



**Type A Accident
Investigation Report**

June 7, 2004

**Construction contractor
electrical accident at
double-circuit structure 38/1,
Watertown-Granite Falls
230-kV Transmission Line**

**East of Watertown,
South Dakota**

This report is an independent product of the Type A Accident Investigation board appointed by Timothy J. Meeks, Chief Operating Officer, Western Area Power Administration.

The Board was appointed to perform an investigation of this accident and to prepare a report following DOE Order 225.1A, Accident Investigations.

The discussion of facts, as determined by the board, and the views expressed in this 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, or subcontractors at any tier, or any other party.

This report makes no legal determinations or finding of liability.

On June 8, 2004, I established an Accident Investigation Board to investigate the June 7, 2004, Construction Contractor Electrical Accident at Double-Circuit Structure 38/1, Watertown-Granite Falls 230-kV Transmission Line East of Watertown, South Dakota. The Board's responsibilities have been completed with respect to this investigation. The analysis, identification of contributing and root causes, and judgments of need reached during the investigation were performed in accordance with DOE Order 225.1 Accident Investigations.

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



Timothy J. Meeks
Chief Operating Officer

Type A Accident Investigation Report

June 7, 2004

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at double-circuit structure 38/1,
Watertown-Granite Falls 230-kV Transmission Line
East of Watertown, South Dakota**

**Western Area Power Administration
U.S. Department of Energy**

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Acronyms

CDT	Central Daylight Time
CSO	Corporate Services Office
DOE	U.S. Department of Energy
DSH	Double-circuit, suspension, heavy-loading
EMT	Emergency medical technician
HLO	Hotline order
JHA	Job hazard analysis
kV	Kilovolt; 1,000 volts
NSP	Northern States Power Company
OHGW	Overhead ground wire
OPGW	Optical ground wire
OSHA	Occupational Safety and Health Administration
PPE	Personal protective equipment
PSOM	Power System Operations Manual
S&H Plan	Safety and Health Plan
RMR	Rocky Mountain Region
UGPR	Upper Great Plains Region

Executive summary

Background

Western Area Power Administration is a Federal power marketing administration and a part of the U.S. Department of Energy. It owns, operates and maintains more than 17,000 miles of transmission lines and sells Federal power in 15 western states. Western divides the responsibility for its transmission systems among four regional offices. The accident addressed in this report occurred while work was being performed on one of Western's transmission structures in its Upper Great Plains Region.

Introduction

On June 7, 2004, at about 2105 hours (CDT), an apprentice lineman employed by Mustang Line Contractors, Inc., a Western contractor, was killed by electrocution while working on a transmission line construction project east of Watertown, South Dakota. The victim was transported by ambulance to a hospital in Canby, Minnesota, where he was pronounced dead.

On June 8, 2004, Timothy J. Meeks, Western's Chief Operating Officer, appointed a Type A Accident Investigation Board to investigate the cause of the accident following DOE Order 225.1A, Accident Investigations.

The board began its investigation on June 9, 2004 and submitted a draft report of its findings to the appointing official on July 7, 2004.

Accident description

At about 2030 hours, June 7, 2004, line crews and equipment from Mustang Line Contractors, Inc., assembled on a paved county road about 600 feet from structure 38/1, on the Watertown-Granite Falls 230-kV line, where a four-man crew was removing the last protective grounds on the de-energized line. Two apprentice linemen (one being the victim), a groundman and an alternate superintendent proceeded to structure 38/1 and the two apprentices were given direction to assist in removing grounds.

The victim climbed the structure, transitioned to a structure ground lead attachment point, attached the snap hook of his fall arrest lanyard to the eye bolt of the ground lead clamp, and removed the "cold-end" of a protective ground out of prescribed sequence. The victim experienced numerous electric shocks before the journeyman lineman could assist in moving the loose ground end a safe distance from the victim. When the ground lead was safely removed, three linemen on the structure lowered the victim to the ground. The ambulance arrived shortly and the victim was transported to the Canby, Minnesota, hospital where he was declared dead on arrival.

Direct and contributing causes

The Board determined that the direct cause of the accident was that the victim disconnected the "cold end" of a protective ground while the other end of the ground was still connected

to the conductor. This condition placed the victim in series with a circuit acutely energized by induction.

The Board also identified numerous contributing causes that could have eliminated or lessened the severity of the accident, had they been adequately addressed.

Conclusions

Western has adequate policies and procedures in place to avert accidents of this type. Western and contractor line management personnel possessed the knowledge, skills and training sufficient to implement and enforce these policies and procedures. However, the contractor's safety plan and procedures were not all-inclusive nor were they rigorously followed.

Judgments of Need

The Board developed five judgments of need from the conclusions and causal factors. These are:

- Western program managers need to ensure that contractor safety plans are all-inclusive (with timely amendments and supplements) in identifying hazardous work that requires analysis, established procedures and protective measures.
- Western and contractor management must continually provide direction and control that ensures compliance with all contract safety requirements. Work scheduling, hazard analysis, work practice, qualified personnel, protective grounding, fall protection, communication, etc., should be discussion topics at routinely scheduled management/supervisor/craft safety-related meetings.
- Contractor management must ensure that hazardous work is performed by only qualified persons, under direct supervision of a foreman and using established work procedures.
- Contractor management needs to ensure that all employees and supervisors understand they are responsible and accountable for their own safety; and to the extent possible (reasonably) the safety of their fellow crew members.
- Contractor management must be responsible in developing and implementing a project-specific grounding plan. Western management must be diligent to ensure that the grounding plans are all-inclusive and submitted, reviewed and approved before work begins.

Type A Accident Investigation Report

June 7, 2004

Construction contractor electrical accident at double-circuit structure 38/1, Watertown-Granite Falls 230-kV Transmission Line East of Watertown, South Dakota

1.0 Introduction

1.1 Background

On June 7, 2004, at about 2105 hours (CDT), an apprentice lineman employed by Mustang Line Contractors, Inc., a Western contractor, was killed by electrocution while working on a transmission line construction project east of Watertown, South Dakota. The victim was transported by ambulance to a hospital in Canby, Minnesota, where he was pronounced dead.

