Operating Experience Summary

U.S. Department of Energy
Office of Health, Safety and Security
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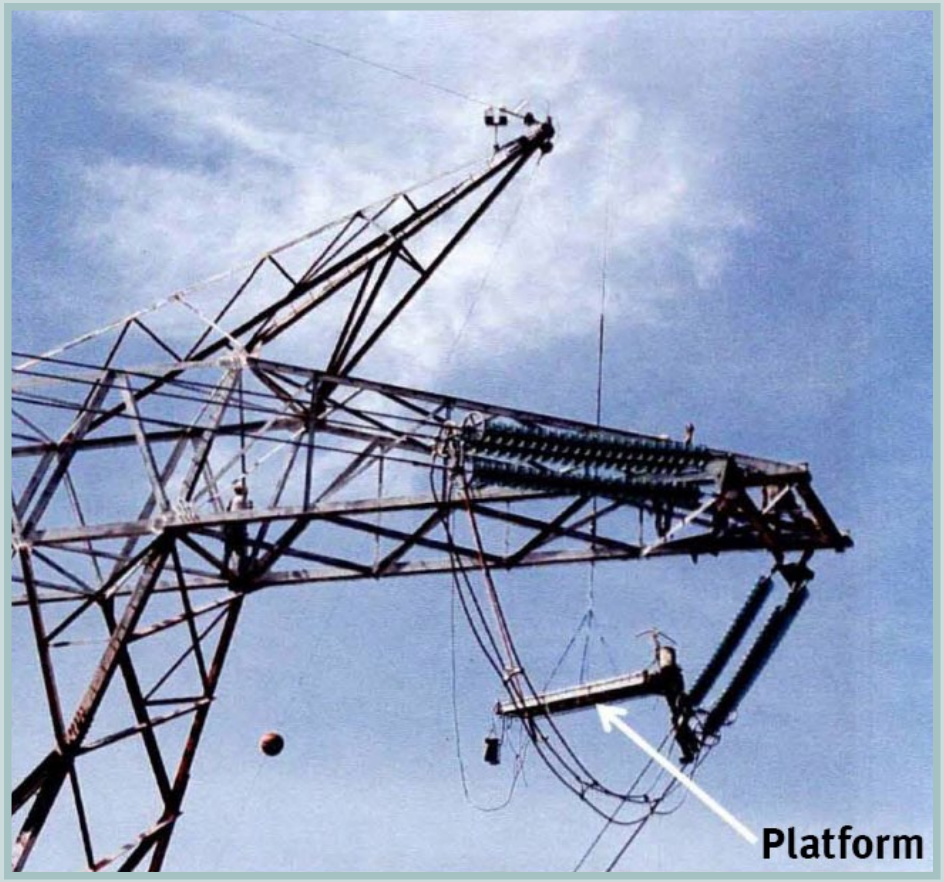

Fall Fatality While Installing Work Platform at Remote Bonneville Power Administration Project 1

The following article provides an overview of the results from the investigation of the September 2012 Bonneville Power Administration fatal fall. A journeyman lineman fell while preparing to install a work platform on a steel tower. An Accident Investigation Board was appointed to determine the causes of the accident and to identify corrective actions; these results are reviewed in this article.

After reading the article, we encourage you to visit the Operating Experience Summary *blog at http://oesummary.wordpress.com/ and rate the article in terms of value to you and provide a comment on the article and/or identify topics that would be of interest to you for future articles.*

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On September 20, 2012, a Bonneville Power Administration (BPA) journeyman lineman fatally fell while a line crew was preparing to install a work platform on a steel tower ahead of an insulator replacement project. The work was being performed as part of scheduled transmission line maintenance in a remote, mountainous location in Montana near the Idaho border. A BPA Level 1 Accident Investigation Board was appointed the next day.

Background

The BPA, a Federal agency based in the Pacific Northwest, was created in 1937 to market electric power from the Bonneville Dam and construct facilities necessary to transmit that power. Today, it markets power from all Federally-owned hydroelectric projects in the Northwest and is one of four regional Federal power marketing agencies within the Department of Energy (DOE). BPA Transmission Field Services (TFS) is responsible for field operations; constructing and maintaining high-voltage electrical transmission systems; and providing safe, reliable and cost-effective service to customers. Thirteen District Offices within TFS coordinate work and resources, and operate and maintain the BPA transmission system, including buildings, grounds, and rights-of-way. Each District Office contains at least one Transmission Line Maintenance crew that builds assigned projects and inspects, maintains, and repairs lines and rights-of-way.

