Type A Accident Investigation Board Report of the April 25, 1997 Contractor Fatality on the Olympia-White River #1 230 kV Line

BONNEVILLE
POWER ADMINISTRATION

Final Report

June 1997

On April 30, 1997, I established a Type A Accident Investigation Board to investigate the April 25, 1997 contractor fatality which occurred on the Olympia - White River # 1 230 kV line, in Olympia, Washington. The board's responsibilities have been completed with respect to this investigation. The analysis, identification of root and contributing causes, and judgment of needs 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.

BPA has had a second fatal accident on June 25, 1997 involving a contractor. The investigation of this accident will include an in-depth review of contractor safety oversight and may require additional changes in BPA procedures not covered in this report.

Randall W. Hardy
Administator and Chief Executive Officer

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INTRODUCTION

On April 25, 1997, at approximately 1510 hours, a lineman for Great Southwestern Construction Inc. was fatally electrocuted when he came in direct contact with a deenergized 230-kilovolt (kV) transmission power line conductor which contained an induced voltage.

On April 30, 1997, Randall W. Hardy, Administrator and Chief Executive Officer for the Bonneville Power Administration, appointed a Type A Accident Investigation Board to investigate the accident in accordance with DOE Order 225.1, *Accident Investigation,* and BPA Manual Chapter 181, *Accident Investigation and Reporting.*

ACCIDENT DESCRIPTION

The accident occurred at approximately 1510 hours on Friday, April 25, 1997 as a lineman, employed by Great Southwestern Construction Inc., of Castle Rock, Colorado, attempted to remove a grip from a conductor. The scene of the accident was at structure 1/3, the third structure in the first mile out of BPA's Olympia Substation on the Olympia-White River #1 230-kV transmission line. The contract for reconductoring the Olympia-White River 230-kV transmission line began on February 19, 1997 and was scheduled to be completed on May 1, 1997. The line had been accorded Construction Status and was cleared for work. Construction status provides assurance that the transmission line cannot, and will not, be intentionally energized because all station sources of energization have been removed, tagged and secured. The job was being completed on time and the crew was scheduled to work Saturday, then return to work Monday, with a projected completion date of Wednesday, April 30, 1997.

The work assignment at the time of the accident was to connect the A-phase conductor to the dead-end tower insulator string at structure 1/3. Cranes were positioned near the structure, beneath the line. A ground rod was driven into the ground and connected to the vehicle frame, via a portable ground, to serve as grounding path. The victim and a coworker, both linemen equipped with fall protection gear, were raised in a basket by the crane boom to the work area on the A-phase conductor. According to crew statements, the victim connected a personal protective ground to the conductor by hand, within the work area, but was not observed tightening the ground clamp onto the conductor.

At the time of the electrical contact, the coworker was attempting to remove the grip from the conductor. This removal process required him to stand on the center work basket rail, allowing him to extend his reach. As the coworker was moving the grip closer to the edge of the basket, the victim moved to assist in the removal process and grabbed the grip. Concurrently, the coworker let loose of the grip to relocate within the basket, leaving the victim holding onto the grip or conductor. Moments later, after repositioning himself in the basket, the coworker attempted to re-enter the work area to help remove the grip. As the coworker touched the victim, while moving toward the grip, he reacted to a shock that propelled him backwards into the basket, away from the conductor and grip. Then the coworker observed the victim holding onto the grip. The coworker stated that smoke was rising from the victim's left glove, and he was slouched over the top basket rail. The coworker than signaled the operator on the ground to retract the boom. The operator retracted the boom approximately 6-8 inches. The victim was still in contact with the grip or conductor.

Observing the accident, the general foreman, approximately 50 to 75 feet away, ran to the crane and jumped on to operate the controls. He retracted the boom, breaking the victim's hand free from the grip or conductor, and lowered the basket to the ground. After the victim was lowered to the ground, the crew performed CPR until emergency units arrived. The victim was transported to Capitol Medical Center, in Olympia, where he was pronounced Dead-on-Arrival (DOA), due to electrical contact, by Capital Medical Center Emergency Room personnel.

ROOT & CONTRIBUTING CAUSES

The Board identified three root causes for the accident. These root causes, if eliminated, may have prevented the accident:

1. Failure of contractor personnel to provide oversight and to review the proper use of portable protective grounds with workers.

2. Failure to properly train workers about electrical hazards associated with high-voltage transmission power lines.

3. Failure to properly attach portable protective grounds at all points or to adequately secure grounds.

In addition, four contributing factors were identified:

1. Great Southwestern line and upper management had responsibility and accountability for worker safety. However, there is no evidence of workers and supervisors being properly trained to perform assigned tasks in a safe manner.

2. Great Southwestern line management appeared unaware of conspicuous job hazards at this site, as shown by their failure to observe obviously unsafe conditions and to allow unsafe actions to proceed.

3. Great Southwestern Construction failed to adequately plan the work, provide adequate safe work procedures, follow their own safety plan, or ensure that existing procedures were implemented and adhered to.

4. Failure to position crane to facilitate safe conditions for linemen.

RESULTS OF INVESTIGATION

The initial on-site investigation and review of crew statements revealed important information about work practices acceptable to the contractor in the installation and removal of portable protective grounds on a conductor as well as on ground rods, vehicles, or other objects or facilities. The crew’s installation and removal of portable protective grounds was performed either with bare hands or with leather gloves on, tightening the clamp either by hand or screw driver. Sometimes ground clamps were not fully secured because they might have to be moved during the work process, and the ground clamp might be located within the work area for easier accessibility. The poor condition and connections of portable protective grounds were also noted.

Inspection of portable protective grounds used at the accident scene showed that the grounds were not properly secured at the ground clamp end. Tightening devices were only finger tight and internal copper wires were frayed on the ends and appeared to be smashed. All ground clamp connections on the vehicle frame, work-basket toe board and ground rod were loose and could be moved easily. Also, the paint underneath the ground clamps had not been removed to allow for metal-to-metal contact, required for proper grounding.

Further, interviews and contract representative daily work inspection records show that another portion of the construction crew was ahead on line (AHOL) putting jumpers in place at the dead-end structures after completing the dead-end connection process at each location. This crew was placing jumpers at structure 7/8, with work being completed on position B and C phases, prior to the accident. Their work on A phase would have been completed after the work at structure 1/3. At the time of the incident at 1/3, there was no ground in place on A phase at structure 7/8. The only portable protective ground on A phase would have been at the work location at 1/3.

There is no evidence of proper training on the dangers of parallel line induction so that workers would clearly understand why personal safety measures are crucial. Less than optimum positioning of cranes, forcing linemen into constrained work positions, and either not noticing or failing to correct the situation when noticed are significant indications of inadequate work planning. Further, though safety meetings were held regularly as required, there is no evidence of anyone being designated as responsible for safety issues on site.

ADDITIONAL INVESTIGATIVE REPORTS

The board will review the accident investigation report from the Washington State's Department of Labor and Industries (WISHA) to obtain any additional information that was discovered from their investigations, including any citations and/or documentation of unsafe working practices or procedures for aerial lift equipment operation. In addition, the accident report from Great Southwestern Construction, when received, will also be reviewed by the board for any judgement of needs, and any additional information pertaining to the work processes, their accident findings, and management controls.

CONCLUSIONS

- Contractor must have experienced, qualified safety personnel with knowledge of relevant electrical hazards on site at all times. This person would be solely dedicated to safety oversight and independent of the project management.
- BPA Contract language must include strong requirements for qualified workers and for work stoppage for any safety rule violation.
- BPA Contracting Officers and their representatives need ongoing technical training on contract safety requirements, rules and regulations, and electrical hazards. The BPA safety professional should make contract site visits to review contractor practices and to assist the field representatives.
- Appropriate regulatory agencies, including the BPA Safety Office, need to be promptly notified about project commencement, location and scope.

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TYPE A
ACCIDENT INVESTIGATION REPORT
OF THE APRIL 25, 1997
LINEMAN FATALITY
ON THE
OLYMPIA - WHITE RIVER # 1 230-KILOVOLT (KV) LINE

This is a report by the Accident Investigation Board (AIB) formed to investigate the electrical contact accident involving an employee of Great Southwestern Construction, Inc., of Castle Rock, Colorado and under contract to the Bonneville Power Administration (BPA).

1.0 INTRODUCTION

1.1 Background

On April 25, 1997, at approximately 1510 hours, a lineman for Great Southwestern Construction Inc., was fatally electrocuted when he came in direct contact with a deenergized 230-kV transmission power line conductor which contained an induced voltage.

On April 30, 1997, Randall W. Hardy, Administrator and Chief Executive Officer for the Bonneville Power Administration, appointed a Type A Accident Investigation Board to investigate the accident in accordance with DOE Order 225.1, *Accident Investigation,* and BPA Manual Chapter 181, *Accident Investigation and Reporting.*

1.2 Facility Description

The accident site is located on the Olympia-White River # 1 230-kilovolt (kV) line right-of-way (ROW), structure 1/3, third structure in the first mile out of BPA's Olympia Substation, located in Olympia, WA. The ROW is located on BPA-owned property. The job was part of a project that included significant structural upgrading and reconductoring of 34 miles of line, designed to raise the line's current-carrying capacity. At the dead-end tower, structure 1/3, the line makes approximately a 90-degree change in direction. Structure 1/3 is a 78-foot 230-kV single-circuit-type "DS" angle/dead-end tower. The work in progress was located on A (north) phase. The line on which the fatality occurred had been disconnected and released to Construction Status. Construction status provides assurance that the transmission line cannot, and will not, be intentionally energized because all station sources of energization have been removed, tagged and secured.

Approximately one mile ahead on line (AHOL), the Olympia-Grand Coulee 287-kV line enters the corridor with the Olympia-White River Line and runs parallel for approximately six miles. Centerline to centerline, the separation between the two transmission lines is 125 feet.

Dead-ending was proceeding on both sides of the tower (See APPENDIX C, Exhibits 1 and 2 and Figure 1). Work-site conditions were extremely muddy from recent rains. Two Manitex M2592 Crane/Manlifts were dragged in by crawler and positioned beneath the lines, one on each side of the tower. Each crane has a 92-foot, noninsulated boom and a two-person basket attached to the end of the boom. The cranes are equipped with three sets of boom controls, one on each side of the crane cab and another in the basket.

The conductor (wire) height at the fatal point of contact is 55 feet.