On June 8, 2004, Timothy J. Meeks, Western's Chief Operating Officer, appointed a Type A Accident Investigation Board to investigate the cause of the accident following DOE Order 225.1A, Accident Investigations.

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1.2 Accident site description

Structure 38/1 is a component of the Watertown-Granite Falls 230-kV transmission line, about 38 miles east of Watertown, South Dakota. The site is located in Lac qui Parle County, Minnesota, about 600 feet west of County Road 11. The weather at the time of the accident was partly cloudy, breezy and hot with a high of 90 degrees for the day.

The work site the day of the accident was uncluttered, however, access was limited due to ground moisture conditions. A line truck equipped with a winch was the only vehicle or motorized equipment at the site. Prior to the accident, contractor crews had been removing guard structures, protective grounds and equipment from the line and right of way. Removing the grounds at structure 38/1 was the last work to be performed before the line was to be released and re-energized.

1.3 Scope, conduct and methodology

The purpose of the investigation was to determine the cause of the accident, including deficiencies, if any, in Western's construction and contractor management systems, and to help

Western promote safety and reduce the potential for similar accidents.

The Board evaluated the Western contract construction program requirements and processes, UGP construction management records, contractor personnel information, witness statements, contractor/government relations and interactions, project safety meeting records, mitigating safety measures, power system configuration, and operational and management controls in place at the time of the accident. The Board conducted interviews with witnesses and other appropriate contractor and Western personnel.

The Board conducted an extensive review of the accident site and structure, switching and clearance documents, special work permits, dispatch logs, construction specifications and drawings, construction and safety management records, personnel qualification certifications, and both Western and contractor safety practices.

The Board used these accident investigation methods:

- Site visits and personal interviews
- Determining facts
- Chronological event charting
- Barrier analysis
- Event and causal factor analysis

2.0 Facts and analysis

2.1 Accident description and chronology

2.1.1 Accident description

The morning of the accident, employees arrived at the contractor's show-up location in Montevideo, Minnesota, at 0700 hours. The contractor's superintendent conducted a safety meeting where it was stressed to use proper grounding practices and safe removal of grounds. Everyone was advised that the line would be prepared for return to service and four crews were dispatched to clear the entire project of equipment, guard structures and protective grounds. Work was stopped at about 1000 hours due to high winds, resumed again at about 1400 hours, and continued until the time of the accident, at approximately 2105 hours.

The victim had spent the afternoon assisting as an apprentice lineman, removing personal grounds at different structure locations. At about 2030 hours, crews and equipment assembled on a paved county road about 600 feet from structure 38/1, where a four-man crew was removing the last grounds on the line. (See Exhibit A.) Two apprentice linemen (one being the victim), a groundman and an alternate superintendent proceeded to structure 38/1. At that point, the two apprentices were given direction to assist in removing grounds. The alternate superintendent and the crew foreman then returned to the assembly area at the county road. One journeyman lineman, four apprentice linemen and one groundman were left to finish removing ground leads on structure 38/1, without the oversight of a foreman.

The victim climbed the structure, transitioned to the protective ground end attached to the structure. He attached the snap hook of his fall arrest lanyard to the eye bolt of the ground lead clamp, and removed the "cold end" of the Phase A protective ground out of the prescribed sequence. (See figures 1-6 and Exhibit B.) Using recorded operations data and modeling the grounding configuration at that point in time, the steady state induction current on the Phase A ground was calculated to be about 1.4 amperes.

The victim experienced numerous electric shocks before the journeyman lineman could assist in moving the loose ground end a safe distance from the victim. After initially calling for help, the alternate superintendent proceeded to the accident location on the structure with another hotstick to assist in removing the ground lead from the conductor.

When the ground lead was safely removed, the victim was immediately lowered to the ground. The ambulance arrived shortly and the victim was transported to the Canby, Minnesota, hospital where he was declared dead on arrival.



Figure 1: Ground lead (2/0 cable, 20 feet, 6 ½ inches long) that was connected between the A phase of the Watertown-Granite Falls 230-kV transmission line and the steel at Structure 38/1. At the time of the accident, the victim disconnected the “cold end” while the “hot end” was still connected to the A phase conductor. This type of grounding assembly is designed for bus-bar or phase-to-phase grounding applications.



Figure 2: This clamp (bus type) was connected to the conductor (“hot end”).



Figure 3: This clamp (duckbill type) was connected to the steel (“cold end”).



Figure 4: Harness, body belt and lanyard worn by victim at the time of accident.

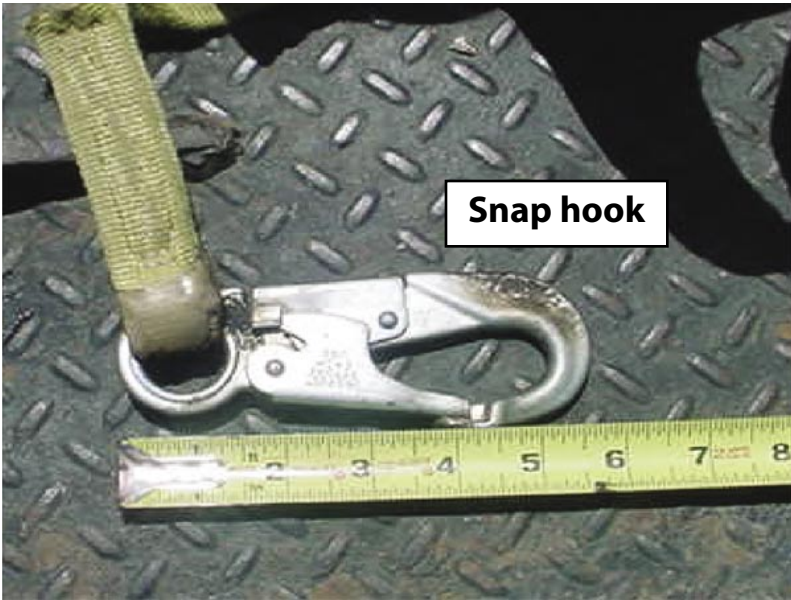


Figure 5: Lanyard snap hook used by the victim to loosen the “cold-end” clamp.