Work Location and Activity

On the day of the event, work crews from Spokane, Washington, and Kalispell, Montana, were scheduled to begin replacing insulators on the Dworshak-Taft #1 500kV transmission line in the remote location. The right-of-way access road from Inter-

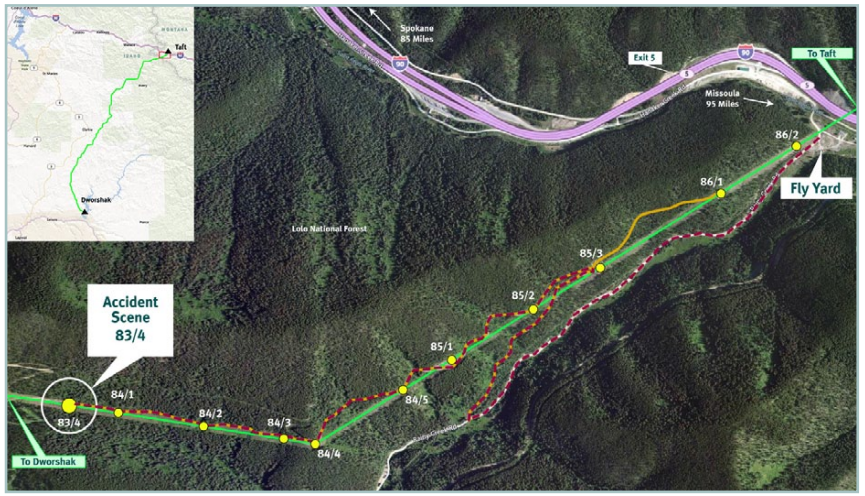

Figure 1-1. Aerial map of access road showing relative location of 83/4 and fly yard
(Click image to enlarge)

state 90 (I-90) to the work site was rough and rutted with steep hillsides and several switchbacks. Figure 1-1 is an aerial view of the 5-mile route from I-90 to tower structure 83/4 (mile 83/ structure 4).

The two crews worked with helicopters on a regular basis and were trained on and familiar with the associated hazards. The line was de-energized, a work clearance had been issued, and the work plan was to use a helicopter to fly platforms, tools, and materials to men working on the tower.

The crews had assembled near the Taft exit of I-90 on the Idaho-Montana border. They had received work clearance on the de-energized Dworshak-Taft #1 500kV line and held a job briefing that included discussion of work hazards and how the work was to be performed. After the job briefing, the helicopter pilot discussed how the helicopter would be used to bring in platforms, tools, and materials from the fly yard 3 miles away and the hazards associated with the job. After the briefings concluded, the combined crews traveled by truck approximately 5 miles to the remote work area.

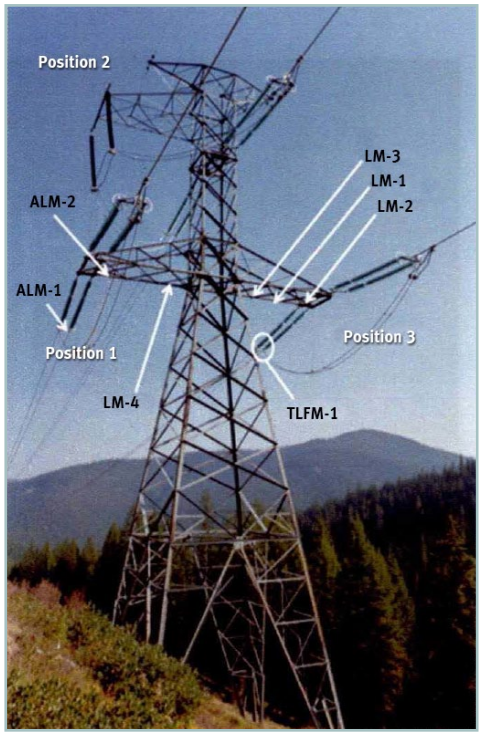

Figure 1-2. Positions of crew on tower 83/4

The Accident

After they arrived at the work location around 0900 hours, the crew put on fall protection equipment, climbed the tower, and called the fly yard crew for the portable protective grounds (PPG) and hot stick (insulated pole used by electric utility workers to protect them from electric shock). Relative positions are shown in Figure 1-2. After installing the PPGs, the crew repositioned, belted-in on the tower, and then called the fly yard to have the platforms flown in. The crew members were between 80 and 100 feet off the ground. While the tower crew waited, Lineman 1 (LM-1) and LM-2 asked LM-4 to confirm how the platforms were to be connected. LM-4 unbelted and moved around the radioman, LM-3, in order to be closer to the others and answer their questions. At 1100 hours, shortly after LM-4 returned to his position and rebelted, the platform arrived.