Exhibit 1 — Site Overview

Exhibit 2 — Side View of Cranes Positioned Beneath Tower

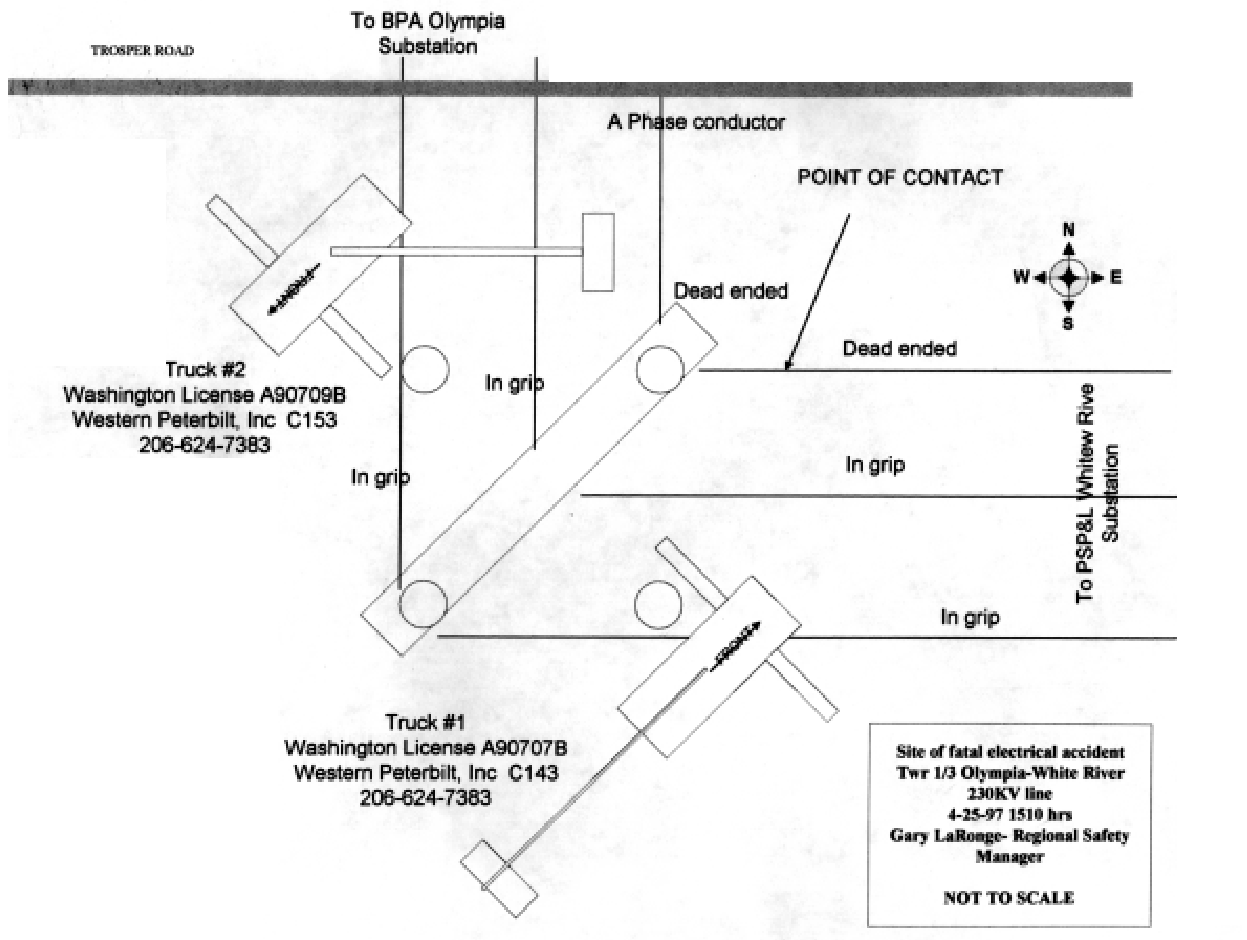

Figure 1 — “Site of Fatal Electrical Accident”

Eight Great Southwestern Construction crew members were on the job at tower 1/3. Two men were in the basket where the accident occurred; one man was operating the controls for that basket from the bed of the crane; the construction foreman and one additional worker were observing the proceedings from about 75 feet AHOL. Two crew members were in another aerial lift on the opposite side of the structure. One additional employee was working at ground level by the structure.

1.3 Scope, Conduct and Methodology

The initial accident investigation commenced on April 25, 1997, with the investigation team headed by BPA Safety Office DOE-trained accident investigators. This investigation continued until April 30, 1997, when Randall W. Hardy, Administrator and Chief Executive Officer, Bonneville Power Administration (BPA), upon approval of the US Department of Energy (DOE), appointed a Type A Accident Investigation Board to investigate the accident in accordance with DOE Order 225.1, *Accident Investigations,* and BPA Manual Chapter 181, *Accident Investigations and Reporting.* The Board commenced its investigation on May 5, 1997, completed the investigation on June 30, 1997, and submitted its findings to BPA Administrator and Chief Executive Officer on July 10, 1997.

The scope of the Board’s investigation was to review and analyze the circumstances to determine the accident’s cause(s). The Board also considered the adequacy of the contractor’s safety management system and work control practices. Additionally, the Board reviewed and analyzed present BPA contractual language, examining the role of BPA’s construction contractor personnel safety standards, including other utilities’ contractual language and standards referring to safety and health procedures.

One purpose of the investigation was to determine the causes of the accident, including deficiencies, if any, in contractor safety management systems, contract employee training and qualifications, and in the interpretation of contractor-acceptable safe working practices. Another was to examine BPA’s contractual language concerning safety and health as well as on-site responsibility for contract compliance issues.

The Board conducted its investigation, focusing on contract management systems, utilizing the following methodology:

- Facts relevant to the accident were gathered through interviews, documentation’s, as well as through physical evidence reviews.

- Electrical tests and computer modeling on the 230-kV transmission line and adjacent circuits were conducted to simulate electrical conditions on the conductor at the time of the incident.

- BPA contractual practices and language were reviewed.

- Contractual practices and language of several private, public, and governmental agencies or utilities were also reviewed.

- Further analysis provided supportive correlation and identification of the accident’s causes.

- Based on analysis of the data, judgments of need for corrective actions to prevent recurrence will be developed.

2.0 FACTS AND ANALYSIS

2.1. Background and Accident Description

The accident occurred at approximately 1510 hours on Friday, April 25, 1997 as the lineman, employed by Great Southwestern Construction Inc., of Castle Rock, Colorado, attempted to remove a grip from a conductor. The contract for reconductoring the Olympia-White River 230-kV transmission line began on February 19, 1997 and was scheduled to be completed on May 1, 1997. The scene of the accident was at structure 1/3, the third structure in the first mile out of BPA’s Olympia Substation, on the Olympia-White River #1 230-kV line. On February 18, 1997, prior to the start of Great Southwestern Construction Company’s contract work, Bonneville Power Administration Transmission Line Maintenance crews, under a work clearance, removed line jumpers at structures 1/1 and 34/1 on the Olympia - White River #1 230-kV transmission line. Then, the line was released to Construction Status. With Construction Status in place, no other clearances or permits were required to complete the task as described within the contract.

Regular Monday morning crew safety meetings had been conducted with all members of the crew present. Either the GSW Superintendent or General Foreman conducted those safety meetings. According to records, the last meeting was held on Monday, April 21, 1997. Records indicate that personal grounding, equipment grounding and crew teamwork were discussed, however no specific details have been provided by GSW.

The job was being completed on time and the crew was scheduled to work Saturday, April 26th, then return to work Monday the 28th, with a projected completion date of Wednesday, April 30, 1997. During the interview process with contractor upper management and crew following the accident, specific questioning determined that no urgency or rush to complete the work was a factor in this accident.

At the time of the accident, the work assignment on structure 1/3 was to connect the A-phase conductor to the dead-end tower insulator string. New conductor was being installed on both sides of the tower. Final connections were being made by the aerial basket crews. This procedure begins with rigging, or “catching off,” the conductor with rigging consisting of a hoist, or come-along, and wire-rope sling assembly attached from the tower bridge arm to a conductor grip on the wire (See Exhibits 3, 5 and 6 and APPENDIX C). Then the conductor terminal end is made up with a compression-type fitting and attached to a string of insulators. The rigging is then slacked off to allow the tower arm to take the full tension of the conductor with the insulator assembly in place.

Exhibit 3 — Grip and Come-Along On Conductor at Scene of Accident

A personal protective ground normally is installed on each conductor to protect the workmen from any source of accidental energization and induction that may be present on the wire (See APPENDIX D). Induced voltages, coupled from adjacent or nearby energized lines, electrical charges carried by wind and dust, etc., or trapped electrical charges found on de-energized transmission lines can be of sufficient magnitudes to be fatal if contacted on an ungrounded conductor.

On Friday, April 25, 1997 at approximately 0900 hours, Manitex Crane/Manlift #1 was dragged into position at dead-end structure 1/3 by a tractor/crawler. This process was required due to muddy conditions in the work area. The location of the manlift was AHOL, adjacent to the structure’s south leg, under the conductors. Shortly thereafter, Manitex Crane/Manlift #2 was dragged into position on the opposite side of the structure, adjacent to the north structure leg. The Manitex M2592 is rated as a 92-foot usable boom with a two-person work basket in place at the end of the boom. Boom operating controls are located both in the basket and on either side of the truck bed.

After the manlifts were positioned and set up, the victim installed a copper ground rod approximately four

(4) feet into the ground, adjacent to the rear of Manlift #1. He attached one end of a portable protective ground to the ground rod and the other end to the vehicle frame; because the boom on this model crane is noninsulated, the driven ground rod is needed to ground the vehicle. Then, the victim and a coworker, another lineman, entered the basket, put on their fall protection gear and attached it to the end of the boom with their lanyards.

The boom was then raised to the work location on the A-phase conductor AHOL. The boom was being operated by another employee, using the driver-side boom controls, because the sting-in and sting-out control operation (extension or retraction of boom sections) in the basket was malfunctioning. The front of the basket was located approximately at conductor level. The victim was located on the left side of the work basket, nearest the tower; the coworker was on the opposite end of the work basket (See Exhibit 4). According to coworker interview information, the victim connected the personal protective ground to the conductor by hand, between the grip and insulators, but was not observed tightening the ground clamp onto the conductor. The other end of the personal protective ground had been connected to the toe-board portion of the work basket, just under the right front corner, according to on-site observations and interviews (See Exhibit 4).

Exhibit 4 — Ungrounded Basket With Personal Ground Connections

At the time of the electrical contact, the coworker was attempting to remove the grip from the conductor (See Exhibits 5 and 6 and APPENDIX C). This removal process required him to stand on the center work basket rail, allowing him to extend his reach. He needed to stand on the rail because the crane, which had been hauled into place as a result of the muddy conditions, was not positioned so that he could proceed normally from within the basket. As the coworker was moving the grip closer to the edge of the basket, the victim moved to assist in the removal process and grabbed the grip. Concurrently, the coworker let loose of the grip to reposition himself within the basket, leaving the victim holding onto the grip or conductor. Moments later, after repositioning himself in the basket, the coworker attempted to re-enter the work area to assist in removing the grip. In that brief time between the coworker letting loose of the grip, repositioning himself in the basket and attempting to assist in removing the grip, something had occurred to change the grounding connection. As the coworker touched the victim while trying to help remove the grip, he received a shock severe enough to propel him backwards into the basket, away from the conductor and grip. When he regained his composure, the coworker observed the victim holding onto the conductor or the grip. According to the coworker smoke was rising from the victim's left glove, and he was slouched over the top basket rail.

Exhibit 5 — Position of Grip on Conductor, Long Shot.

Exhibit 6 — Position of Grip on Conductor, Close-up.

The coworker immediately yelled “sting-in” to the equipment operator at the controls. On the original sting-in request, the equipment operator retracted the boom approximately at 6 to 8 inches. This short distance accomplished nothing to aid the victim. According to interviews, the equipment operator could not respond further because he was on the opposite side of the cab from the work and could not clearly see the work activity nor hear anything over the noise of the adjacent manlift. Seeing there was a problem, the general foreman, approximately 50 to 75 feet away, ran to the crane and jumped on to operate the passenger-side controls. Not aware that the equipment operator was at the driver-side controls, he thought that the basket had pinned the victim into the conductor. Upon hearing a further request for sting-in, the foreman immediately retracted the boom and lowered the basket to the ground. This broke the victim’s hand free from the grip or conductor (the victim was still attached to the basket with his safety gear). The victim’s coworker tried to aid the victim and support him until they reached ground level. When they reached the ground, the other crew members assisted in removing the victim from the basket and placed him on stable ground adjacent to the basket and tower leg, where CPR was started.

2.1.1 Chronology of Events

Pictures contained within APPENDIX C summarize the chronology of significant work process events that the lineman would have performed just prior to the accident. The graphic summary of events below (Figure 2) shows the accident in the context of the overall construction contract.