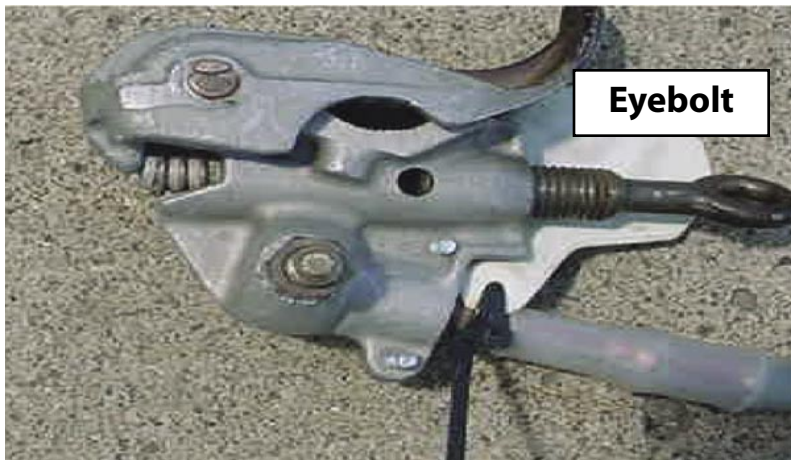


Figure 6: Eyebolt of “cold-end” clamp where victim attached the lanyard snap hook to loosen the ground connection.

2.1.2 Chronology of events

Figure 7 provides a chronological summary of significant events that relate to this accident.

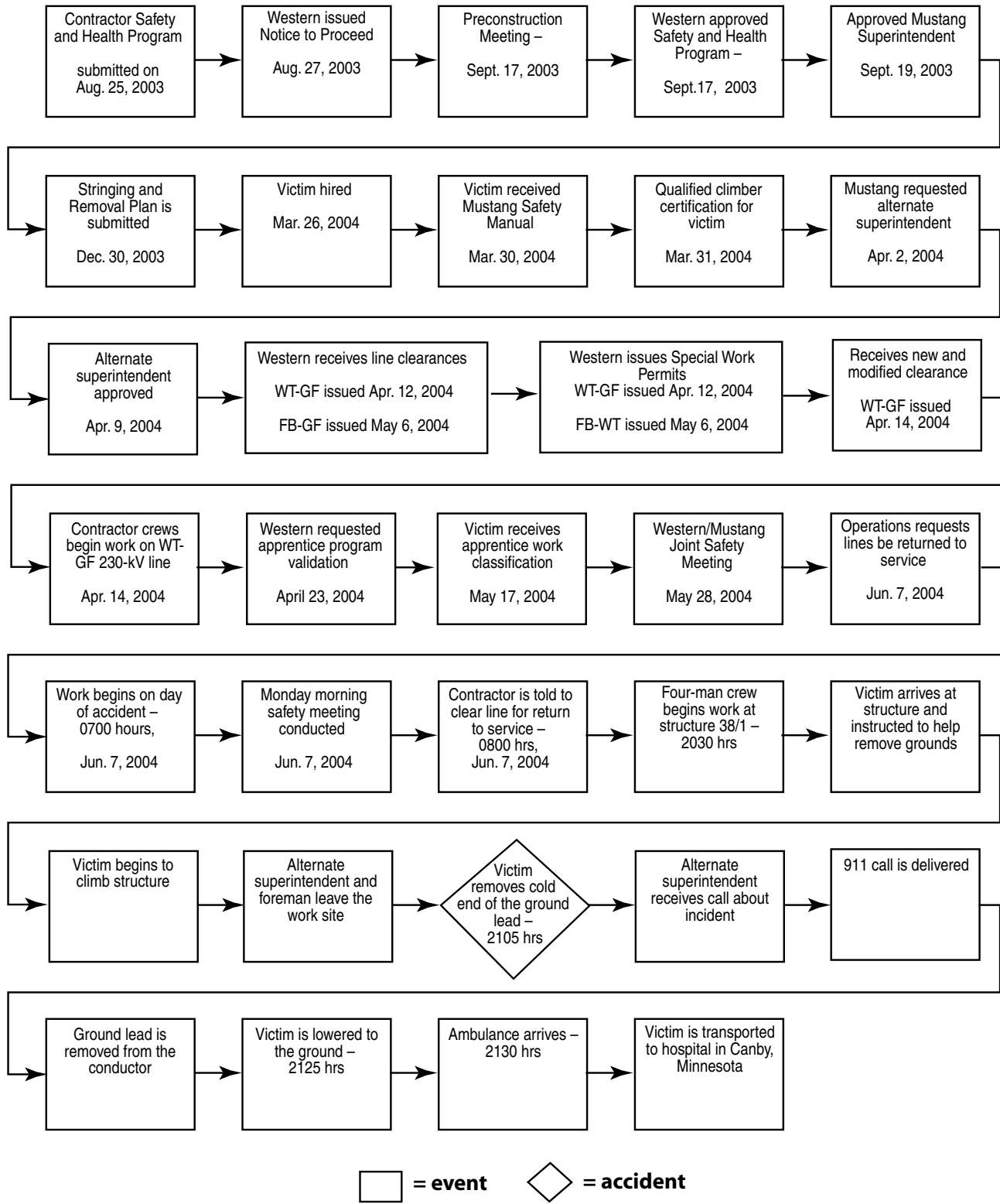


Figure 7: Chronology of events

2.1.3 Emergency response and investigative readiness

After the victim made electrical contact, he fell back on the crossarm in an unconscious state, with the loose ground end attached to his fall arrest lanyard. The journeyman lineman on the structure commanded that everyone “freeze” in their present positions. The journeyman lineman then transitioned to the victim and used his hotstick to distance the loose ground end from making further electrical contact. In that time, the line had visibly discharged to the victim several times. The linemen on the structure were unable to attend to the victim until they could get another hotstick up the structure to remove the ground lead end from the conductor. This was necessary to allow attending to the victim in a safe manner.