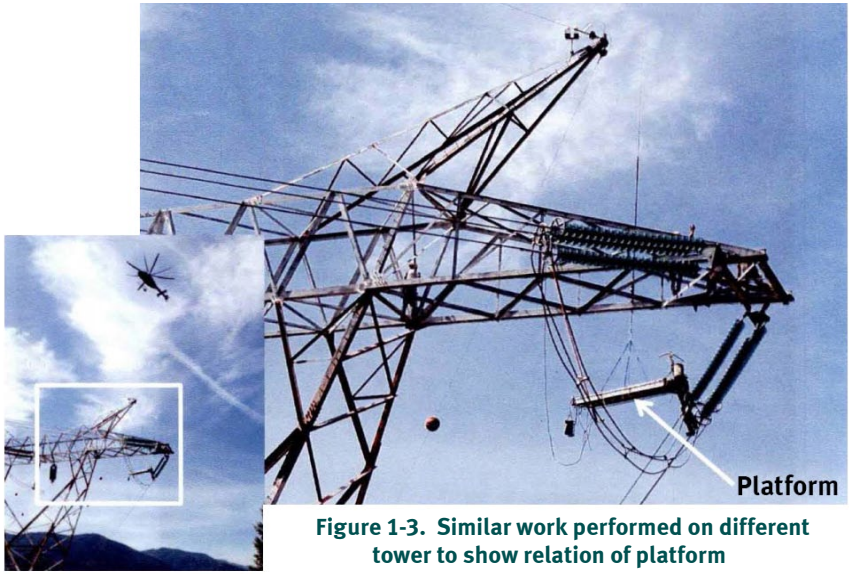

Figure 1-3. Similar work performed on different tower to show relation of platform

As the platform was being lowered, it was parallel to the power line but then rotated 90 degrees as it approached the tower. (Figure 1-3 shows relation of a platform to a similar tower.) The pilot was hovering and maneuvering to get the platform to turn parallel to the insulators when LM-1 decided to change work locations to help guide the platform. He unbelted and moved left behind LM-3 toward the center of the tower; LM-3 stated that he saw LM-1's hands grasping the structure on both sides of him when LM-1 was directly behind him, indicating LM-1 was still in control. However, as LM-1 moved farther left, he lost his footing and fell. The time was approximately 1102.

Accident Response

Seven crew members were on the tower. Immediately after the fall, LM-2 and LM-4 began descending, while the Temporary Lineman Foreman (TLFM) stayed on the tower to call the fly yard to report the accident and direct them to call National 911. The pilot also called the fly yard and requested that they call for a Spokane medevac helicopter. After the linemen reached the ground, one retrieved an automated external defibrillator (AED) from the nearby truck and applied it to LM-1.

After calling the fly yard, the TLFM called National 911, and his call was patched to the Mineral County dispatcher. The TLFM was able to transmit pertinent information before the call was dropped. He then called the Dittmer/BPA Control Center and told them to call the County for a MedStar Life Flight. Because there was heavy smoke from forest fires in the Missoula, Montana, area, Life Flight could not take off, so ground response was dispatched from Spokane. In addition, an Emergency Medical Service (EMS) ambulance was dispatched from Superior, Montana, 45 miles away, with an estimated arrival time of 40 minutes.

Because no backboard or stretcher was available at the work site, the fly yard crew fashioned a backboard from a fiberglass hook ladder and trailer sideboards and prepared to retrieve LM-1 and fly him back to the fly yard to meet the expected emergency vehicles. The helicopter then carried the improvised backboard and a rescuer (LM-5) to the accident scene. When they arrived, the helicopter pilot recognized that CPR had begun. LM-1 was loaded onto the backboard, and the helicopter lifted him and the rescuer (LM-5) and transferred them to the back of the truck so CPR could continue. A Line Equipment Operator then drove the truck the 5 miles down the hill to the I-90 Taft exit while LM-3, -5, and -6 and an Apprentice LM continued CPR. When the truck reached the highway, the EMS vehicle had just arrived; the EM Techs took over CPR and began advanced life support. LM-1 was pronounced dead at 1221.