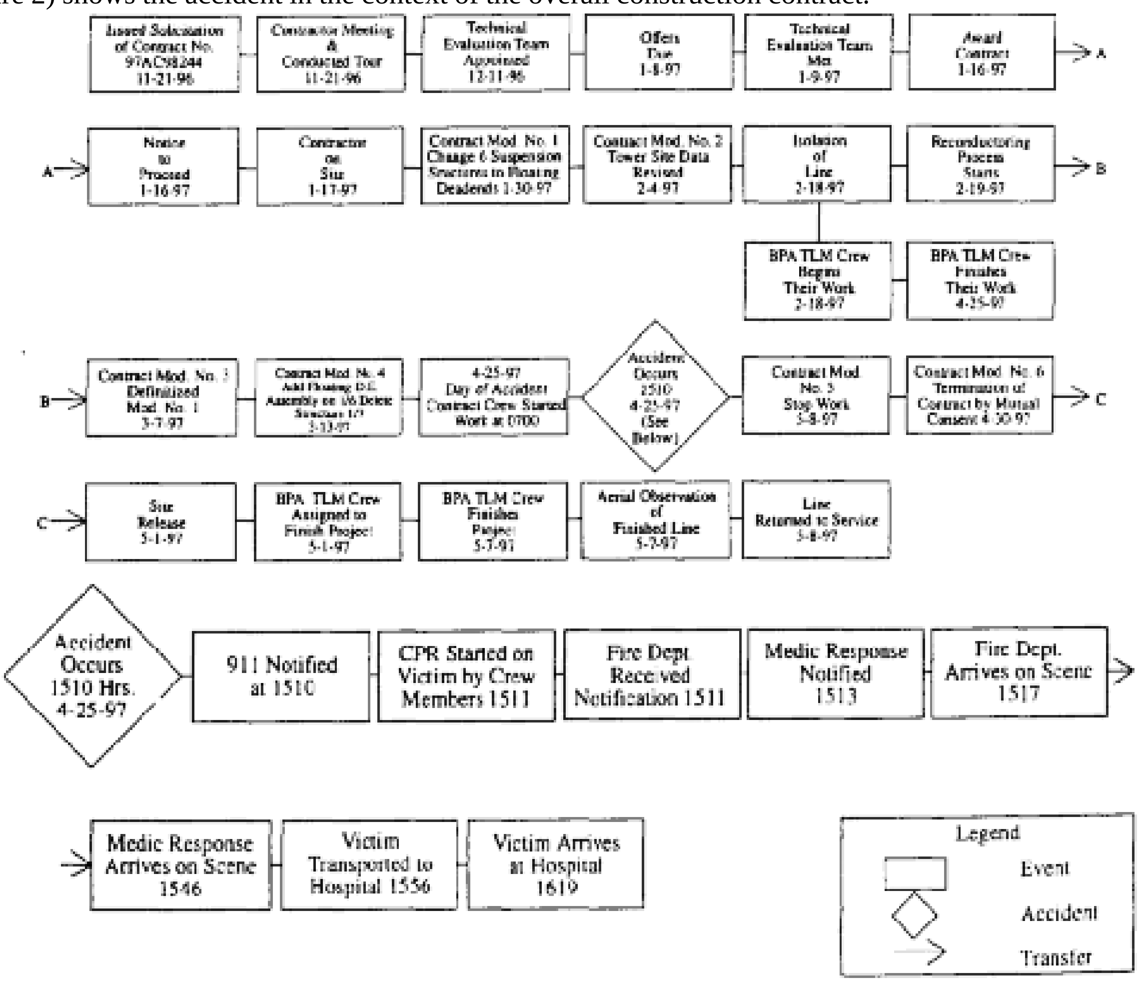

Figure 2, Summary of Events and Accident Chronology

2.1.2 Emergency Response and Investigative Readiness

Employees of Great Southwestern Construction immediately called 911. The victim's coworkers started First Aid/CPR, when the basket reached the ground, until the emergency medical units arrived. The Black Lake Fire Department received the call at 15:11 and arrived at the accident scene at 15:17. The Emergency Medical Responder, Rescue Medic 5, received their notification call at 15:13 and arrived at the scene at 15:46. CPR and first aid were administered by the Emergency Medical Responders for approximately 30 minutes. Coworkers assisted in the removal of the victim from the accident scene to the emergency medical vehicle, located 100 to 125 yards away. The victim was transported to Capitol Medical Center at 15:56, arriving at 16:19. The injured lineman was pronounced Dead-on-Arrival (DOA), due to electrical contact, by Capital Medical Center Emergency Room personnel.

According to the Thurston County Medical Examiner's office, the injured lineman received electrical entrance burns on his left first finger, left thumb, and left palm area with a single electrical exit burn located just below the right knee. Visible injuries to the victim included entrance burns on the left index finger, left thumb and left palm area. The exit burn location was just below the right knee.

The 33-minute time frame for Rescue Medic 5 to be dispatched until arriving on the scene occurred because of difficult access conditions at the accident scene and rush-hour traffic conditions in the greater Olympia area. The time of 15:46 was marked at the point of actual contact with the lineman at the accident scene, not the emergency vehicle arrival at the accident site location. The overall quality of the accident response effort by contractor employees and medical personnel on April 25, 1997 was satisfactory. On-site personnel took prompt, appropriate and effective action following the accident to preserve and secure the integrity of the accident scene.

2.1.3 Significant Electrical Hazards

Electric and magnetic fields are present around energized transmission lines and can produce high voltage and/or currents in adjacent, isolated conductors. When there is an isolated conductor in an electric field, a voltage will be induced on the isolated conductor as a function of the voltage on the energized circuit and the distance between the lines. When the isolated conductor is grounded, a current discharging the energy will flow in the isolated conductor. If a second remote ground is added, a much larger, magnetically induced current will flow.

The prevailing electrical conditions were examined at tower 1/3 to determine the source and magnitude of the electrical energy that caused the fatal accident. Figure 3 shows those conditions.

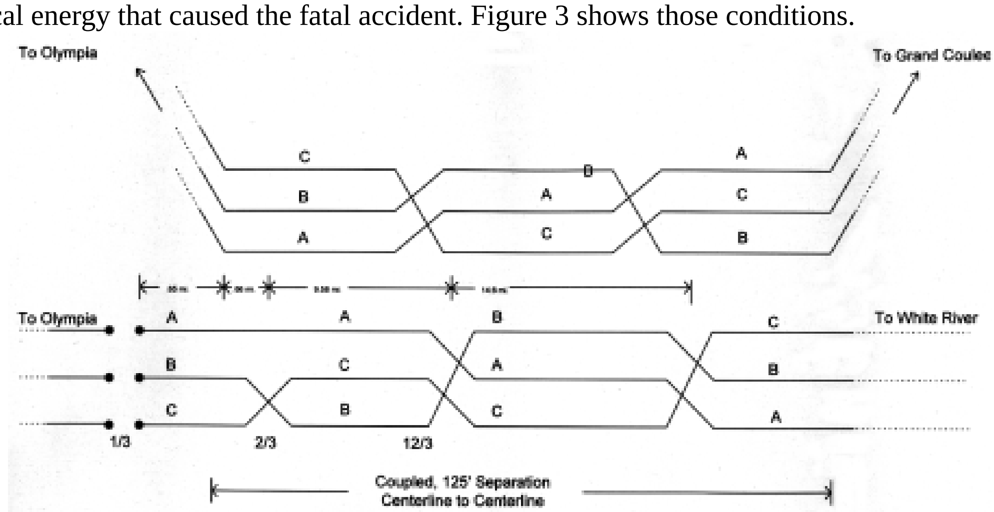

Figure 3. 3-Phase Schematic of Coupled Portion Between Olynpia-White River (230 kV) & Olympia-Grand Coulee (287 kV)

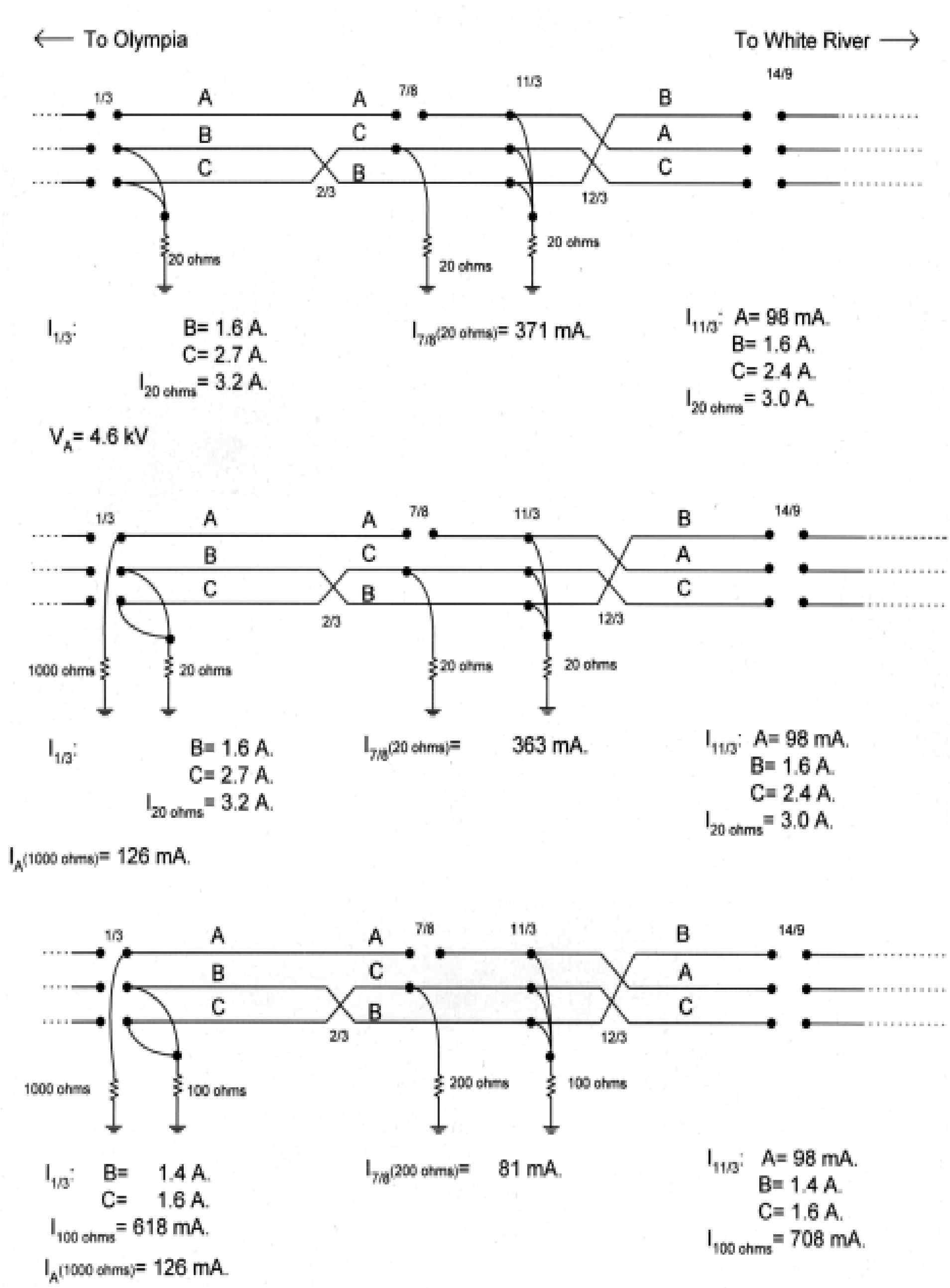

Figure 3, High-Voltage Line Conditions, Continued from page 9

The Olympia-Coulee 287-kV line, 125 feet north of and running parallel to the Olympia-White River circuit, was operating at 300 kV at the time of the accident.

The AIB has determined that the A-phase conductor at 1/3 may have had a “coupled” voltage of over 4 kV. When the victim’s body grounded the conductor, a 60-Hz discharge current of over 125 ma would have flowed through his body until the act of pulling him away from the conductor broke the circuit. The coworker, when he touched the victim, undoubtedly made an arcing contact — that is, he did not have a solid grip on the victim — and was knocked away.

