive ladder, insulating gloves).	Worker received an electrical shock.

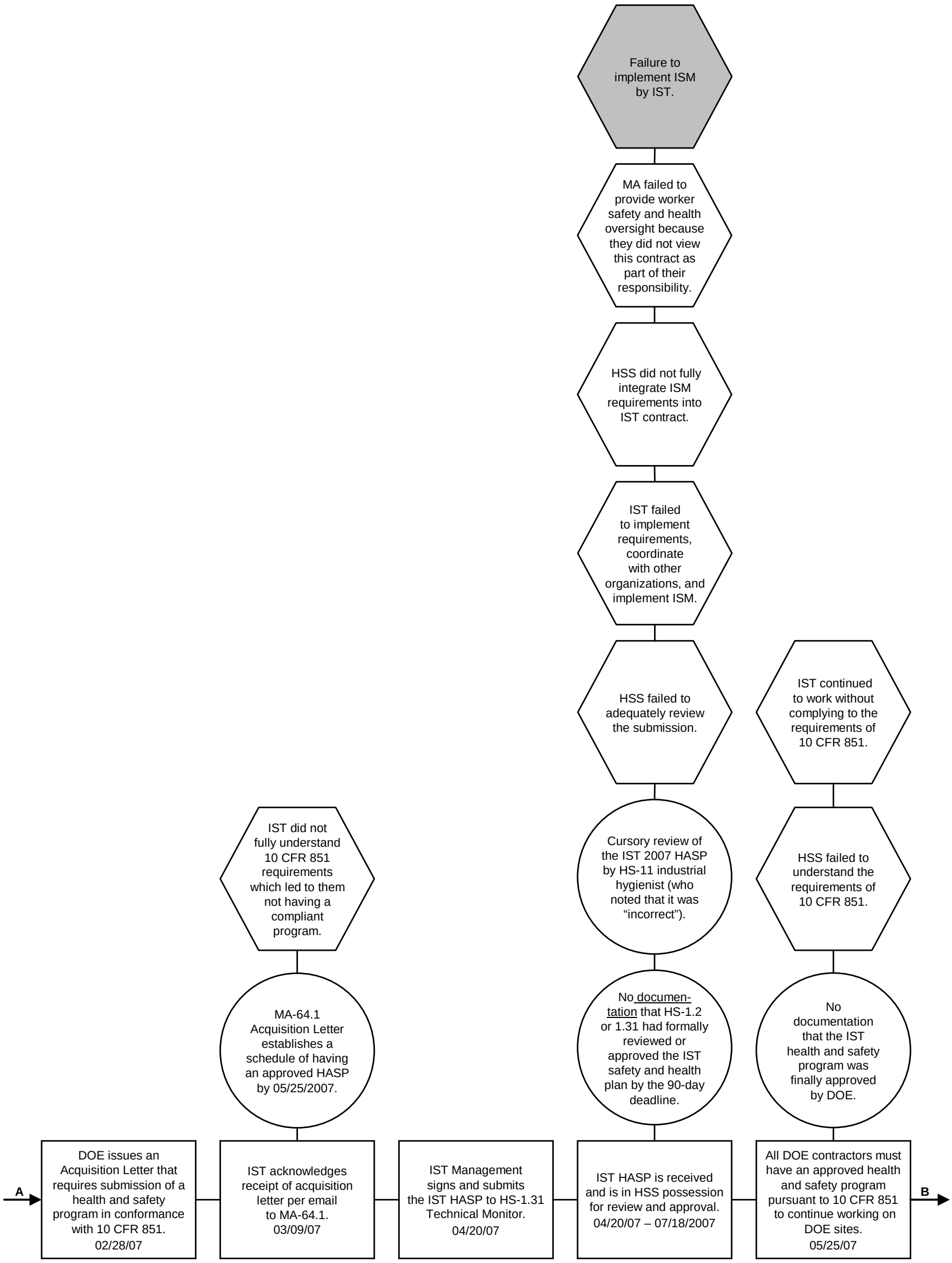
Appendix G: Events and Causal Factor Analysis

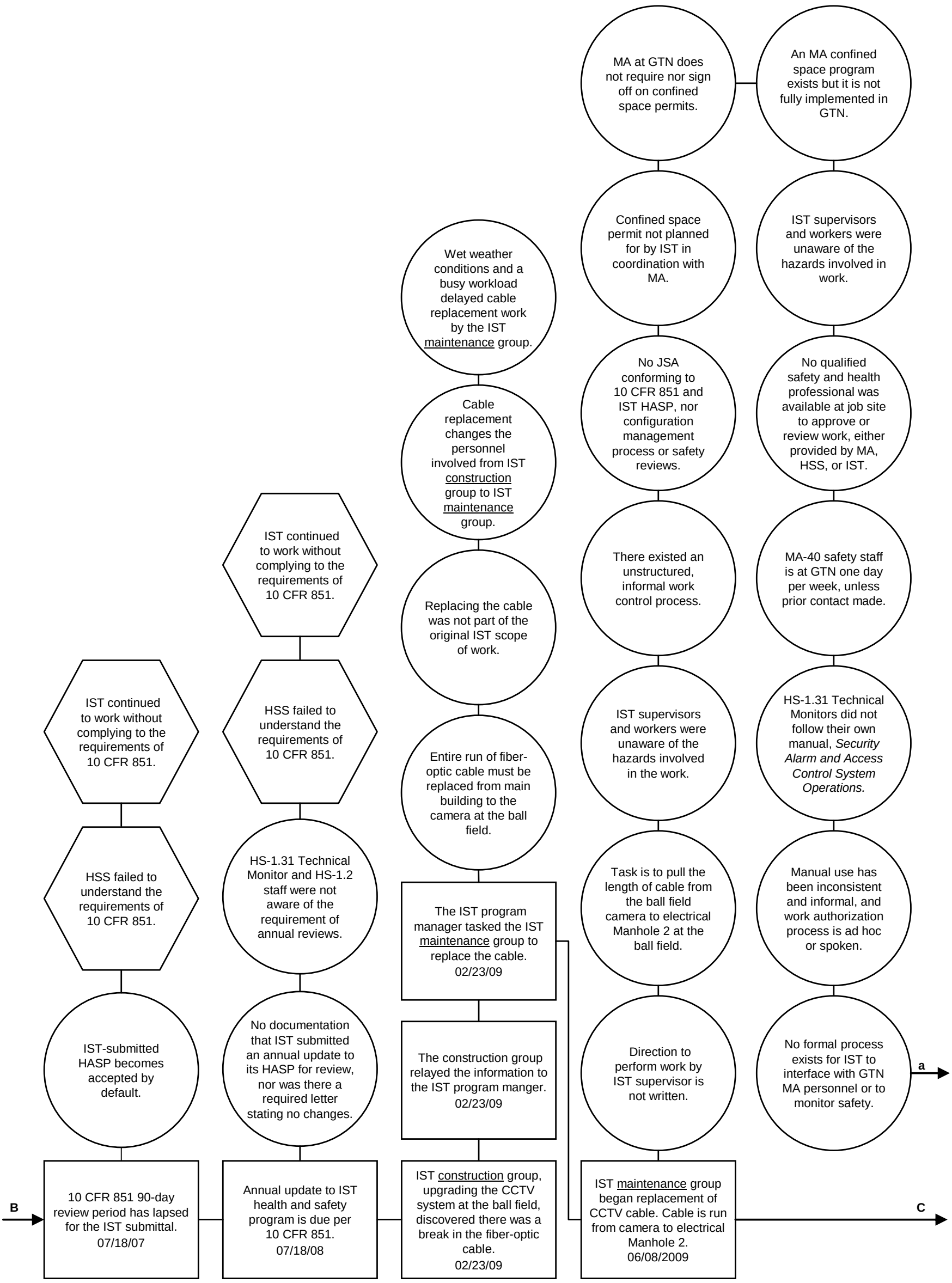
Events and Causal Factor Analysis

An events and causal factors analysis was performed in accordance with the DOE Workbook, *Conducting Accident Investigations*. The events and causal factors analysis requires deductive reasoning to determine those events and/or conditions that contributed to the accident. Causal factors are the events or conditions that produced or contributed to the accident, and they consist of direct, contributing, and root causes. The direct cause is the immediate event(s) or condition(s) that caused the accident. The contributing causes are the events or conditions that, collectively with the other causes, increased the likelihood of the accident, but which did not solely cause the accident. Root causes are the events or conditions that, if corrected, would prevent recurrence of this and similar accidents. The causal factors are identified in Figure G-1 on the following page.