The Investigation and Causes

The Accident Investigation Board (Board) determined the facts of the accident and analyzed them to determine what happened, why it happened, and the actions necessary to prevent recurrence. The Board used various types of Change and Causal Factors analysis to determine the direct and root causes of the accident, which are discussed below.

- The direct cause is the immediate event or condition that causes an accident. In this event, the direct cause of the fall was LM-1's loss of contact with the tower while he was unbelted and changing positions.
- Root causes are factors that, if corrected, would prevent recurrence of the same or similar accident. In this event, the root cause was LM-1 not using the fall protection function (safety strap) incorporated into the safety harness to remain attached to the tower. However, the Board noted that changing locations unattached is a common practice and does not violate BPA's work rules and policies.

- The Board was not able to determine contributing causes that increased the likelihood of the fall and fatal injury but did not cause them. The Board noted that this is inherently dangerous work; that BPA provides training to mitigate the dangers of the work; and that LM-1 was trained and qualified to perform the work.

The Board performed barrier analysis, based on the premises that (1) hazards are associated with all tasks and that (2) a barrier is a management or physical means to control or prevent the hazard from reaching the target. The Board determined that there were no management or physical barriers that would have prevented the fall accident (loss of footing while changing positions). However, the Board did determine that a barrier – 100% fall protection attachment – would have mitigated the consequences of a fall. See text box, *Is 100 percent fall protection required?*

The Board also performed change analysis to examine planned or unplanned changes that caused undesirable results related to the accident. The process analyzes the difference(s) between what is normal or expected and what actually occurred before the accident. In this event, the use of a helicopter was a change but did not contribute to the fall. When it was pointed out that the crews had worked overtime in the period preceding the accident, the Board acknowledged that the 80 hours worked in a 7-day period was higher than normal. However, since the hours worked did not exceed the BPA Policy and each crew member had been afforded required rest periods between shifts, the Board was unable to determine if the work schedule was a factor. In addition, the Coroner determined that there were no medical or other conditions that would have prevented LM-1 from performing his duties.

Therefore, based on available evidence, the Board concluded that the LM-1's fall was caused by his lack of contact while being unbelted and changing position on the tower.

Human Performance Factors

Managers and workers should constantly strive for balance between safety and schedule to keep the work environment safe. In normal human behavior, production behaviors can sometimes take precedence over prevention and are influenced by an organization's safety culture. Within DOE,

Is 100 Percent Fall Protection Required?

It is important to note that so-called *free climbing*, that is, moving around without belted-in fall protection/without being 100 percent tied off, is not a violation of Occupational Safety and Health Administration (OSHA) regulations or BPA standards. Neither OSHA nor BPA requires that qualified workers wear fall protection while climbing or changing position. Title 29 Code of Federal Regulations 1910.269(g)(2)(v), *Occupational Safety and Health Standards – Electric Power Generation, Transmission, and Distribution*, states, "Fall protection equipment is not required to be used by a qualified employee climbing or changing location on poles, towers, or similar structures, unless conditions, such as, but not limited to, ice, high winds, the design of the structure (for example, no provision for holding on with hands), or the presence of contaminants on the structure, could cause the employee to lose his or her grip or footing." The BPA Accident Prevention Manual Rule F-1, Fall Protection, states that "...approved fall protection shall be used when working aloft above four feet on all towers..." However, the BPA Work Standard, Section X-Miscellaneous, Section X.C-1, *Fall Protection*, states that "fall protection is not required by qualified climbers when climbing, changing work or rest locations, unless conditions such as ice, high winds, etc., could cause the employee to lose their grip or footing." As a result, there was no requirement for trained and qualified LM-1 to use fall protection 100 percent of the time.

Findings	Recommendations
All crew members were following all applicable rules, standards, and policies concerning fall protection.	BPA shall review the current rules, standards, and policies to determine if the Agency should adopt a 100 percent fall protection requirement.
The Board found that the job briefing met the intent of the BPA Accident Prevention Manual (APM) Rule J-1 requirement; however, it was not recorded on the most current form that indicates that a rescue plan was discussed.	BPA management shall ensure all workers will utilize form 5480.25e (Job Briefing Information Sheet) or the most current version of the Job Briefing Notebook (March 2010). BPA management shall ensure the Job Briefings include a thorough discussion of a rescue plan.
The Board found that currently within the Agency there is no requirement to have a backboard as part of rescue equipment inventory. A backboard on site may have expedited the rescue efforts.	BPA shall evaluate the need for and provide backboards where necessary to assure [sic] crews are able to comply with the requirements for rescue equipment as stated in Section X.P-1 (2.a) of BPA's Work Standards, Section X, *Miscellaneous*.
The Step-and-Touch Kit was not utilized during this work.	BPA Management shall review APM Rule G-1 and TLM Standards and Guides Sections I.A.2 and I.A.3 with the Bell and Kalispell crews.
Proper voltage testing procedures were not used when verifying the line as de-energized.	BPA management shall review APM Rule G-2 and BPA Work Standard VI.B with the Bell and Kalispell crews.
The insulated overhead ground wire was not grounded.	BPA management shall review APM Rule G-9 with the Bell and Kalispell crews.