In the meantime, an attempt to make a 911 call on the contractor’s cell phone failed due to inadequate coverage. A construction inspector traveling to the structure (to verify completion of ground removal operations) heard talk on the contractor’s radio that someone had been burned and that the attempted 911 call had failed. He immediately made a 911 call for assistance and conveyed the nearest county road intersections to the dispatcher. When the construction inspector arrived at the site, he observed an employee hanging from his body belt attached to a steel member above the center phase on the north side of the structure.

The alternate superintendent from the county road location brought a hotstick to assist in disconnecting the ground lead end from the conductor and the victim’s fall arrest lanyard snap hook. After this was accomplished, the victim was immediately lowered to the ground with a handline connected to the winch on a line truck at the base of the structure. The inspector observed an effort to find a pulse on the victim. Apparently, due to the time elapsed and the severity of the injuries, no CPR was attempted.

The ambulance arrived at County Road 11, about 600 feet east of structure 38/1, at approximately 2130 hours. Another inspector and the contractor’s employees instructed the ambulance to travel the transmission line right-of-way toward the first inspector, who guided it to the west side of the structure where the victim had been brought to the ground. The victim was then transported to the hospital in Canby, Minnesota, where he was pronounced dead on arrival. The attending physician stated the victim suffered several severe burns and was killed instantly due to electrocution.

Western’s lead construction representative immediately reviewed and secured the accident site, obtained site photographs, took written statements from contractor personnel at the site and inspectors involved in responding, and collected information relative to the accident, which was presented to Western’s Accident Investigation Board.

The contractor had developed and submitted provisions for first-aid and medical care, as required by construction specifications and the contractor’s Safety and Health Plan. Immediate first-aid and CPR (aloft) were not possible, considering the condition that the ground lead could not be disconnected from the conductor for a considerable amount of time. Emergency response plans compliant with the project specifications were in place for the project.

2.1.4 Project safety program assessment/remediation counter measures

After the accident scene had been released, the investigation board chairman provided a debriefing (with recommended remedial actions) for Western's maintenance manager, construction manager, safety manager, construction representatives and operations managers at the Watertown Operations Office. Discussion topics included contractor safety plan deficiencies, superintendent effectiveness, special work procedures for protective grounding, employee awareness and oversight of apprentice work. There was consensus that the contractor should not resume work until these concerns had been addressed by the contractor, a supplemental safety plan was submitted and approved, and relevant counter measures were developed to ensure that accident prevention would be adequate.

2.2 Hazards, controls and management systems

2.2.1 Construction safety

Construction specifications

Western's construction standards and specifications provide for management controls to prevent accidents. Key provisions relative to this accident are requirements for:

- The project specifications, paragraph 1.1.2, Description of Work, states, "Parallel stringing procedures shall be implemented as specified in the 'Transmission Line Safety Requirement' paragraph when removing the existing OHGW and stringing the new OPGW for the entire length of the transmission line."
- Contractor submittal of a safety program prior to beginning work, including requirement for a written plan for any proposed work adjacent to energized circuits, stringing and removal plan, fall protection, and certified grounds to ensure adequate activity hazard analysis and provide for protective measures. Approval of the safety and health program, including amendments and supplements thereto, is for the purpose of determining compliance with the specifications only and shall not relieve the contractor of the responsibility for the safety and health of persons and property.
- Joint Western and Contractor safety meetings, including a pre-construction safety meeting, management safety awareness meetings, periodic joint safety meetings, new employee orientation, weekly "tool box" meetings and job hazard analysis.
- Contractor's submittal of the superintendent's resume and qualifications providing at least three years experience as a superintendent or foreman in high-voltage transmission line construction and minimum of two years' experience in installing OPGW, and demonstrated knowledge of OSHA standards and safe work practices.
- Contractor request of clearances, hot line orders and issuance of special work permits by Western to the contractor.
- Training, knowledge and skill level of all contractor employees.

Pre-construction meeting

Western holds a pre-construction meeting with both Western and contractor personnel before beginning work under a construction contract. The pre-construction meeting associated with Phase 5 of installing fiber optic overhead ground wire on transmission lines in Minnesota and South Dakota under Contract DE-FB65-03WC63400 was scheduled with Mustang Line Contractors, Inc. A copy of the meeting agenda was enclosed. This meeting was scheduled for September 17, 2003, at Western's UGP Construction Office, Huron, South Dakota.

Pre-construction meetings are typically administrative in nature and the agenda for this meeting followed this format. Specific safety topics were included and the contractor's safety plan was approved with comments.

The meeting was held as scheduled and attended by the president of Mustang Line Contractors, Inc., the contractor superintendent, the contractor's project manager, eight Western Construction and Safety management employees and Western construction representatives. The meeting generally followed the agenda and specifically addressed the Safety and Health Program section by approving the contractor's Safety and Health Plan with additional comments addressing the emergency response plan, new employee orientation, periodic toolbox safety meetings and job hazard analysis requirements. The contractor superintendent's responsibility for carrying out the contractor's safety and health program was also addressed.

Pre-job safety meeting

Western routinely holds a pre-job safety meeting with both Western and contractor personnel prior to beginning work. The meeting for this contract was held onsite at the contractor's show-up location on May 28, 2004. The minutes of this meeting indicate attendance by the contractor's superintendent, numerous contractor employees, including the victim, as well as Western's UGP construction manager, field engineer, safety specialist, and construction representatives.

Recorded minutes indicate the meeting was comprehensive and numerous safety topics pertinent to the specific job were addressed. Discussion items included a safety commitment and policy message from Western's Administrator, the responsibility of the superintendent to implement and enforce a safety plan, personal responsibility for safety, safety ethics and common goals, reviewing work plans, emergency response, recognizing inexperienced employees need to learn, hazard awareness and recognition, effects of long work days, proper use (as learned in school) and application of personal protective grounds, the importance of safety both on and off the job, and the need to always be aware of surroundings and to always ask questions.

2.2.2 Personnel qualifications and experience

Victim

The accident victim had limited experience in high-voltage line work. He graduated from a lineman training program and worked for more than two years with low-voltage power distribution systems. He did possess a certificate as a qualified climber for wood pole

structures and had been indentured by IBEW as a step-two apprentice lineman. The victim's employer had certified him as a qualified climber for the specific project work, being high-voltage lattice steel structures. On the day of the accident, the victim had been assisting in removing "cold end" ground leads from other structures, only after a journeyman had removed the conductor lead with a hot stick, and transferring them to the ground on a tag line.