APPENDIX E shows the effects of current on the human body. As noted, time exposed and current magnitude are the crucial factors. The AIB concluded that 125 ma passed through the victim’s heart region as it crossed his body, from its entrance point on his left hand to its exit point below his right knee.

2.1.4 Investigation of Great Southwestern Construction Safety Plan

Great Southwestern Construction, Inc. submitted a safety plan listing operations which, as a minimum, are applicable to their transmission line installations. The following rules have been extracted from their plan:

1. Use of personal grounds when handling conductor adjacent to energized lines.
2. Hotsticks to install personal and conductor grounds.
3. Personal grounds shall be used as required when handling conductors to prevent shock due to induced voltage.
4. Great Southwestern has determined the following as a minimum potential hazard: Working in near proximity of energized lines.
5. A job-specific safety plan in place for each type of work performed.
6. Job Project Managers are directly responsible to the company President in regard to safety. The Project Manager must assure all subordinates are properly trained. Weekly safety meetings are held with all project employees and documented.
7. Generally, a work site inspection is conducted prior to the start of work to identify any hazards and determine preventative or corrective action.
8. Great Southwestern believes in preventing accidents by early hazard identification; adequate first aid and safety training for all employees; prompt and accurate record keeping and recognition for people that contribute significantly to safety goals.

The BPA AIB cannot be sure of the exact conditions at the moment the victim was shocked. Crew members say that a personal ground was in place in the work area, but no one saw it being tightened down or otherwise secured. Subsequent statements by the crew members present cannot place the personal ground at any location after contact was made. No hotsticks, as prescribed in Great Western's Safety Plan, were reported being used, although standard utility practice is to use only fiberglass-insulated live-line tools to install or remove portable protective grounds.

Work conditions at the site were muddy, so the crane had to be dragged into position by a crawler. The crane was not tested for adequate boom extension and basket positioning. Apparently, that positioning did not allow adequate basket alignment, which required the victim and his coworker to overextend, utilizing the rails on the basket to reach the grip. It is possible that the victim had a such a tight grasp on the conductor because, since the basket was out of position, he needed more leverage to lift the 40-lb. grip.

The last recollection anyone has of the positioning of the personal ground is that the grounding end was connected to the toe board of the basket. The conductor end was, perhaps, not placed outside of the work area because the crane was not located correctly enough to allow for such placement, though crew members have said that they sometimes place personal grounds in the work area for convenience. Preferred work practices dictate that the ground clamp be located outside of the work area to ensure that ground connections will not be disturbed during the work process.

Why was the victim injured and not his coworker, who also handled the grip? The AIB thinks the rigging used by the linemen formed an "incidental" ground that was broken when the rigging was disconnected. Grounding would still have been secure if the personal ground had remained attached.

The crane boom itself was used to break the victim's hold on the conductor, pulling him away as it came down. But the personal protective ground shows no evidence of having been ripped from the line (its other end was attached to the basket). After the accident, investigators found the conductor end of the personal ground attached to the rail from the inside, leading some to question if the ground had ever really been in place.

Great Western's Safety Plan commits the contractor to identifying potential hazards beforehand and instigating preventative action; yet, the operator controls in the basket were not working properly, and the operator was operating the controls from a position in which he could not clearly see the work proceeding on the line. The initial actions taken by the operator were not sufficient to dislodge the victim from the conductor. Thus, the foreman had to run 75 feet, jump on the crane, and operate the opposite-side controls, actions that could have taken a full minute or more.

Records of the regular safety meetings held by Great Western, as specified in their Safety Plan, including that of April 21, the last one held before the victim's death, show that personal grounding and teamwork had been discussed. Previous minutes indicate induction was also discussed, but how complete these discussions were is not known.

2.1.5 OSHA Regulations

Relevant sections of the Occupational Safety and Health Administration, committed to by both BPA and Great Western Construction, are shown in below:

OSHA 1926.954-Grounding for protection of employees

Subpart V

Title: Power transmission and Distribution

(e) Attaching grounds.
(1) When attaching grounds, the ground end shall be attached first, and the other end shall be attached and removed by means of insulated tools or other suitable devices.
(2) When removing grounds, the grounding device shall first be removed from the line or equipment using insulating tools or other suitable devices.
(f) Grounds shall be placed between work location and all sources of energy and as close as practicable to the work location, or grounds shall be placed at the work location. If work is to be performed at more than one location in a line section, the line section must be grounded and short circuited at one location in the line section and the conductor to be worked on shall be grounded at each work location. The minimum distance shown in Table V-1 shall be maintained from ungrounded conductors at the work location. Where the making of a ground is impracticable, or the conditions resulting therefrom would be more hazardous than working on the lines or equipment without grounding, the grounds may be omitted and the line or equipment worked as energized.

OSHA 1926.955

Subpart V

Title: Power Transmission and Distribution

(3) Where there is a possibility of the conductor accidentally contacting an energized circuit or receiving a dangerous induced voltage buildup, to further protect the employee from the hazards of the conductor, the conductor being installed or removed shall be grounded or provisions made to insulate or isolate the employee.
(d) Stringing adjacent to energized lines. (1) Prior to stringing parallel to an existing energized transmission line a competent determination shall be made to ascertain whether dangerous induced voltage buildups will occur, particularly during switching and ground fault conditions. When there is a possibility that such dangerous induced voltage may exist the employer shall comply with the provisions of para-

graphs (d) (2) through (9) of this section in addition to the provisions of paragraph (c) of this 1926.955, unless the line is worked as energized.
(5) During stringing operations, each bare conductor, subconductor, and overhead ground conductor shall be grounded at the first tower adjacent to both the tensioning and pulling setup and in increments so that no point is more than 2 miles from a ground.
(i) The grounds shall be left in place until conductor installation is completed.
(ii) Such grounds shall be removed as the last phase of aerial cleanup.
(iii) Except for moving type grounds, the grounds shall be placed and removed with a hot stick.
(6) Conductors, subconductors, and overhead ground conductors shall be “grounded at all dead-end or catch-off points.
(8) - (i) All conductors, subconductors, and overhead ground conductors shall be bonded to the tower at any isolated tower where it may be necessary to complete work on the transmission line.
(ii) work on dead-end towers shall require grounding on all de-energized lines.
(9) When performing work from the structures, clipping crews and all others working on conductors, subconductors, or overhead ground conductors shall be protected by individual grounds installed at every work location.

These rules cover three main points: Qualifications of employees, a strict protocol for use and installation of temporary grounds, and consideration of the inductive potential of parallel lines, including appropriate line grounding away from the immediate work area. The question raised by these rules is the adequacy of supervision by Great Western Construction, on this project, as well WAC 296-45, 65033, Transmission Line Construction causes and lessons learned at all levels of management and labor will be helpful to those in field work locations.

2.1.6 Washington State Department of Labor and Industries, Safety Standards for Electrical Workers

The following standards directly relate to the accident of April 25, 1997:

WAC 296-45-65026, Personal Protective Grounding

(1) Purpose
(a) Reduce the potential voltage difference across the worker: The primary function of personal protective grounds is to provide maximum safety to personnel while they are working on de-energized lines or equipment. This will be accomplished by making provisions which will reduce the potential voltage differences at the work site (voltage across the worker) to a safe value in case the equipment or line being worked on is accidentally energized from any possible source.
(b) Protect from induced voltage: The secondary function is also to protect against reduced voltage from adjacent parallel energized lines.
(4) Testing prior to installation of ground. Before grounds are installed, the de-energized line or equipment shall be tested for voltage by the following methods:
(a) Tester testing: Approved testers (audio and/or visual) may be used; however, they shall be tested immediately before and after use to verify that the tester is in good working condition.
(b) Hot line testing: A de-energized line may be buzzed or tested, to insure that it is de-energized using an approved hot line tool with a substantial piece of metal on the end.
(3) Grounding equipment
(d) Approved ferrules and grounding clamps: Grounding jumpers shall have approved ferrules and grounding clamps that provide mechanical support for jumper cables independent of the electrical connection.

(5) Attaching and removing ground(s)
(a) Inspection before use: Grounding equipment shall be given a visual inspection and all mechanical connections shall be checked for tightness before each use.
(b) Ground surface cleaning: The surface to which the ground is to be attached shall be clean before the grounding clamp is installed; otherwise, a self-cleaning clamp shall be used.
(c) Ground attachment procedure: When attaching ground(s), the ground end shall be firmly attached first to a reliable ground and then the other end shall be attached to the line or equipment by means of approved hot line tools.
(d) Ground removal procedure: No ground shall be removed until all employees are clear of the temporary grounded lines or equipment.

WAC 296-45, 65033, Transmission Line Construction

(1) Metal tower construction.
(4) Stringing near, above, below or otherwise adjacent to energized lines.
(e) During stringing operations, each bare conductor, subconductor and overhead ground conductor shall be grounded at the first transmission structure adjacent to both the tensioning and pulling set-up and in increments so that no point is more than two miles from a ground, and
(i) The grounds shall be left in place until the conductor installation is complete.
(ii) Such grounds shall be removed as the last step of aerial cleanup.
(iii) Except for moving type grounds, the grounds shall be placed and removed with a hot stick.
(iv) Conductors, subconductors and overhead ground conductors shall be grounded at all dead-end or catch-off points.
(g) All conductors, subconductors and overhead ground conductors shall be bonded to the tower at any isolated tower where it may be necessary to complete work on the transmission line.
(h) Work on dead-end towers shall require grounding on all de-energized lines.
(j) When performing work from the structure, clipping crews and all others working on conductors, subconductors, or overhead ground conductors shall be protected by individual grounds installed at each such work location.

These WISHA standards address the mandatory grounding requirements that govern the contractor's work that took place. The regulations specifically address protection from induced voltages, the physical makeup of the personal grounds, attaching and removing the personal grounds, and specific locations that require grounding. These standards underscore the insufficiencies by GSW management and supervision concerning the safe work procedures that were violated.

2.2 TYPICAL CONTRACT PRACTICES

The following summary table contains several private, public and governmental agencies or utilities which were compared to determine typical industry oversight practices on contractors performing work.

Table 1

Utility	Oversight	Contractor Response
Public		
Tacoma	Minimal oversight to recommend compliance & correction through Engineer or inspector.	Prepare a hazard assessment.

Bonneville Power Administration	Minimal oversight (hands off policy) to recommend compliance & correction through Inspector (CSR).	Contractor is responsible for safety plan to address any hazard assessment, assurance of knowledgeable or competent workmen.
Western Area Power Administration	Some oversight to recommend compliance & correction through Inspector or Safety Manager.	Contractor is responsible for safety, assurance of knowledgeable or competent workmen.
Department of Energy Hanford	Minimal oversight to recommend compliance & correction through Contracting Officers, Inspector or Safety Manager.	Contractor is responsible for safety, risk, assurance of knowledgeable or competent workmen, & must prepare Environment, Safety, & Health (ES&H) Managenent Plan.
Private		
Washington Water Power	Minimal oversight to recommend compliance & and correction through Engineer, Inspector or Safety Manager.	Contractor is responsible for safety, risk, assurance of knowledgeable or competent workmen, and must prepare a hazard assessment.
Pacific Power & Light	No oversight involvement with outside contractors.	Normal practice is to stay off job until contractor completes work. To date, uses only union contractors.

BPA's oversight is comparable to other NW utilities. WAPA provides a greater oversight than BPA and other NW utilities. PP&L provides the least amount of oversight.

Additional information is provided by the following Federal requirements, used by other Federal Agencies, not BPA. BPA uses the Bonneville Purchasing Instructions (BPI) , clause 15-2, Safety and Health, as their procedures and guidelines.

Federal Acquisition Regulation:

The contracting officer shall insert the clause at 52.236-13, Accident Prevention, in solicitations and contracts when a fixed-price construction contract or a fixed price dismantling, demolition, or removal of improvements contract is contemplated and the contract amount is expected to exceed the small purchase limitation.