most serious events do not happen during high-hazard or complex operations because workers are paying attention, many people are involved, things move slowly, and everyone is mindful. Most serious events occur during so-called "routine" operations, such as installing a work platform or replacing insulators. It is during these routine operations that focus on safe behaviors is crucial.

Findings and Recommendations

After analyzing the facts to determine what happened and what needs to be done to prevent recurrence, the Board arrived at ten Findings; for six of those Findings, the Board made a corresponding Recommendation as summarized on the left.

More information about the event and the Board's Findings and Recommendations is available in the Board's report, which can be accessed at http://www.hss.doe.gov/sesa/corporatesafety/aip/docs/accidents/typea/AIB_Fatal_Fall_Dworshak-Taft_1_Transmission_Tower.pdf.

KEYWORDS: Fall protection, BPA, tower, lineman, helicopter, 83/4

ISM CORE FUNCTIONS: Define the Scope of Work, Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls, Provide Feedback and Improvement

Accident Investigation into Serious Injuries from Fall from Fixed Ladder at Brookhaven National Laboratory 2

The following article reviews the Brookhaven National Laboratory event where a maintenance metals worker fell 15 feet from a fixed ladder on June 29, 2012. An Accident Investigation Board was appointed to determine the causes of the accident and identify corrective actions; these results are reviewed in this OE Summary *article.*

After reading the article, we encourage you to visit the Operating Experience Summary *blog at http://oesummary.wordpress.com and rate the article in terms of value to you and provide a comment on the article and/or identify topics that would be of interest to you for future articles.*

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On June 29, 2012, at Brookhaven National Laboratory (BNL), a Brookhaven Science Associates (BSA) maintenance metals worker climbing an exterior fixed ladder to perform a walkdown for a future job fell approximately 15 feet to the pavement. After being stabilized at the scene, the worker was taken by ambulance to the hospital emergency room where he was diagnosed with multiple thoracic and cervical vertebrae fractures. (ORPS Report SC--BHSO-BNL-BNL-2012-0022; final report issued March 19, 2013) An Accident Investigation Board (Board) was appointed to investigate the event, determine its causes, and identify Judgments of Need (JON) to prevent recurrence of a similar event. The Board's report is available at http://www.hss.doe.gov/sesa/corporatesafety/aip/docs/accidents/typea/6-29-2012-BNL_AI_Report.pdf.

The Accident

On the day of the accident, the maintenance metals worker (MMW) met the Facility Project Manager (FPM) and Facility Complex Engineer (FCE) at Building 830 to discuss planned work to be performed on the roof of adjoining Lab 17. The work involved caulking and sealing around a rooftop duct housing where caulking had deteriorated. Specifically, the MMW, who had more than 20 years of experience at the site, was to inspect the area, estimate the tools and materials that might be needed, and estimate the time needed to complete the task. The three agreed to go up on the roof one at a time using the fixed ladder, and no one would carry anything. The MMW, who wore Personal Protective Equipment (PPE) of safety shoes, gloves, and safety glasses with side shields, started up the ladder first. As he ascended, the FPM and FCE began a side conversation that diverted their attention (the Board's report did not attribute the fall to a lack of supervision). When they heard the MMW mutter something, they looked up and saw that, although both his feet were on a rung, he had lost the three-point contact, and his body had begun to swing to the right, putting his back against the wall. As the MMW fell, his feet struck a wall-mounted light fixture and he landed feet first on the pavement 15 feet below.

The FPM and FCE immediately called for emergency response. The MMW tried to stand following his fall but was instructed to remain on the pavement. The FCE noticed that the MMW was conscious and was trying to keep his face off the hot asphalt. To alleviate the discomfort, the FCE retrieved a baseball glove from a nearby car and placed it under the MMW's head. Emergency Medical Technicians arrived and observed the MMW lying on his side but did not see any open fractures or bleeding. They placed him on a back board, applied a cervical collar around his neck, placed him in an ambulance, and transported him to the hospital.