Construction representative(s)

Western's lead construction representative working with the contractor at the time of the accident had more than 25 years of high-voltage electrical experience with Western and the Bureau of Reclamation; and has worked for Western as a contract employee since retiring from Federal service in 1994. During his Federal employment, he served as a safety manager for 21 years and a field construction engineer for more than four years. He worked with contractors throughout the western United States on numerous high-voltage construction projects requiring protective grounding. As a Western safety manager, he was instrumental in establishing standards for protective grounding, developing fall protection requirements and safety provisions for contract construction.

The Western construction representative holding the HLOs and clearance for the project had more than 29 years experience and has worked for Western since 1977. During this time he worked 24 years as a high-voltage lineman and switchman and five years as an on-site contract construction inspector. He has a depth of knowledge relative to the work being accomplished on the project.

Contractor's superintendent

The contractor's superintendent has 30 years experience in the high-voltage construction industry, including four years with Mustang Line Contractors. He met the specific experience requirements of three years as a superintendent or foreman in high-voltage transmission line construction. He also had the requisite OSHA knowledge and had a properly submitted resume.

Western's employees

Other Western employees involved in the work on the Watertown-Granite Falls transmission line project included construction managers, engineers, safety specialists, craftsmen and dispatchers. Without exception, these employees have adequate experience and training to perform the work involved.

Contractor's employees

The contractor's workforce, other than the contractor superintendent and victim, consisted of six journeyman linemen, six apprentices and four groundmen. The journeymen had many years of high-voltage construction experience on similar structure and voltage classification and working under parallel line conditions. The employees at the accident site were all trained in first aid and CPR.

2.2.3 Western's policies and procedures

Western Order 440.1, Chapter IX, Construction Safety

Western's directive establishes minimum safety and health standards to ensure contract construction activities are conducted in a safe and healthful manner. Contractors are responsible for developing, implementing and ensuring compliance with their Western-approved safety and health program.

Western's accident investigation program

Western investigates accidents and near-miss incidents to determine direct causes and prepare judgments of need. The judgments of need, which are widely circulated, are used as discussion topics for future safety meetings and are intended to prevent future occurrences of similar incidents.

Western's Power System Operations Manual, Chapter 1, "Power System Switching Procedure"

This document establishes coordinated and consistent switching procedures for the safe and reliable operation and maintenance of those facilities of the Federal power system for which Western is responsible. These procedures include clearances, hot line orders, special conditions, danger tags, general switching and special work permits.

2.2.4 Human factors and training

The Board met with personnel involved with the construction project and found no evidence of animosity or ill feeling among themselves or toward Western or Mustang. The cooperation and working relationship between contractor and Western personnel were found to be satisfactory; however, concern was expressed about the ability of contractor supervision to provide leadership in safety management. There was no indication that anyone felt pressured to complete the work in any way other than in a safe manner.

The Board found no evidence of physical impairment among the contractor personnel, or any use of alcohol or drugs by those present at the work site.

A review of personnel classifications showed that contractor crew members who started to remove grounds at structure 38/1 had adequate training and experience to perform the work safely. When the crew was revised to one journeyman, four apprentices and one groundman, the crew's competency to safely complete the job was compromised.

The Board found that weather conditions at the time of the accident were not adverse and had no affect on the accident.

2.2.5 Management systems

Western's Occupational Safety and Security Program

This program outlines most aspects of planning and directing the safety program for all activities including the construction, operation and maintenance of high-voltage transmission lines, substations and related facilities in a large geographical area. The safety program

includes a wide variety of functions directed at eliminating undesirable operating conditions and planned construction operations with the intent of minimizing hazards. Construction is generally performed by contract employees, while operation and maintenance is performed by Western employees.

The program allows for comments and input in the development of safety policies and provides guidelines to field managers and supervisors who formulate local safety policy. It provides general safety oversight and direction at all operational levels in field offices where operational and work procedures are developed.

Specific provisions of Western's safety guidelines:

- Provide for review of designs and specifications for new facilities to ensure compliance with existing safety standards
- Provide for review of construction contractor safety programs and work procedures to ensure compliance with specifications and safety standards
- Provide participation of a safety advisor in meetings between contractor and Western managers
- Promote working with managers and administrative staff to evaluate employee skills and safety training needs
- Promote participation of operation and maintenance staff in supervisory safety meetings
- Provide technical guidelines to assist supervisors and managers in developing specialized safety training
- Require coordination and oversight of Western's complete safety audit system
- Provide technical guidance to committees and meetings
- Require investigation of accidents resulting in personal injury or property damage
- Require development and implementation of safety awareness programs

Western's Construction Management Program

This program is under the direction of the relevant regional construction manager. That manager is responsible for all contract construction operations involving high-voltage transmission lines, substations and integral system facilities. As such, the manager:

- Directs office and field engineering staff involved in construction management operations and maintains appropriate administrative, technical and field relationships with project and contractor personnel.

- Serves as the Contracting Officer's representative on construction contracts.
- Develops and supervises necessary onsite engineering and construction management services.
- Recommends and directs changes in engineering designs and construction management operations.
- Executes a comprehensive construction safety program with the assistance of the regional Safety and Security Office.
- Reviews, approves and monitors implementation of contractor-provided project specific safety plans, including amendments and supplements thereto.
- Directs and supervises the field engineering staff in accomplishing these specific functions:
 - Supervision and surveillance of contract construction operations to ensure compliance with contract specifications, existing codes and regulations, industry standards and Western's practices and policies.
 - Onsite inspection of equipment and material, and monitoring labor forces.
 - Coordinates field activity during phased construction to minimize outages and hazards to personnel and equipment.
 - Cooperates with contractor management and supervision, and provide project inspection that ensures the construction contractor maintains an effective safety program.

Construction services are provided by contractors performing under the Federal Acquisition Regulations and the associated specifications and special provisions of the construction contract.