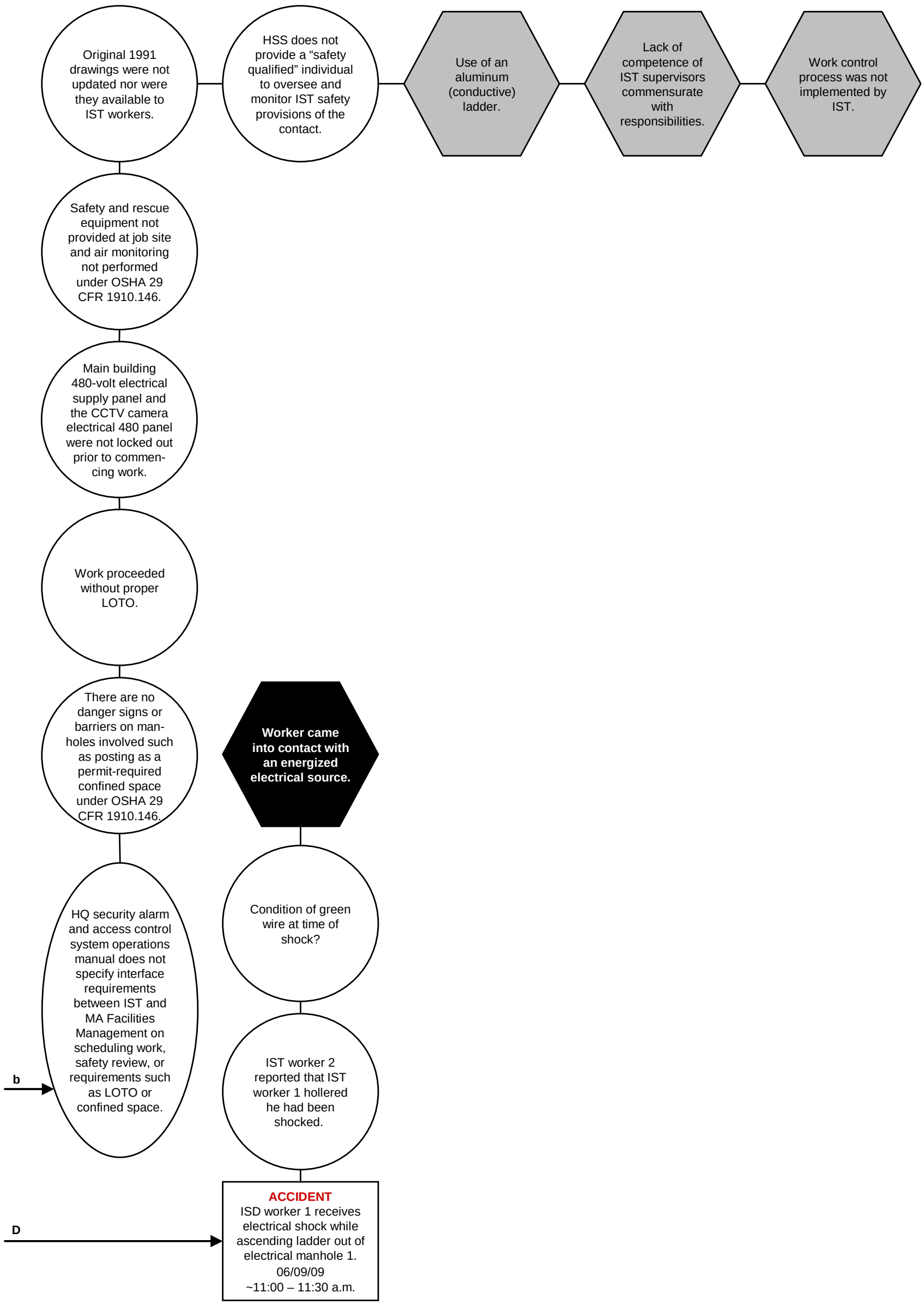
Figure G-1. Events and Causal Factors




Failure to implement ISM by IST.