The Investigation

The Board noted that the MMW was experienced and had worked onsite for many years. The Board investigated several aspects, including training; medical examinations and certification for work at heights; work planning and control; and ladder compliance with existing safety codes.

Training

A Job Training Assessment is a list of the worker's training requirements that the supervisor determines to be necessary to complete the tasks within each worker's job title. The Board determined that the MMW's training was current.

Medical Criteria and Examinations

The BSA medical surveillance program meets the requirements of 10 Code of Federal Regulations (CFR) 851, *Worker Safety and Health Program*. There are 20 different medical surveillance examinations and additional examinations for specialized work such as entering confined spaces or working at heights. The MMW had received his Material Handler medical exam in 2011 and was not scheduled for a repeat examination until December 2012.

Since the temperature on the day of the accident was approximately 90° F, BSA had declared a *heat stress day*, which called for 15 minutes of rest for every 45 minutes of continuous work. The MMW had not worked outside that day. Prior to going to Lab 17/Building 830, he had spent the workday processing paperwork in an air-conditioned office, so the Board determined that heat was not a factor. A BNL physician familiar with the worker's medical history told the Board that the MMW had no medical condition that influenced the accident.

Work Planning and Control (WPC)

There are three approaches to work planning and control at BSA: worker-planned, prescribed, and permit-planned. The work being conducted at the time of the accident was considered *worker-planned*; that is, work that recognizes the skill levels and technical capabilities of the workers and does not require the level of rigor detailed in *permit-planned* work.

The Board examined internal requirements and procedures for supervising work and found that BSA's fall protection procedure does not apply when workers are inspecting, investigating, or looking at workplace conditions as the MMW, FPM, and FCE were doing. Because the task was considered skill-of-the-craft or low hazard, the fall protection procedure did not apply.

The Board found that a work order had been prepared consistent with the procedure.

The Fixed Ladder

The fixed ladder was originally installed in 1962, then removed and reinstalled when the building was expanded in 1968. The current ladder configuration is shown in Figure 2-1 on the following page. The original installation was compliant with the applicable design standard, American National Standards Institute (ANSI) A14.3-1956, but the relocation did not ensure that the ladder was still consistent with the ANSI standard. In 1970, when the Occupational Safety and Health Act was enacted, ANSI A14.3-1956 was adopted as the applicable design standard for enforcement of 29 CFR 1910, *Occupational Safety and Health Standards*.

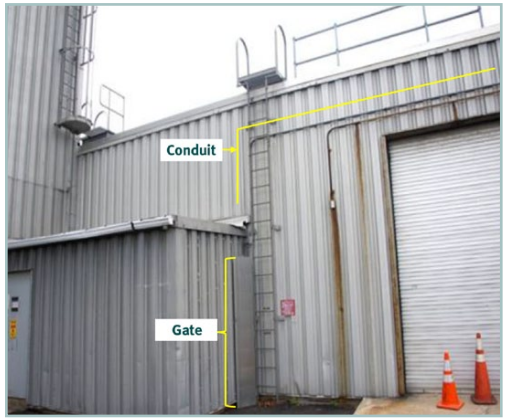


Figure 2-1. Current location of the fixed ladder showing gate and conduit

Two or more decades ago, a lockable side-hinged gate was installed to cover the bottom eight rungs of the ladder. The gate was intended to prevent access to the Lab 17 roof because of radiological exposure concerns during sample loading or removal in the building below. That exposure concern no longer exists, but the gate remains. In addition, in 1992, a 1-inch rigid metal conduit was installed on the exterior of Lab 17 to carry power to a nearby storage area. That conduit starts next to the ladder, halfway up its 18-foot length, then turns to run horizontally and away.

In 1968 when the ladder was reinstalled, it was not inspected and did not comply with then-current ANSI A14.3-1956 codes. The Board determined that the ladder is noncompliant with OSHA requirements and/or ANSI standards in the following five areas.

- There is a non-uniform distance between the first rung and the pavement (i.e., not 12 inches).
- The ladder guard preventing access is mounted onto the left ladder rail and violates both ANSI A14.3-1956 and 29 CFR 1910.27, which requires a 15-inch clearance on either side of the vertical center line on a fixed ladder.
- The conduit installed behind the ladder in 1992 violates a 7-inch clearance requirement described in both ANSI A14.3-1956 and 29 CFR 1910.27.
- The top rung of the ladder is not flush with the platform.
- The height of the upper extension rails meets requirements, but the 36-inch width between them is not compliant.