The program provides for a project-specific safety plan, requirements for the ongoing development and implementation of the plan, and general oversight and direction of all field operations related to the execution and effectiveness of the safety plan.

Specific contract provisions for the contractor safety plan include:

- Provide a safety plan and implement construction activities that take all precautions to protect the safety and health of employees and the public.
- Comply with the latest effective Occupational Safety and Health Administration (OSHA) Standards 29 CFR 1910 and 29 CFR 1926.

- The superintendent shall have a minimum of three years experience in the type of construction contained in the specifications, a demonstrated knowledge of applicable OSHA construction safety standards, a comprehensive resume and the responsibility of providing oversight and supervision of all onsite work activities.
- Propose a safety and health plan to the COR for approval at least 10 days prior to start of construction operations. Amendments and supplements shall be provided, in a timely manner, to address specific work procedures to ensure adequate analysis of hazards and provision of protective measures.
- Provision for training employees in the recognition and avoidance of unsafe conditions.
- Procedures for specific sequences of work to ensure adequate activity hazard analysis and provision of protective measures.
- Provisions for the use and furnishing of personal protective equipment .
- Policy and procedure for enforcing safety and health regulations.
- Fall protection program identifying hazards and listing equipment and procedures used on the specific project the meets the requirement of OSHA 1910.269.
- Certification of those employees considered to be qualified climbers.
- Management safety awareness meetings and periodic joint safety meetings.
- Failure to effectively implement and enforce the safety plan and the specification requirements may result in the Contracting Officer's directed removal of the job superintendent or may result in suspension of all or part of the work.

2.3 Barrier analysis

A barrier is defined as anything that is used to control, prevent or impede a process and is intended to protect a person or object from hazards. The Board conducted a barrier analysis that identified safety, administrative and management barriers that failed. Successful performance of any of these barriers would have prevented or mitigated the severity of the accident. The barriers that failed are listed in Table 2.1.

Table 2.1: Performance of Barriers

Barriers	Purpose	Performance
Contractor Safety and Health Plan	To convey the project scope of work, address safety aspects of specific work processes and develop a plan that mitigates hazardous working conditions.	The barrier failed because the S&H Plan did not adequately address the inherent hazards of stringing adjacent to energized facilities, and no grounding plan with procedures for specific sequences of work was developed.
Contractor line management	To designate an on-site job superintendent to implement, monitor and enforce a project-specific S&H Plan and provide effective job, work force and safety planning.	The barrier failed because the superintendent did not effectively communicate and implement the S&H Plan to the work force supervisors and personnel. They could not demonstrate knowledge of the existence of a project S&H Plan.
Requirements management	To identify and validate the qualifications of the work force; and identify the need for specific work procedures.	The barrier failed because the victim demonstrated a lack of knowledge and experience when he did not employ full fall protection at the work site, misused the snap hook as a tool to remove the ground lead and removed the “cold end” of the protective ground out of a prescribed safe sequence.
Training and skills	Ensure employees have the knowledge to recognize hazards and competency in safe work practice.	The barrier failed because the victim did not recognize the potential hazards, was not using required fall protection measures, misused the fall arresting lanyard and failed to recognize (or use) a proper and safe sequence for removing grounds.

Hazard recognition and analysis	To identify all potential hazards and develop work procedures to mitigate those hazards.	The barrier failed because no written or oral job hazard analysis was provided, the crew makeup was incorrect, no foreman was present to stop the victim's action and the victim did not recognize the hazard.
Supervision	To provide appropriate craft skills, direction and communication, hazard recognition, oversight and work force control that will mitigate unsafe work practices.	The barrier failed when the crew formulation changed without the required direction and communication and both the superintendent and foreman left the site before the new crew began work.

2.4 Causal factors

The Board determined that the direct cause of the accident was that the victim removed a personal protective ground end out of sequence, thereby leaving the "hot end" still connected to the A-phase conductor of the Watertown-Granite Falls 230-kV transmission line. This condition placed the victim in series with a circuit acutely energized by induction.

The Board also identified numerous contributing causes that could have eliminated or lessened the severity of the accident, had they been adequately addressed. Contributing causes are defined as those issues that increase the likelihood or severity of the accident without individually causing it. Contributing causes are important enough to be recognized as requiring corrective action. The causal factors are identified in Table 2.2.

Table 2.2: Causal Factor Analysis

Direct cause	Discussion
Removing a protective ground out of proper sequence	The victim should have had knowledge of the proper ground removal sequence from lineman school training, past work experience, and assisting in the removal of "cold-end" ground connections on other structures the day of the accident. It appeared that the victim, a Step 2 apprentice lineman, proceeded without adequate direction or supervision to remove the ground connection out of the prescribed sequence that would have prevented the accident.

Contributing causes	Discussion
Inadequate job planning	Pre-job planning with activity hazard analysis and protective measures were not adequate. The hazards and mitigation measures were not identified in a project-specific stringing and grounding plan. Western specifications require safety planning to include procedures for specific work sequences to ensure adequate activity hazard analysis and protective measure provisions, especially for stringing operations and working adjacent to energized electrical facilities.
Knowledge and experience	Only employees qualified by training or experience should be permitted to perform hazardous work procedures. In considering the victim's training, work history and incorrect application of fall protection equipment, the individual should only have been climbing and removing grounds under the direct supervision of a crew foreman.
Job hazard analysis (JHA)	A JHA would have provided discussion and mitigation measures to eliminate the hazard. It did not appear to be a general practice of the superintendent and foremen to conduct JHAs for special work procedures that presented hazardous conditions. These discussions would have addressed a need to resolve the concerns of using apprentice linemen, induced voltage, fall protection, PPE, essential tools and special work procedures that would have provided the safe sequence of removing grounds.
Designating/directing work crews	Line management and supervisory persons must be effective in identifying necessary knowledge and skills to recognize, avoid and prevent unsafe work conditions. The designated crew for removing grounds appeared to be adequate when the work began at structure 38/1. However, when the crew was changed to one journeyman and four apprentice linemen in the structure, a need for direction and oversight was disregarded.