(ACCIDENT PREVENTION)

(a) In performing these contracts, the Contractor shall provide for protecting the lives and health of employees and other persons; preventing damage to property, materials, supplies, and equipment; and avoiding work interruptions. For these purposes, the Contractor shall-
(1) Provide appropriate safety barricades, signs and signal lights;
(2) Comply with the standards issued by the Secretary of Labor at 29 CFR part 1926 and 29 CF part 1910; and
(3) Ensure that any additional measures the Contracting Officer determines to be reasonable necessary for this purpose are taken.
(b) If this contract is with any Department of Defense agency or component, the Contractor shall comply

with all pertinent provisions of the U. S. Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1, dated October 1987.

(c) The Contractor shall maintain an accurate record of exposure data on all accidents incident to work performed under this contract resulting in death, traumatic injury, occupational disease, or damage to property, materials, supplies, or equipment. The Contractor shall report this data in the manner prescribed by the Contracting Officer.

(d) The Contracting Officer shall notify the Contractor of any noncompliance with these requirements and of the corrective action required. This notice, when delivered to the Contractor or the Contractor's representative at the site of the work, shall be deemed sufficient notice of the noncompliance and corrective action required. After receiving the notice, the Contractor shall immediately take corrective action. If the Contractor fails or refuses to take corrective action promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor shall not base any claim or request for equitable adjustment for additional time or money on any stop order used under these circumstances.

(e) The Contractor shall be responsible for his subcontractors' compliance with this clause.

Alternate I (APR 84). If the contract will involve work of a long duration or hazardous nature, add the following paragraph (f) to the basic clause:

(f) Before commencing the work, the Contractor shall -

(1) Submit a written proposal for implementing these clauses; and

(2) Meet with representative of the Contracting Officer to discuss and develop a mutual understanding relative to administration of the overall safety program.

Summary:

The typical oversight practices of various utilities and agencies involved in contract line or construction works are similar to that of BPA: Providing little oversight on the contractor's safety program or practices; placing the responsibility and training solely on the contractor; and making the contractor responsible for meeting all Federal, state and local laws. The contractor is responsible for developing adequate training, recognizing the hazards and hiring qualified employees.

2.3 BPA'S CONTRACTOR PERSONNEL SAFETY & ENVIRONMENT

2.3.1 Historical Policy (Prior to 1992)

BPA has historically placed responsibility for personnel safety & environmental protection on construction contractors. Safety and environmental protection under this policy was generally good, with some exceptions. A series of environmental accidents and a general concern about industry wide contractor personnel safety, caused BPA to initiate a review of construction contractor safety and environmental protection in January 1991. This review involved broad participation with interested parties throughout BPA and was reviewed with senior management.

BPA specifications required contractors to enhance compliance with OSHA requirements. BPA contracts stated that contractors are responsible for environmental protection.

BPA Construction Representatives (inspectors) primarily monitored contractor results for compliance with contract requirements for the work product. Field inspectors were expected to halt seriously unsafe contractor operations if observed. The contractor's judgment generally prevailed in matters where no serious, immediate hazard was present. Historically, no emphasis had been placed on safety as a criterion in contractor selection.

2.3.2 BPA's Current Policy

As stated in a July 14, 1992 memorandum from Lyndon E. Bradshaw, BPA Director of Construction (See APPENDIX F), "BPA construction's contracting approach will continue to place responsibility for ensuring safety of contractor personnel, property, and environment on the contractor. BPA will influence contractors to improve their safety programs by requiring written safety plans and environmental protection plans from all construction contractors. Contractors will be required to submit environmental contingency response plans. Contractor compliance with OSHA rules and environmental regulations will be emphasized in BPA specifications.

"BPA will use safety records as a selection and screen-out factor in selecting construction contractors. BPA will collect, summarize, and report contractor accident frequencies."

"Field inspectors will take a more active role to enforce BPA specifications which are intended to assure contractor safety and environmental protection. Field inspectors will intervene to modify unsafe contractor operations with a primary focus on avoiding serious injuries or accidents. Field inspectors will be required to receive additional safety and environmental contingency response training to support their expanded role."

2.4 Accident Analysis

Analysis conducted by the Board addressed three types of issues associated with the accident: Great Southwestern management, contractual, and physical. Prevention measures for these problems either failed or were missing. Successful performance with regard to any of these problems could, or would, have prevented or mitigated the severity of the accident.

2.4.1 GSW Contractual/Management Issues

As stated in GSW Contract 98244, Safety and Health (15-50M) (October 96) (BPI 15.2), the Contractor safety responsibilities are as follows:

1. The Contractor shall assure that no person employed on this contract works in surroundings or under conditions that are unsanitary, hazardous, or dangerous to their health or safety. In fulfilling these requirements, the Contractor shall comply with:

a. Department of Labor Safety and Health Standards for Construction under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327 et seq.).

b. Occupational Safety and Health Act of 1970, (Public Law 91-598) and applicable rules and regulations as may have been delegated to the States.

c. Supplemental BPA safety and health requirements stated below or elsewhere in the contract.

2. If there are conflicts between any of the requirements referenced in this contract, the more stringent requirement will prevail.

3. If the Contractor fails or refuses to promptly comply with any safety and health requirement, the Construction Site Representative (CSR) may notify the Contractor of any noncompliance and the Contractor shall take immediate corrective action. Such notice, whether oral or written, when served on the Contractor or any of its employees at the site of work, shall be deemed sufficient. If the Contractor fails or refuses to promptly correct the condition, the CSR may stop all or any portion of the work. Failure of the CSR to provide notice of noncompliance or to stop work shall not relieve the Contractor of its responsibility for the safe performance of the work.

4. The Contractor shall furnish hard hats and other required safety equipment, except that which has been specified to be furnished by BPA.

5. Dangerous induced voltages may be present because of energized adjacent facilities. The Contractor shall take adequate safety measures to protect its employees and others from induced voltages as well as direct contact.

6. Each working crew shall contain at least two (2) journeyman electrical workers, having satisfactory experience with energized high-voltage facilities of the type to be worked on. The Contractor shall submit the prospective electrical workers resumes to the Contracting Officer. These resumes shall clearly demonstrate the competency of the individual electrical worker.

7. Before touching or coming within the minimum approach distance of overhead static (ground) wire or high voltage line conductors, it must be grounded at that location by either a portable protective ground or a permanent ground connection, except at 500 kV or above, a portable protective ground must be installed.

8. The Contractor shall not perform any work on energized BPA high voltage conductors or equipment and shall not come within Minimum Approach Distances shown. If, after the equipment or facilities are cleared, tagged, and properly grounded, additional portable protective grounds are needed they may be installed as close to the work being performed as practical by the contractor.

Lessons learned from similar high-voltage transmission line work activities and accidents were not fully incorporated into the work planning by planners, management, supervisors, and/or workers who prepared and carried out this work function. Precursors to this accident may not have been reported or communicated to management or supervision. GSW upper management was unaware that procedures involving the use of portable protective grounds were not being followed. The work practices of the employees of Great Southwestern were not the same as stated in the Safety Plan submitted. GSW line management supervision did not follow GSW initiated safety plans.

A safety meeting, with all workers involved, was conducted on the Monday before the accident. But supervisors did not ensure that workers fully understood safety requirements for the work, acceptable work practices and acceptable utility industry working standards, nor did they adequately verify that safe work processes were being implemented at the job site. Lack of supervisory oversight of the work activities at the time of the accident was a serious problem.

Important GSW management and oversight measures were less than adequate. Safety management failed because appropriate managers were not aware of, or ignored, the methods of the work being performed, nor did they fully understand their own roles and responsibilities below senior corporate level. This includes no designated safety management person on site. The corporate safety manager is also VP for Business Development, located in Castle Rock, CO. Processes in place to ensure worker safety were not being carried out or used effectively, and normal oversight processes were not implemented.

2.4.2 Contractual Issues

BPA's contractual oversight concerning the enforcement of the contract safety requirements of the contractor was adequate, based on present operating policies and contractual language. Efforts were made by BPA, in regards to review of the contract language, that the contractor fully understood their responsibilities or had methods in place to ensure required compliance as to safety and qualifications of contractor employees. BPA's involvement with contractor safety is consistent with the Electrical Utilities in general, which is to have a "hands-off" approach to contractor safety, putting the responsibility for safety as solely belonging to the contractor. It is the opinion of the Board that BPA could not have prevented this accident. When possible hazardous induced voltages may exist, more emphasis may need to be given that the electrical hazards specific to this job are addressed and given adequate attention by the contractor and BPA's COTR. BPA needs to continue the refresher training of its own CO's and COTR's to assure BPA they have an adequate understanding of appropriate OSHA regulations of electrical hazards, such they have knowledge of select qualified contractors, review their safety plans, and recognize possible hazards within the work locations. .

2.4.3 Physical Issues

The types of personal protective grounds chosen, as required by both OSHA and WISHA, were acceptable when maintained in good condition. However, the particular grounds used were unacceptable for assembly of components, attachment, securing, and installation processes. Live line tools were not used to install portable protective grounds, and where portable protective grounds were installed, at each grounding location, created a safety hazard. The contractor did not utilize or require that standard utility grounding practices be used. The vehicle was grounded by means of a personal protective ground attached between the vehicle's rear bumper and a ground rod placed approximately four (4) feet into the ground; but the contractor's method of grounding through the vehicle (using the vehicle as a primary component of the grounding circuit) is not accepted utility practice. (WISHA does not allow the practice.)

2.5 CAUSAL FACTORS

The root causes of the accident (the fundamental causes that, if eliminated or modified, could prevent a recurrence of this or similar accidents) were as follows:

(1) Failure of contractor personnel to provide oversight and to review the proper use of portable protective grounds with workers.

(2) Failure to properly train workers about electrical hazards associated with high-voltage transmission power lines.

(3) Failure to properly attach portable protective grounds at all points or to adequately secure grounds.

The combination of these causal factors was the primary reason the lineman was susceptible to electrical contact with the transmission line conductor at the time of the accident. These root causes, if eliminated or changed, could have prevented this accident and might prevent future occurrences. All these root causes should be taken to the senior management level of Great Southwestern Construction, Inc. for review and implementation within their organization policies. The Board believes that presenting the root causes and lessons learned at all levels of management and labor will be helpful to those in field work locations.

3.0 CONCLUSIONS AND JUDGMENTS OF NEED

Conclusions are a synopsis of those known facts and analytical results that the Board considers especially significant. Judgments of needs are managerial controls and safety measures believed helpful in preventing or mitigating the probability or severity of an occurrence. They both flow from analysis of the apparent causal factors and are directed at guiding managers in the development of follow-up actions.

Conclusion	Need
GSW management did not assure that their employees understood, or followed, their own Safety Plan. Knowledge & understanding of the electrical hazards associated with this work & this project were seriously lacking.	The contract needs to require the contractor to have a knowledgeable, experienced safety professional, independent of project management or supervision, with authority to insist on safe practices, be on site at all times for the duration of the contract. This would help assure that the training, proper use of and maintenance of equipment, and understanding of the high-voltage hazards were communicated to the contract personnel.
BPA's contracting policies need to be reviewed and the contract language needs to be strengthened & clarified. The Contracting Officer's Representatives need a clear understanding of the language & enforcement policies of the contract.	Other utilities do not interfere with the contractor's work, including their safety efforts. Such policy places accountability for safety on the person responsible for the construction process. Also, such policy does not allow reponsibility for safety to be weakened by being divided among numerous parties. However, if BPA judges that the agency should assume some contractor responsibility, then the BPA contract should require that all contractor and subcontractor personnel doing transmission or substation work should have journey-level skills. The Contracting Officer and/or duly appointed representative may stop work for any violation of any contract regulation or applicable state and Federal regulations. The contract should provide that such stoppage could not be considered a change or delay. The contractor will indemnify & defend Bonneville against personal injury & wrongful death claims brought with respect to injury or death suffered in the course of the work under this contract. There needs to be a paragraph-by-paragraph review of the contract language so that the Contracting Officer's Representative clearly understands the requirements of the contract.
The Contracting Officer's Representatives need ongoing technical training on contract requirements, rules & regulations, & electrical hazards associated with line construction.	Training for these representatives should be conducted by safety professionals. The BPA safety professional should assist the field representative by conducting job site visits to reinforce the necessary information while reviewing contractor work practices.
WISHA was not adequately notified that this project was underway &, therefore, could not make appropriate safety inspections.	The construction contract should require the contractor, at the start of the project, to notify the appropriate state or Federal safety regulators of the commencement, location & scope of the project. The Contracting Officer should promptly notify the BPA Safety Office.