The Board concluded that, over the years, there had been multiple missed opportunities to identify and correct deficiencies in the fixed-ladder safety program: in 1962 when the ladder was constructed; in 1968 when it was relocated; in 1973 when OSHA 29 CFR 1910 became a requirement; and finally under BSA requirements for annual inspections.

The Causes

The Board identified the *root cause* as BSA's hazard recognition process failing to identify the inherent risk associated with elevated work when climbing a fixed ladder. The *direct cause* was the employee's falling from the fixed ladder (after losing three points of contact) and striking the asphalt pavement. The Board identified five *contributing causes*.

1. BSA failed to satisfy 29 CFR 1910 fixed ladder requirements.
2. The BSA Tier 1 safety inspection process is inadequate to identify unsafe conditions and practices.
3. The BSA employee concerns program is not being utilized as a means of challenging unsafe conditions.
4. The BSA work planning and control process was not followed for identifying hazards and developing controls for the task.
5. The work planning and control process, in failing to provide adequate hazard recognition, led to the false judgment that elevated work is low hazard work.

Human Performance Improvement

The Board evaluated Human Performance Improvement (HPI) attributes to determine if they played a part in the accident. Human error alone is not a cause of failure, but rather the effect or symptom of deeper trouble in the system. Analysis of events in different types of industry has shown that between 60 and 90 percent of major accidents have some type of human error as a contributing cause. Of these human errors, only 30 percent are due to an active mistake or individual error, and 70 percent are due to pre-existing weaknesses in the organization that supports or directs the work.

In this investigation, the Board received testimony that the work was considered to be *skill of the craft*, in which highly practiced actions are executed from memory. In such a scenario, the worker is highly familiar with the task, and the worker can perform the work without significant conscious thought. However, in this event, the Board believes that the worker was more likely performing the work in *knowledge mode*. In *knowledge mode*, worker actions are more likely in response to an unfamiliar situation (e.g., the non-OSHA/ANSI-compliant ladder design that was different from expected). No compensatory barrier for performing in this mode was provided to the worker, such as a work permit, job safety analysis, or detailed work instruction that would have included use of additional PPE.

In response to an unfamiliar situation, rather than using known rules, a worker may try to reason or even guess his/her way through the situation. According to the Board's report, the human error at BNL likely occurred when the worker was eye level with the platform and was unable to determine the safe way to ascend to the platform as a result of the noncompliant ladder design. He fell when he lost the three points of contact (hands and/or feet) necessary to be safe.

Judgments of Need

Judgments of Need (JON) are the managerial controls and safety measures that the Board determined to be necessary to prevent or minimize the probability or severity of a recurrence. JONs are linked directly to causal factors and form the basis for corrective action plans which must be developed by line management. Summaries of the nine JONs follow. Additional details for each one can be found in the Accident Investigation final report.

- BSA needs to revise the Standards Based Management System (SBMS), which includes training and qualification, worker safety and health, and work planning and control, to ensure fixed ladder inspection criteria are included to ensure compliance with ANSI A14.3 and 29 CFR 1910.27. (JON 1)
- BSA needs to document (through job risk analyses) the hazards associated with, and recommended controls for, performing elevated work on or accessed from all fixed ladders. (JON 2)
- BSA needs to revise the work planning and control process to categorize the work according to all recognized hazards and to reduce the practice of defaulting to *worker-planned work* even when significant hazards are present. (JON 3)
- BSA needs to implement a comprehensive fixed-ladder inspection program that identifies deficiencies and ensures implementation of effective corrective actions. (JON 4)
- BSA needs to revise the ladder safety training module to detail the hazards and safe use of all ladders. (JON 5)
- BSA needs to ensure that all supervisors have verified that their subordinates have completed all requirements identified by their Job Training Assessments. (JON 6)