<p>Lack of supervision</p>	<p>The decision of the superintendent and foreman to leave the job site before the grounds were removed was wrong. At a minimum, a verbal delegation of responsibility to provide oversight of the apprentice linemen actions should have been made before they left the structure site. At that point, there was no one in control of the work site to ensure (with oversight and direction) the safe work practice of the four apprentice linemen.</p>
<p>Workers not taking personal responsibility for their own safety</p>	<p>The victim's limited knowledge and experience prohibited him from safely removing grounds without the supervision of a qualified lineman. The facts show that he proceeded on his own to remove the ground without communicating with the journeyman lineman, disregarded proper fall protection requirements and used the fall arresting lanyard snap hook as a tool to remove the ground end. These actions lead to the conclusion that he failed to take responsibility for his own safety.</p>
<p>Inadequate implementation/enforcement of contractor's Safety and Health Plan</p>	<p>The contractor superintendent's primary responsibility is to provide adequate skills, equipment, direction, oversight and supervision at the job site. This is determined by adequate activity hazard analysis and implementation of effective work procedures. Implementation and enforcement of the safety plan did not ensure a qualified work crew, foreman oversight, proper fall protection measures and specific work procedures for removing grounds. The critical decisions (on the day of the accident) to remove grounds to return the line to service and change the work crew formulation would necessitate the need for task-specific hazard analysis.</p>

3.0 Conclusions and judgments of need

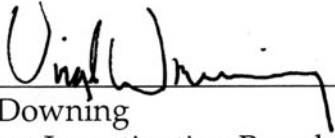
Conclusions are a synopsis of facts and analytical results that the Board considers especially significant. Judgments of need are management controls and safety measures believed necessary to prevent or mitigate the probability of recurrence. They flow from the determination of facts, analysis of data and causal factors and are directed at guiding managers in developing follow-up actions.

Table 3.1: Conclusions and Judgments of Need

Conclusions	Judgments of need
<p>The contractor’s job and safety planning did not provide for a project-specific grounding plan, effective hazard analysis and written procedure for the correct sequence of removing grounds. The safety plan did not specifically address conditions of parallel stringing, the potential for induction and essential mitigation measures.</p>	<p>Western program managers need to ensure that contractor safety plans are all-inclusive (with timely amendments and supplements) in identifying hazardous work that requires analysis, established procedures and protective measures.</p>
<p>The contractor’s management and supervision did not provide an effective safety program and mindset that would lead to preventing the accident. The lack of a hazard analysis, as well as communications, fall protection and special work procedures as comprehensive requirements would indicate ineffective implementation and enforcement of the contractor’s safety plan.</p>	<p>Western and contractor management must continually provide direction and control that ensures compliance with all contract safety requirements. Work scheduling, hazard analysis, work practice, qualified personnel, protective grounding, fall protection, communication, etc., should be discussion topics at routinely scheduled management/supervisor/craft safety-related meetings.</p>
<p>Employers must only allow qualified persons to perform hazardous operations. In this case, the apprentice should not have been allowed to remove grounds without direction, oversight and control from a foreman.</p>	<p>Contractor management must ensure that hazardous work is performed by only qualified persons, under direct supervision of a foreman and using established work procedures.</p>
<p>The foreman and workmen did not take responsibility for work site safety. There was no effort to communicate a changed work condition and hazardous conditions.</p>	<p>Contractor management needs to ensure that all employees and supervisors understand they are responsible and accountable for their own safety; and to the extent possible (reasonably) the safety of their fellow crew members.</p>

<p>Hazard recognition and grounding to protect employees are essential to providing a safe work site when working on de-energized electric lines and equipment. Effective grounding includes the design, testing, type and application, attaching and removing procedures and maintenance of protective grounds.</p>	<p>Contractor management must be responsible in developing and implementing a project-specific grounding plan. Western management must be diligent to ensure that the grounding plans are all-inclusive and submitted, reviewed and approved before work begins.</p>
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4.0 Board signatures



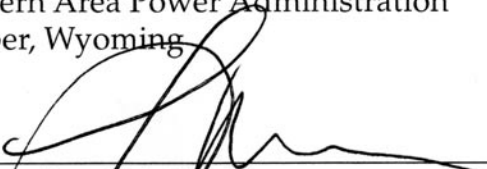
Virgil Downing
Accident Investigation Board Chairperson
Western Area Power Administration
Loveland, CO

Date: August 16, 2004



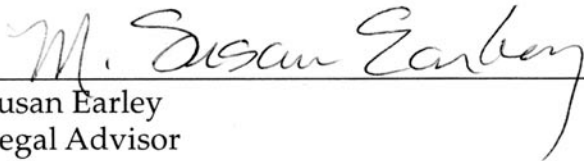
Michael A. Fyffe
Accident Investigation Board Member
Western Area Power Administration
Casper, Wyoming

Date: August 16, 2004



Lazaro (Larry) M. Romero
Accident Investigation Board Member
Western Area Power Administration
Lakewood, CO

Date: August 16, 2004



Susan Earley
Legal Advisor
Western Area Power Administration
Lakewood, CO

Date: August 16, 2004

5.0 Board members, advisors and staff

Chairperson	Virgil Downing, Western, RMR
Member	Michael Fyffe, Western, RMR
Member	Lazaro (Larry) M. Romero, Western, CSO
Member/Legal advisor	Susan Earley, Western, CSO
Technical writer	LaVerne Kyriss, Western, CSO

APPENDIX A

Appointment of Accident Investigation Board

memorandum

DATE: June 8, 2004

REPLY TO
ATTN OF: A7000

SUBJECT: Accident Investigation Board Appointment, Contractor Fatality in Upper Great Plains Region

TO: Distribution

This memorandum establishes an Accident Investigation Board to investigate the contractor fatality of June 7, 2004, that occurred on the Granite Falls-Watertown 230kV fiber optics project. The following Western employees will serve as Chairperson and members of the review board.

Virgil Downing – RMR Construction Manager, Loveland, CO, Chairman
Mike Fyffe – RMR Safety Specialist, Casper, WY, member
Larry Romero – CSO Design Group, Lakewood, CO, member

The scope of the board's investigation will include, but is not limited to, identifying all relevant facts, analyzing those facts to determine the direct contributing and root causes of the accident, developing conclusions, and determining the judgments of need; that when implemented, should prevent the recurrence of the accident. The investigation will specifically address the role of management systems as they may have contributed to the accident and the application of lessons learned from similar accidents within Western.