MA failed to provide worker safety and health oversight because they did not view this contract as part of their responsibility.
HSS did not fully integrate ISM requirements into IST contract.
IST failed to implement requirements, coordinate with other organizations, and implement ISM.
HSS failed to adequately review the submission.
IST continued to work without complying to the requirements of 10 CFR 851.
IST did not fully understand 10 CFR 851 requirements which led to them not having a compliant program.
Cursory review of the IST 2007 HASP by HS-11 industrial hygienist (who noted that it was "incorrect").
HSS failed to understand the requirements of 10 CFR 851.
MA-64.1 Acquisition Letter establishes a schedule of having an approved HASP by 05/25/2007.
No documen-tation that HS-1.2 or 1.31 had formally reviewed or approved the IST safety and health plan by the 90-day deadline.
No documentation that the IST health and safety program was finally approved by DOE.
A
DOE issues an Acquisition Letter that requires submission of a health and safety program in conformance with 10 CFR 851. 02/28/07
IST acknowledges receipt of acquisition letter per email to MA-64.1. 03/09/07
IST Management signs and submits the IST HASP to HS-1.31 Technical Monitor. 04/20/07
IST HASP is received and is in HSS possession for review and approval. 04/20/07 – 07/18/2007
All DOE contractors must have an approved health and safety program pursuant to 10 CFR 851 to continue working on DOE sites. 05/25/07
B


B
10 CFR 851 90-day review period has lapsed for the IST submittal. 07/18/07
IST-submitted HASP becomes accepted by default.
HSS failed to understand the requirements of 10 CFR 851.
IST continued to work without complying to the requirements of 10 CFR 851.
Annual update to IST health and safety program is due per 10 CFR 851. 07/18/08
No documentation that IST submitted an annual update to its HASP for review, nor was there a required letter stating no changes.
HSS failed to understand the requirements of 10 CFR 851.
IST continued to work without complying to the requirements of 10 CFR 851.
IST construction group, upgrading the CCTV system at the ball field, discovered there was a break in the fiber-optic cable. 02/23/09
The construction group relayed the information to the IST program manger. 02/23/09
The IST program manager tasked the IST maintenance group to replace the cable. 02/23/09
Entire run of fiber-optic cable must be replaced from main building to the camera at the ball field.
Replacing the cable was not part of the original IST scope of work.
Cable replacement changes the personnel involved from IST construction group to IST maintenance group.
Wet weather conditions and a busy workload delayed cable replacement work by the IST maintenance group.
IST maintenance group began replacement of CCTV cable. Cable is run from camera to electrical Manhole 2. 06/08/2009
Direction to perform work by IST supervisor is not written.
Task is to pull the length of cable from the ball field camera to electrical Manhole 2 at the ball field.
IST supervisors and workers were unaware of the hazards involved in the work.
There existed an unstructured, informal work control process.
No JSA conforming to 10 CFR 851 and IST HASP, nor configuration management process or safety reviews.
Confined space permit not planned for by IST in coordination with MA.
MA at GTN does not require nor sign off on confined space permits.
C
No formal process exists for IST to interface with GTN MA personnel or to monitor safety.
Manual use has been inconsistent and informal, and work authorization process is ad hoc or spoken.
HS-1.31 Technical Monitors did not follow their own manual, Security Alarm and Access Control System Operations.
MA-40 safety staff is at GTN one day per week, unless prior contact made.
No qualified safety and health professional was available at job site to approve or review work, either provided by MA, HSS, or IST.