This is a report by the Accident Investigation Board (AIB), formed to investigate the electrical contact accident involving an employee of Great Southwestern Construction, Inc., of Castle Rock, Colorado and under contract to the Bonneville Power Administration (BPA).

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BOARD SIGNATURES

Date: June 30, 1997

Truman W. Conn
Accident Investigation Board Chairperson
BPA Walla Walla Regional Manager,
Transmission Business Line

Date: June 30, 1997

Eugene McClellan
Accident Investigation Board Member
BPA Safety & Occupational Health Manager,
Business Services
Lead Accident Investigator,
DOE Trained Accident Investigator

Date: June 30, 1997

Charles R. Hubbard
Accident Investigation Board Member
BPA Safety & Occupational Health Manager,
Business Services
DOE Trained Accident Investigator

Date: June 30, 1997

John F. White Jr.
Accident Investigation Board Member
BPA Supervisory Electrical Engineer,
Technical Services,
Transmission Business Line

Date: June 30, 1997

Robert L. Jones
Accident Investigation Board Member
BPA Attorney - Advisor,
Office of General Counsel

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BOARD MEMBERS, ADVISORS, AND STAFF

Chairperson	Truman W. Conn, BPA, TFP/Walla Walla
Member	Eugene McClellan, BPA, CC-Z992
Member	Charles R. Hubbard, BPA, CC-Z992
Member	John F. White Jr., BPA, TNE-CSB
Member	Robert L. Jones, BPA, LL-7
Technical Advisor	D.A. Gilles, Consultant
Technical Support	Robert M. Hasibar, BPA, TNE-AMPN-2
Technical Writer	Stuart Sandler, Contractor
Contract Advisor	Victoria M. Pederson, BPA, TSP-CSB
Administrative Support	Kathleen A. Griffin, BPA, TF-DOB-1

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APPENDIX A
APPOINTMENT MEMO FOR TYPE A ACCIDENT INVESTIGATION

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(8-89)

United States Government **Department of Energy**

memorandum

Bonneville Power Administration

DATE: April 30, 1997

REPLY TO
ATTN OF: CC

SUBJECT: Accident Review Board

TO: James H. Curtis, Senior VP For Business Services - C

This memorandum is to confirm the appointment of the individuals listed below to the Bonneville Power Administration's Accident Review Board. The purpose of the Board is to investigate the fatal contractor accident that occurred on April 25, 1997.

Truman W. Conn	BPA Walla Walla Region Manager, Transmission Business Line, Board Chairperson.
Eugene McClellan	BPA Occupational Safety and Health Manager, Business Services, Lead Accident Investigator and DOE Trained Accident Investigator.
Charles R. Hubbard	BPA Occupational Safety and Health Manager, Business Services, DOE Trained Accident Investigator.
John F. White Jr.	BPA Supervisory Electrical Engineer, Technical Services, Transmission Business Line, Board Member.
Robert L. Jones	Attorney - Advisor, General Counsel, Board Member.

The following individuals will provide technical and administrative support to the board:

D.A. Gillies	Consultant expert to Bonneville in electrical and grounding requirements and regulations.
Kathleen A. Griffin	BPA Office Manager, Transmission Field Services, Transmission Business Line, Administrative Support.

The accident shall be thoroughly investigated and a report prepared in a manner consistent with DOE Order 225.1 and BPA Manual Chapter 181. During the investigation, the team shall review the accident site, equipment, work procedures, management systems, and other elements that are possible factors in the accident. Working with the Washington State Department of Labor investigation team is important to assure a complete, thorough, and competent assembly of facts. Do not hesitate to seek the technical assistance of any others that may help in your analysis of the findings. Bonneville's final report shall include the facts, analysis of facts, probable cause (conclusions), and judgment of needs.

The report shall be forwarded by memorandum which states the Board's recommendations to me within 30 calendar days. The Board should keep this Office advised of the continuing investigative process.

Randall W. Hardy
Administrator and Chief Executive Officer

cc:
Adm. Chron. File - A
S. Hickey - A-7
J. Curtis - C-7
G. McClellan - CC
R. Hubbard - CC
J. Gillies - CC
R. Jones - LL-7
H. Spigal - T
F. Johnson - TF
K. Griffin - TF
O. Albro - TFO
T. Conn - TFP
J. White - TNE
M. Nelson - TS
Official File - CC (PE-53-12)

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DOE F 1325.8 e Electronic Form Approved by CGIR - 01/20/95
(8-89)

United States Government **Department of Energy**

Bonneville Power Administration

memorandum

DATE: May 30, 1997

REPLY TO ATTN OF: CC/PERS

SUBJECT: Accident Review Board, Contractor Fatality, April 25, 1997

TO: Randall W. Hardy, Administrator and Chief Executive Officer - A
THRU: James H. Curtis, Senior VP For Business Services - C

The Accident Review Board (ARB) currently investigating the contractor fatality which occurred on April 25, 1997, is requesting that the time frame for submitting the ARB's final report be extended.

To meet requirements for a thorough investigation, the completion of additional testing and the further assessment of management systems is necessary to bring the investigative process to closure. The Board respectfully requests that the date for final reporting be extended to June 27, 1997. With your concurrence, a complete report will be submitted at that time.

Ralph Fair

Ralph Fair
Safety Manager

cc: Adm. Chron. File - A
T. Conn - TFP/Walla Walla
Official File - CC (PE 53-12)

Rfair:tm:2384:6/2/97 (x-Accident/ARBExt.doc)

APPROVED: ____________

DISAPPROVED: ____________

DATE: 6/3/97

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APPENDIX B
DEFINITIONS, ACRONYMS & INIALISMS

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APPENDIX B - DEFINITIONS, ACRONYMS & INIALISMS

ahead on line (AHOL): The direction of increasing tower numbers or miles on a power line. Normally numbered from source to load.

back on line (BOL): The direction of decreasing tower numbers or miles on a power line.

capacitance: The property of an arrangement of conductors and dielectrics that stores energy in the form of an electric charge when potential differences exist between the conductors.

choker: A high-strength wire rope cable used in various applications when working on a power line.

circuit: A system of conductors through which an electric current is intended to flow. Sometimes normally open paths which do not ordinarily conduct in a network can also be considered part of a circuit.

come-along: A hand-operated, mechanical devise used for pulling heavy loads.

conductor: The wire cable strung between transmission towers through which the electric current flows.

conductor positions: Looking ahead on line (the direction in which the structures are numbered) the left-hand conductor is No. 1, the center No. 2, and the Right-hand No. 3. Conductors 1, 2 and 3 are normally labeled as Phases A, B and C, respectively.

CO - Contracting Officer: Responsibilities include ensuring performance of all actions required for effective contracting, ensuring compliance with the terms of the contract, and safeguarding the interests of BPA in its contractual relationships.

COTR - Contracting Officer's Technical Representative: Responsibility is to monitor whether BPA received, in a timely manner, the goods or services that conform to the technical requirements set forth in the contract.

CSR - Contract Site Representative: Authorized representative of the COTR, who is responsible for on-site inspection and review of the work performed under the contract.

corridor: A strip of land forming a passageway for transportation or utility facilities.

current: A generic term, usually modified by an adjective, meaning the *amount* of electrical charge flowing through a conductor, as compared to VOLTAGE, the *force* that drives the electric charge.

current, fibrillation: The current magnitude at which the main pumping chambers of the heart begin inordinate action resulting in immediate arrest of blood circulation. Once fibrillation occurs, it rarely stops spontaneously.

current, let-go: The current (approximately 10 ma) above which the wrist and arm muscles cannot voluntarily release a grip.

current, short-circuit: The current that flows when an electrical circuit is completed. In this document, it is the current that flows when an isolated object is connected to ground.

dead-end: A tower where the conductor ends and is jumpered from from one side to the other to complete the electrical circuit.

dead-end assembly, insulator: The special configurations of insulators for attaching conductor dead-ends to dead-end towers at full line tension.

dead-end body: A fitting compressed on a conductor or ground wire to permit attachment to a **dead-end assembly**. Usually consists of an outer aluminum body and an inner steel body.

EMTP: A computer program used to simulate steady state and transient effects of multiphase power circuits.

field, electrical: A field around an electrical facility whose magnitude is a function of the applied voltage.

field, magnetic: A field around an electrical facility whose magnitude is a function of current.

float: A term used to describe an object that is isolated in an electrical field.

grip: A tool that attaches to the conductor to permit pulling or snubbing without damage to the conductor. Grips are specially designed for each size conductor and can way as much as 78 pounds.

ground, personal protective: A flexible cable, usually copper or aluminum, with connectors on either end, that is applied between a de-energized power line and ground (earth). Used to protect workers from hazardous voltages that may be present on de-energized power lines.

ground resistance: A measurement of the resistance of a point on the earth to a remote location.

ground rod: A copper or copper-clad steel rod driven into the ground (earth) to act as a path to ground for the attached personal protective grounds used for the protection of workers on or near de-energized power lines.

groundman: A worker on a line crew who remains on the ground and assists the aerial crew by raising tools and materials to them.

hoist: See come-along.

inductance: The property of an electric circuit that causes it to store energy in the form of a magnetic field. Because of inductance, a varying current in a circuit induces an electromotive force (voltage) in that circuit or in a neighboring circuit.

insulator: An extremely low-conductive support for a conductor. It inhibits the flow of current from the conductor to earth or another conductor. The insulator skirt product may be either Pyrex, porcelain, or toughened glass. Main parts consist of the cap - upper part made of metal; the skirt - middle section made of insulating material; and the ball stem - lower metal portion. The ball stem connects to the cap of next insulator in a string.

journey level skills: Competent skills and knowledge of a trade or craft, attributed to a journeyman, normally one who has served a formal apprenticeship.

jumper: A conductor which loops from one side of a dead end tower to the other to join conductors on either side, completing the electrical circuit.

kilovolt (kV): The prefix kilo indicates 1000; thus, 1 kilovolt (kV) equals 1000 volts.

milliamp (ma): A measurement of current; 1 milliamp = 1/1000 amp.

OSHA: Occupational Safety and Health Administration (Federal).

overhead ground wire: A protective wire strung above the conductors to shield the conductor from lightening.

phase: A conductor that carries one of three seperate phases (designated A, B and C) of power in an *Alternating Current* system. Used same definition as Conductor Position.

power system (electric): A group of one or more generating sources and connecting transmission lines operated under common management or supervision to supply load.

press, conductor: A hydraulic press for installing compression fittings on the conductor. Common sizes deliver pressures of 60 to 150 tons.

reconductoring: The procedure of replacing the existing conductors (wires) on a power line with new, usually larger conductor.

right-of-way (ROW): An easement for a certain purpose over the land of another, such as the strip of land used for a road, electric transmission line, ditch, pipeline, etc.

tower, dead-end: A heavy tower designed for use where the transmission line loads the tower primarily in tension (pull) rather than *compression* (downward push); for example, in turning large angles along a line or bringing a line into a substation.

transmission: In power-system usage, the bulk transport of electricity from large generation centers over significant distances to interchanges with large industries and distribution networks of utilities.

WISHA: Washington Industrial Safety and Health Administration, Department of Labor & Industries.