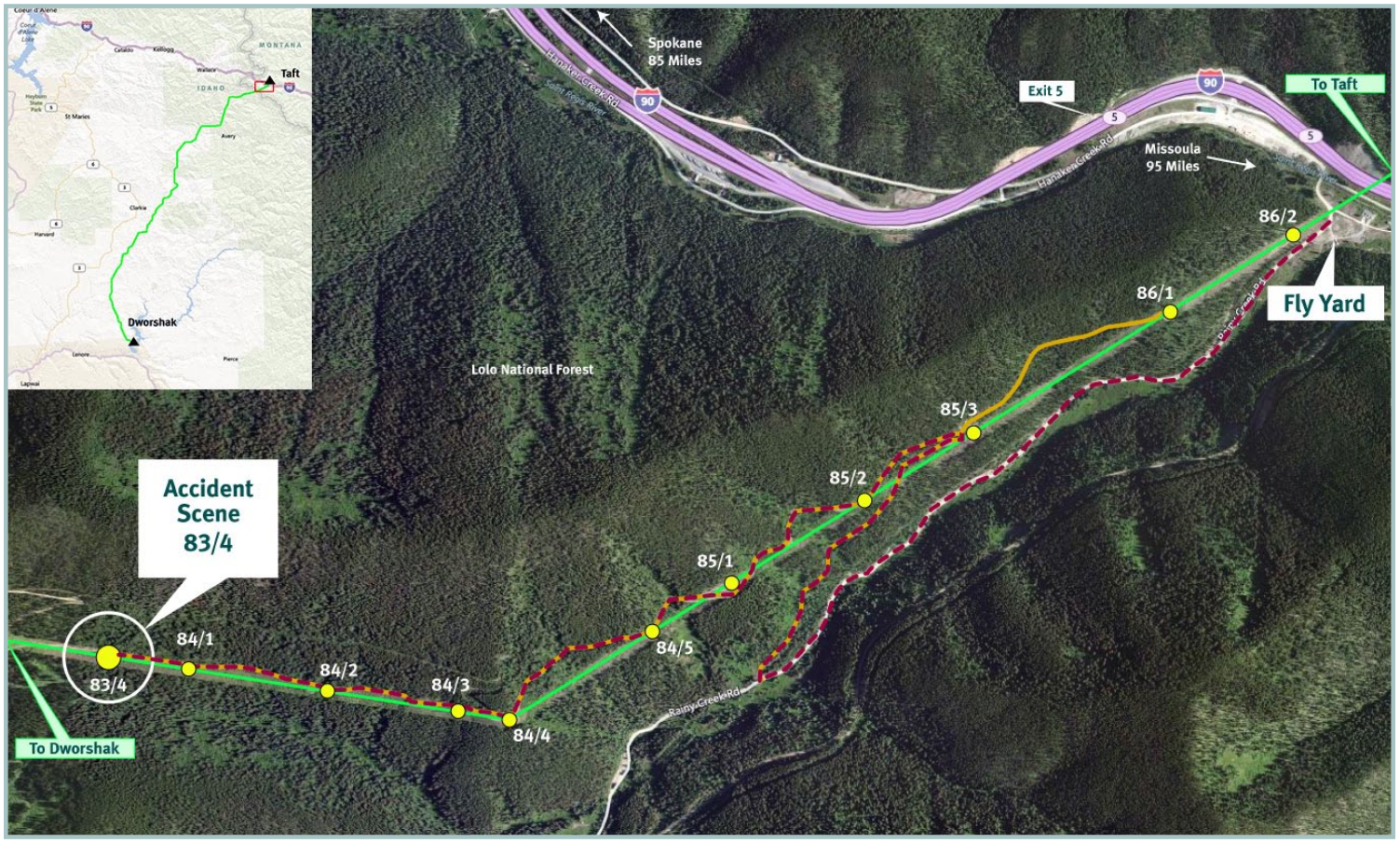
- BSA needs to develop an effective safety and health inspection program for identifying workplace hazards and implementing effective controls for ensuring compliance with contractual requirements established by 10 CFR 851. (JON 7)
- BSA needs to revise work planning and control requirements to ensure that during all phases of performing work (including estimation) hazards are effectively evaluated and appropriate controls are implemented. (JON 8)
- BSA needs to ensure that SBMS hazard recognition and feedback mechanisms are integrated for effective communication of risks associated with fixed ladders. There were multiple missed opportunities to identify and correct the hazards associated with this work activity. (JON 9)

The complete investigation report can be accessed at http://www.hss.doe.gov/sesa/corporatesafety/aip/docs/accidents/typea/6-29-2012-BNL_AI_Report.pdf.

KEYWORDS: Fixed ladder, Standards Based Management System, SBMS, hazard recognition, HPI, work planning and control, missed opportunities, ladder inspection, 29 CFR 1910, ANSI A14.3

ISM CORE FUNCTIONS: Define the Scope of Work, Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls, Provide Feedback and Improvement

Exhibit A: Enlarged Aerial Map of Access Road (from page 1)



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