IST supervisors and workers were unaware of the hazards involved in work.
An MA confined space program exists but it is not fully implemented in GTN.
a

Original 1991 drawings were not updated nor were they available to IST workers.
HS-1.31 does not provide a "safety qualified" individual to oversee and monitor IST safety provisions of the contact.
MA at GTN does not require nor sign off on confined space permits.
An MA confined space program exists but is not fully implemented in GTN.
Safety and rescue equipment not provided at job site and air monitoring not performed under OSHA 29 CFR 1910.146.
No JSA conforming to 10 CFR 851 and IST HASP, nor configuration management process or safety reviews.
No qualified safety and health professional was available at job site to approve or review work, either provided by MA, HSS, or IST.
Main building 480-volt electrical supply panel and the CCTV camera electrical 480 panel were not locked out prior to commen-cing work.
MA-42 staff reported not available to open covers for IST.
The approximately 7 prior entries reported by IST workers into the electrical manhole involved in the accident occurred without incident.
There existed an unstructured, informal work control process.
MA-40 safety staff is at GTN one day per week, unless prior contact made.
Work proceeded without proper LOTO.
IST workers obtain crowbars to open electrical manhole covers from MA-42 facilities management contractor staff.
IST workers make a decision to use the existing ground cable (green wire) to pull the new fiber-optic cable.
IST supervisors and workers were unaware of the hazards involved in the work.
HS-1.31 Technical Monitors did not follow their own manual, Security Alarm and Access Control System Operations.
There are no danger signs or barriers on man-holes involved such as posting as a permit-required confined space under OSHA 29 CFR 1910.146.
Task is to pull length of cable from ball field electrical manhole 2 to electrical manhole 1 then to the main building.
They disconnect the ground (green wire) supplying the camera transformer/CCTV at the ball field.
Floor of pit in electrical manhole 1 appeared damp.
Manual use has been inconsistent, informal, and work authorization process is ad hoc or spoken.
HQ Security Alarm and Access Control System Operations Manual does not specify interface requirements between IST and MA Facilities Management on scheduling work, safety review, or requirements such as LOTO or confined space.
Direction to perform work by IST supervisor is not written.
The transformer remains energized. This could have caused a condition where hazardous energy was returned to IST worker 1.
Aluminum ladder was moved from electrical manhole 2 to electrical manhole 1, where the accident occurs.
No formal process exists for IST to interface with GTN MA personnel or to monitor safety.
a
Weather conditions are dry.
Confined space permit not planned for by IST in coordination with MA.
IST worker 1 enters electrical manhole 1 using an aluminum ladder taken from electrical manhole 2.
There are no danger signs or barriers on man-holes involved such as posting as a permit-required confined space under OSHA 29 CFR 1910.146.
b
C
Four IST workers begin work at electrical manhole 1 (south entrance) and electrical manhole 2 (ball field). 06/09/09 ~09:00 a.m.
D


Original 1991 drawings were not updated nor were they available to IST workers.
HSS does not provide a "safety qualified" individual to oversee and monitor IST safety provisions of the contact.
Use of an aluminum (conductive) ladder.
Lack of competence of IST supervisors commensurate with responsibilities.
Work control process was not implemented by IST.
Safety and rescue equipment not provided at job site and air monitoring not performed under OSHA 29 CFR 1910.146.
Main building 480-volt electrical supply panel and the CCTV camera electrical 480 panel were not locked out prior to commen-cing work.
Work proceeded without proper LOTO.
There are no danger signs or barriers on man-holes involved such as posting as a permit-required confined space under OSHA 29 CFR 1910.146.
Worker came into contact with an energized electrical source.
HQ security alarm and access control system operations manual does not specify interface requirements between IST and MA Facilities Management on scheduling work, safety review, or requirements such as LOTO or confined space.
Condition of green wire at time of shock?
b
IST worker 2 reported that IST worker 1 hollered he had been shocked.
D
ACCIDENT
ISD worker 1 receives electrical shock while ascending ladder out of electrical manhole 1.
06/09/09
~11:00 – 11:30 a.m.