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APPENDIX C
Typical Process Used in Aerial Deadending of a 230,000 Volt Powerline

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APPENDIX C - Typical process used in aerial deadending* of a 230,000 volt powerline.

*aerial deadending - process in which conductors (wires) are terminated to a tower.

Photo 1&2 This main rigging assembly consists of a conductor grip, a hoist or come-along, and a wire rope sling terminated at the structure. This assembly is used to temporarily hold the conductor in place until the aerial crew makes a permanent connection to the tower.

Photo 3&4 The aerial crew is in an aerial lift or “bucket”. In this initial procedure the workers are preparing to bring together the conductor and the string of insulators. This process is necessary to ensure that an accurate measurement of the conductor can be made.

Photo 5 The crew is now measuring the distance from the attachment point on the tower to the end of the insulator assembly, including the offset distance of the terminal fitting that will make up the end of the conductor. They will mark the conductor for cut off.

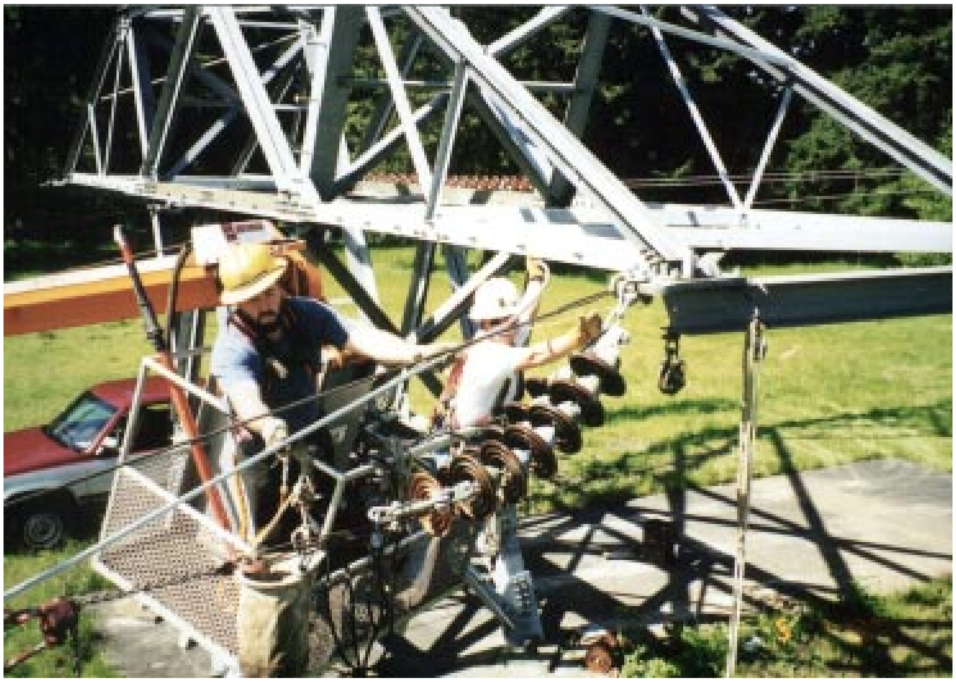

Photo 6 A pair of ratcheting cutters is used to cut the steel cored aluminum conductor.

Photo 7 A terminal fitting is being put on the conductor end. This assembly will be pressed onto the conductor with a 60 ton hydraulic press.

Photo 8 The worker is cutting away the outer aluminum strands of the conductor to expose the steel core in preparation of pressing on the terminal assembly. The steel core will be pressed into a steel sleeve. This sleeve is part of the complete terminal fitting.

Photo 9&10 The hydraulic press is being used to permanently attach the fitting to the conductor. The hydraulic press is being operated with a press motor located in the aerial lift. The press motor operates the hydraulic system at approximately 10,000 p.s.i.

Photo 11 With the pressing completed, the conductor end is now attached to the insulator assembly.

Photo 12 The worker is releasing the tension on the hoist in preparation of removing the rigging used to bring the insulators to the conductor.

Photo 13 The crew is removing the rigging used to bring the insulators to the conductor.

Photo 14 The crew now moves back to the main assembly (ref. photos 1&2) that was used to temporarily attach the conductor to the tower. The crew member is releasing the tension on the hoist, allowing the just completed dead end assembly to take the full tension of the line.

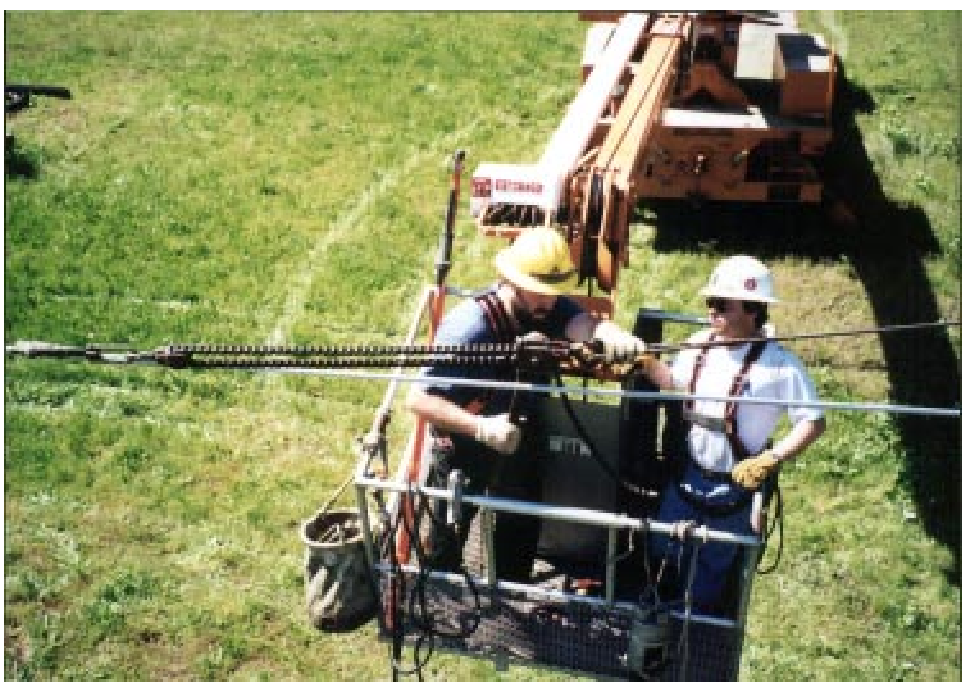

Photo 15 With the tension off of the main rigging assembly, the crew is now removing the assembly from the conductor.

Photo 16 The worker is preparing to drop out the wire rope sling into the tower. The sling will be removed from the tower before the crew returns to the ground.

Photo 17&18 The crew is moving into position to remove the hoist from the conductor grip.

Photo 19 With the main body of the hoist in the work platform, the worker is removing the end of the hoist from the conductor grip.

Photo 20 The hoist is removed and the last step will be to remove the conductor grip.

APPENDIX D
Proper Grounding Sequence of Deadended Tower

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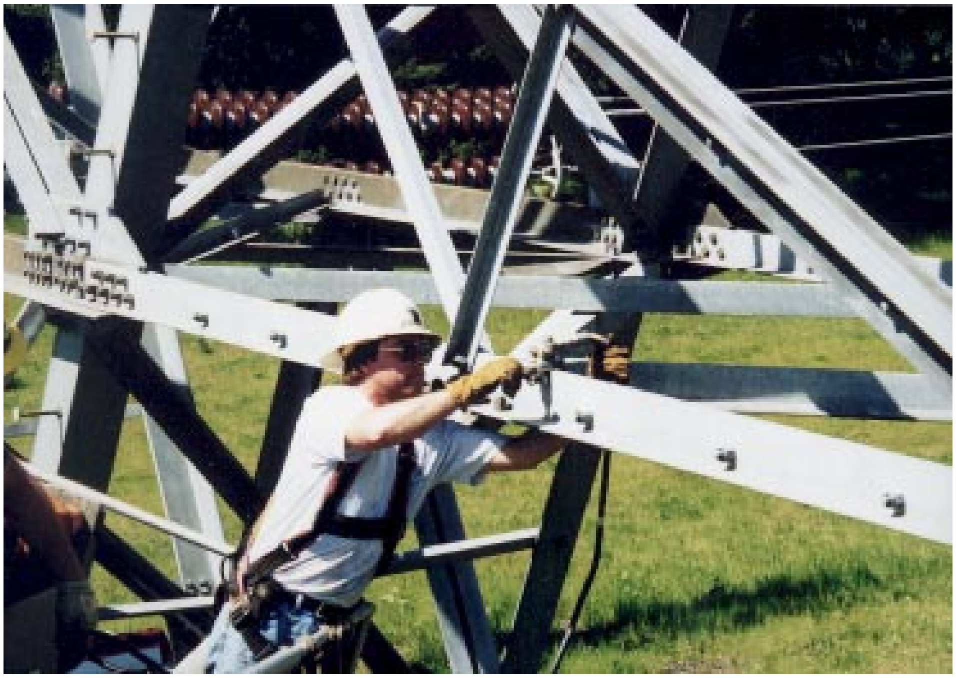
APPENDIX D - Proper grounding sequence of a deadend tower.



PhotoA Worker is attaching a ground end clamp of the personal protective ground to the tower. The personal protective ground is a flexible copper cable, with clamps on either end. The ground cable protects the workers from any source of accidental energization that may occur on the powerline. It also protects the workers from any electrical charges that may be trapped on the deenergized conductor. These charges can be significant, up to several thousand volts.

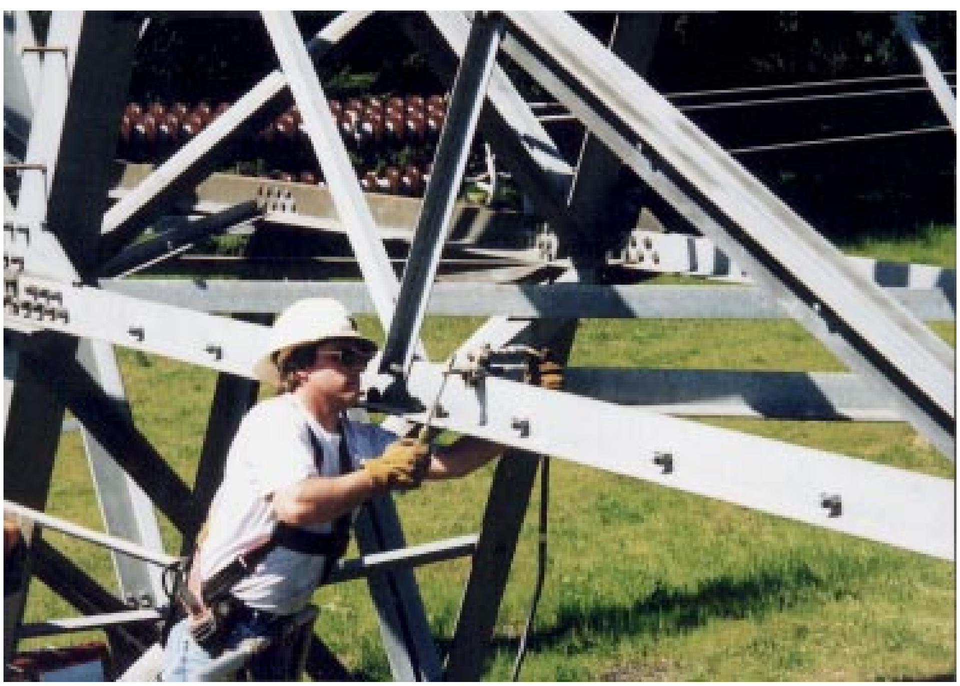


Photo B The worker is securing the ground end of the ground cable. It is important that a solid connection is made to ensure that a good electrical bond is achieved.