The Board will provide my office with periodic reports on the status of the investigation. Draft copies of the factual portion of the investigation report will be submitted to me for accuracy review. The report should be provided to me by July 9, 2004. Any delay to this date shall be justified and forwarded to this office. Discussions of the investigation and copies of the draft report will be controlled until I authorize release of the final report.

By copy of this memorandum, I am advising the supervisors of each board member that this assignment is full-time until the investigation and final report are completed. The Board shall charge their time and expenses to work order number N/FCPS LINCM 92510.


Timothy J. Meeks
Chief Operating Officer

Distribution

A7900, P. Davis

A7900, L. Romero

B. Marsh, J0700, Loveland, CO

M. Fyffe, J0703, Casper, WY

C. LeDoux, J5000, Loveland, CO

V. Downing, J5600, Loveland, CO

cc:

M. HacsKaylo, A0000

✓ T. Dembrowski, A7700

J. Bladow, J0000, Loveland, CO

R. Harris, B0000.BL, Billings, MT

R. Boyer, B0700.BL, Billings, MT

APPENDIX B

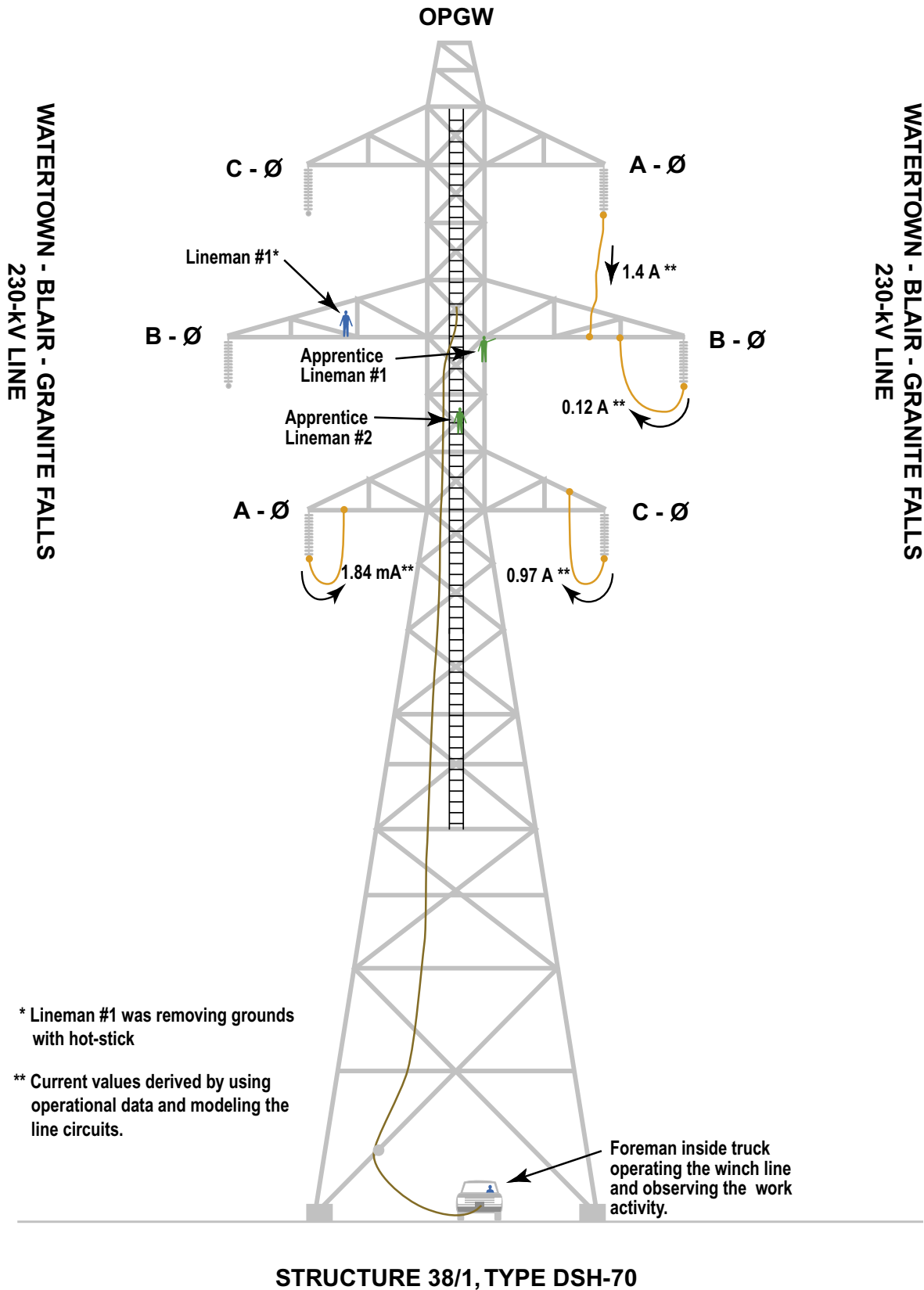
Structure configuration drawings and system operating diagrams

- Exhibit A** **Drawing of Double Circuit Structure 38/1 showing approximate location of ground leads and personnel just prior to time of work crew change**
- Exhibit B** **Drawing of double circuit structure No. 38/1 showing location of workers at the exact time of accident**
- Exhibit C** **South Dakota-Watertown Area Operating Diagram No. SYD-B-14 showing perimeter of safe work area**

EXHIBIT A

Date: June 7, 2004

APPROXIMATE LOCATION OF GROUND LEADS AND PERSONNEL JUST PRIOR TO TIME OF WORK CREW CHANGE



* Lineman #1 was removing grounds with hot-stick

** Current values derived by using operational data and modeling the line circuits.

EXHIBIT B

Date: June 7, 2004

Time: Approx. 9:05 p.m

LOCATION OF GROUND LEADS AND PERSONNEL AT THE EXACT TIME OF THE ACCIDENT