Photo C The crew is performing a "buzzing" test on the conductor. This test is used to confirm that the conductor is deenergized before apply the conductor end of the personal protective ground. If there are high voltages present, an audible discharge will be heard when the metal end of the insulated clamp stick is brought near the conductor.

Photo D The conductor end clamp of the ground cable is loaded into the insulated clamp stick in preparation of apply the ground to the conductor.

Photo E The conductor end of the personal protective ground is being applied to the conductor. The clamp is normally placed well outside the work area as not to be disturbed during the work process.

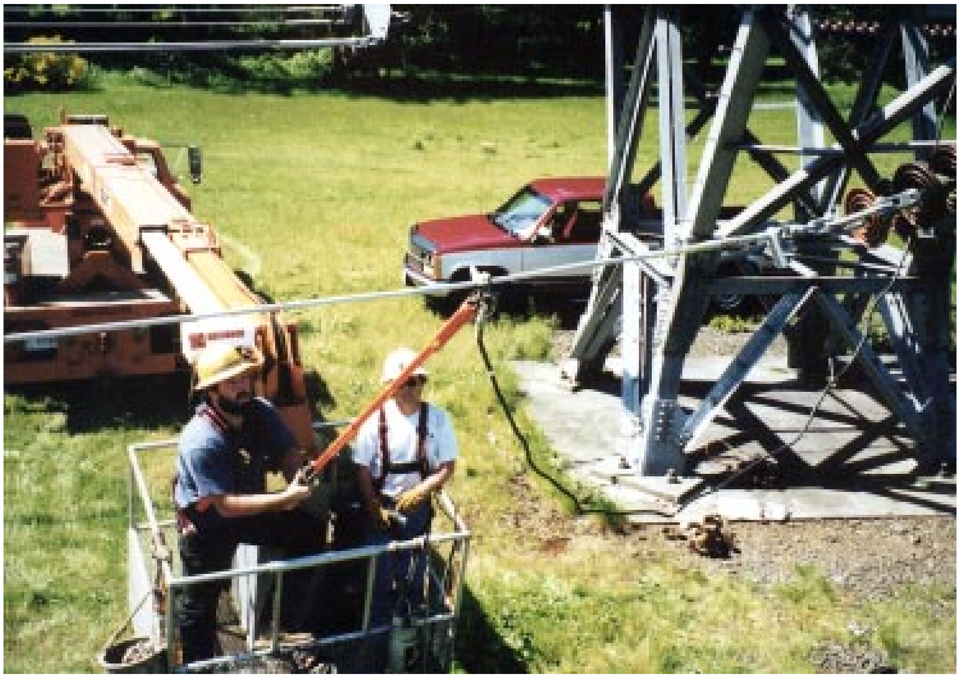


Photo F The worker is securing the clamp to the conductor. Work may now safely proceed on the conductor.

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APPENDIX E - "Injuries Caused by Electric Shocks"

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Injuries caused by electric shocks

Effects of electricity on the body

The effect of electricity on the body is dependent on the amount of current and the length of time the body is exposed to it. The higher the current, the less time a human can survive the exposure.

The path of electricity through the body is also critical. For example, current passing through the heart or brain is more life-threatening than current passing through the fingers.

It takes approximately 1,000 milliamps (1 amp) of current to run a 100 watt light. Here are the effects you can expect from just a fraction of that current for a few seconds.

Amount of current	Effect on a human
1 milliamp	Can just be felt.
5 to 9 milliamps	Cannot let go.
20 to 50 milliamps	Increasing pain.
Above 50 milliamps	May be fatal.

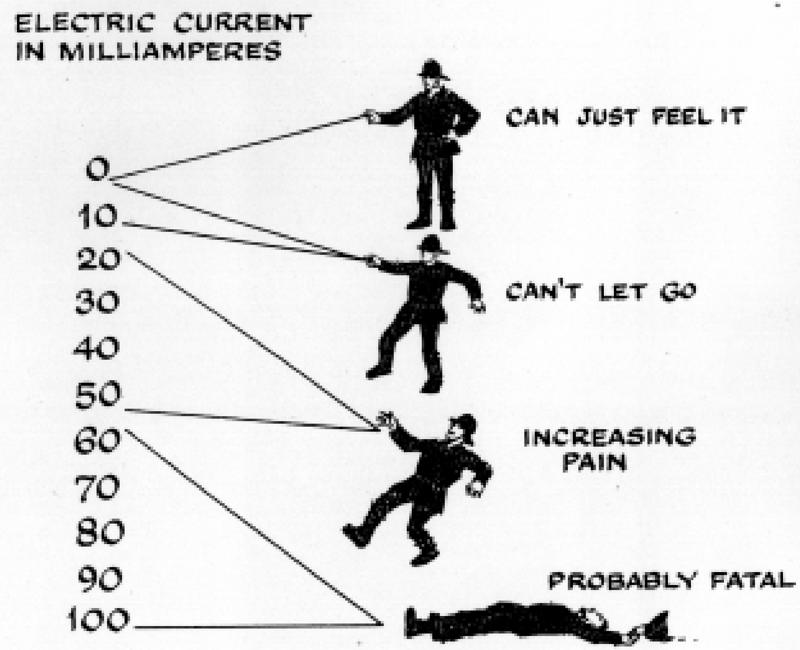
The figures above illustrate that a small amount of amperage for a few seconds or more can be fatal. *(See also illustration #3.)*

It is the amperage that kills or injures. But the voltage, which pushes the current through the body, also has an important effect.

When a victim is exposed to household voltages, he or she may suffer a muscle spasm and may be locked-on to the electrical source until the circuit is turned off, or until the victim is often dragged clear by the weight of his or her body falling clear of the contact. Relatively long periods of contact with low voltage are the cause of many electrical fatalities in the home.

At very high voltages (on power lines, for example) the victim is often quickly blasted clear of the circuit. This results in

#3 AVERAGE BODY TOLERANCE



less internal damage, such as heart failure, but terrible surface burns at the entrance and exit of the current.

A victim exposed to a large electric arc can be injured by the intense heat or by ultraviolet rays which can cause serious eye damage.

In addition to the factors outlined above, the effect of electricity on the body depends on: (1) Condition of the skin; (2) The area of skin exposed to the electrical source; and (3) The pressure of the body against the source.

Severity of the shock will be increased if the point of skin contact is moist or broken.

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APPENDIX F - Bradshaw Memo

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BPA F 1325.01
(01-89)
(Previously BPA 1100)

U.S. DEPARTMENT OF ENERGY – BONNEVILLE POWER ADMINISTRATION

Memorandum

DATE : July 14, 1992

FROM : Lyndon E. Bradshaw, Director
Division of Construction - MK

SUBJECT: Construction Contractor Personnel Safety and Environmental Protection

TO :
P. Michie - APG
M. Brown - EE
G. Parks - EF
I. Thurein - EL
D. Perry - EO
F. Gebhardt - LA
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D. VanCoevering - MO
H. Haven - SI
H. Perry - SR
D. Prill - SRM
R. Lahmann - SRP
L. Stelzer - TA
D. Johnson - TD
T. Kafara - TD5
H. Starkey - TE
D. Spragg - UD
W. Freeland - UD5
R. Ridenhour - UA
P. Eichin - UE
A. Polvi - WA
T. Conn - WD
M. Hermeston - WD5
R. Goranson - WE
T. DeKlyen - YH

The purpose of this memo is to explain and provide some background on the policy change approved by the BPA Policy Committee on May 26, 1992, on construction contractor personnel safety and environmental protection.

A number of actions are being initiated as a result of this policy change and it's important that people understand the basis for the change. Please share this with your organizations and if there are questions, please have people contact Marty Crouch, ext. 2717.

Background

BPA has historically placed responsibility for personnel safety and environmental protection on construction contractors. Safety and environmental protection under this policy was generally good, with some exceptions. A series of environmental accidents and concerns about contractor personnel safety caused the Division of Construction to initiate a review of construction contractor safety and environmental protection in January 1991. This review involved broad participation with interested parties throughout BPA and was reviewed with senior utility executive members of the OM&C Review Board.

Review Findings

The review found that BPA does not keep sufficient records to calculate contractor accident frequencies like those the Safety Office produces for BPA organizations.

A Montana court, in McCall v. BPA, et al., ruled that in the state of Montana an owner has a non-delegable duty to ensure a safe workplace for employees of independent contractors engaged in inherently dangerous work. Similar rulings could be expected in other states.

Contractors at Western Area Power Administration have experienced several serious accidents recently. Secretary Watkins has indicated that agencies should be proactively and effectively involved in contractor safety.

BPA contractors have released hazardous substances into the environment on several occasions. These include: PCB-contaminated soil at Arlington, pole treatment mixtures at three sites, and lead-based paint at Umatilla.

Previous Policy

BPA's construction contracting approach placed responsibility for ensuring safety of contractor personnel and property on the contractor. BPA specifications required contractors to comply with OSHA requirements. BPA contracts stated that contractors are responsible for environmental protection. Hazardous materials disposal contractors have carried a minimum of $1 million environmental impairment liability coverage.

BPA field inspectors primarily monitored contractor results for compliance with contract requirements for the work product. Field inspectors were expected to halt seriously unsafe contractor operations when observed. Contractor's judgment generally prevailed in matters where no serious immediate hazard was present.

Historically, no emphasis had been placed on safety as a criterion in contractor selection. The previous policy had been based partly on legal advice that the "arms-length" approach to contractor safety placed BPA in the best position to defend itself when being sued for damages resulting from an accident.

Environmental laws hold parties jointly and severally responsible for environmental damage. BPA cannot contractually avoid responsibility and potential liability for environmental damage. Joint and several responsibility differentiates environmental damage from damage to person or non-environmental real property.

New Policy

The new policy contains the following features. BPA will continue to place responsibility for ensuring safety of contractor personnel, property, and environment on the contractor. BPA will influence contractors to improve their safety programs by requiring written safety plans and environmental protection plans from all construction contractors. Contractors will be required to submit environmental contingency response plans. Contractor compliance with OSHA rules and environmental regulations will be emphasized in BPA specifications.

BPA will use safety records as a selection and screen-out factor in selecting construction contractors. BPA will collect, summarize, and report contractor accident frequencies.

BPA will continue to require hazardous materials disposal contractors to provide a minimum of $1 million of environmental impairment liability insurance. BPA would control any necessary environmental contingency responses performed by contractors.

The Policy Committee referred a recommendation to eliminate the present required environmental impairment liability insurance back to staff for further work. A recommendation on this matter will be made to the Policy Committee in the near future.

Field inspectors will take a more active role to enforce BPA specifications which are intended to assure contractor safety and environmental protection. Field inspectors will intervene to modify unsafe contractor operations with a primary focus on avoiding serious injuries or accidents. Field inspectors will be required to receive additional safety and environmental contingency response training to support their expanded role.

Expected Impacts

We expect to achieve several results from the new policy. Major benefits will be improved safety in contractor's workplace, and improved protection for the environment. Costs of these benefits may include increased potential for being found liable in lawsuits arising out of construction accidents, and increased responsibility placed on field inspectors. Construction costs may increase due to increased demands on contractors for safety and environmental protection planning, and increased requirements for contractors to follow safety guidelines.

Conclusion

BPA has established a policy of proactive relations with construction contractors, wherein safety is an important contractor selection factor, field inspectors more closely monitor contractor safety programs and work methods, and contractors increase their planning for worker safety and environmental protection, providing assurance that contractors have established safe working conditions and procedures for their employees.

MCrouch:tks:2717 (VS17-MKM-0705E)

cc:
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Deputy Administrator - A
Executive Assistant Administrator - A
Senior Assistant Administrator - A
Assistant Administrators - AC, AJ, D, E, M, P, R, S
Contracts and Property Manager - AE
Assistants to the Administrator - AI, AL, AR
General Counsel - AP
Area Managers - L, T. U, W
Deputy Assistant Administrator - M
Area Executive Officer - YH
Official File - MKM (EQ-6)