Type B Accident Investigation Board Report
Hand Injury at the Salt Waste Processing Facility
October 6, 2009

November 2009
U.S. Department of Energy
Savannah River Site

Disclaimer

This report is an independent product of an Accident Investigation Board appointed by Jeffrey Allison, Manager, Department of Energy Savannah River Operations Office.

The Board was appointed to perform a Type B Investigation of this accident and to prepare an investigation report in accordance with DOE Order 225.1A, *Accident Investigations*.

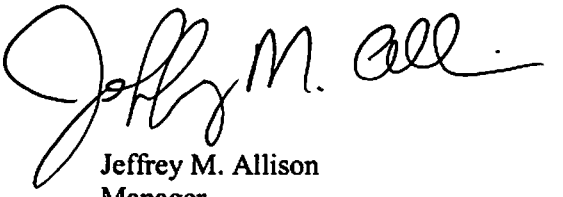
The discussion of facts, as determined by the Board, and the views expressed in this report do not assume and are not intended to establish the existence of any duty at law on the part of the U.S. Government, its employees or agents, contractors, their employees or agents, or subcontractors at any tier,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

This report neither determines nor implies liability.

Acceptance Statement and Release Authorization

On October 15, 2009, I established a Type B Accident Investigation Board to investigate the hand injury at the Savannah River Site Salt Waste Processing Facility on October 6, 2009. The Board's responsibilities have been completed with respect to this investigation. The analyses and the identification of contributing causes, the root cause, and judgments of need resulting from the investigation were performed in accordance with DOE Order 225.1A, *Accident Investigations*.

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



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EXECUTIVE SUMMARY

This report documents the results of the Type B Accident Investigation Board (Board) investigation of the October 6, 2009, hand injury at the Department of Energy (DOE) Savannah River Site (SRS) Salt Waste Processing Facility construction site.

Accident Summary

An Apprentice Crane Operator received a serious injury to the left hand and fingers while performing lubrication of the wire rope on a mobile crane. The Apprentice had his hand caught between the wire rope and the sheave over which the rope passes, resulting in a crushing injury to the left hand and fingers.

Construction site supervision was aware that the lubrication evolution was to be conducted, but the evolution was not identified in the listing of work activities for the shift. A task-specific Job Hazards Analysis had not been performed to develop formal controls for the evolution. The job was discussed in the Safe Work Briefing for the shift, but the specific lubrication method being used at the time of the accident was not discussed. The lubrication method being used at the time of the accident was not in accordance with methods specified in the mobile crane's operating manual.

Facility Description

The Salt Waste Processing Facility (SWPF) is currently under construction at SRS. The purpose of this project is to design and build a nuclear and chemical processing facility to treat high-level radioactive liquid waste stored in underground storage tanks at SRS. The facility will provide the capability to separate the tank waste into a small volume of high activity waste and a larger volume of low activity waste. The high activity waste will be vitrified in the existing Defense Waste Processing Facility and stored onsite awaiting ultimate disposal. The larger volume of low activity waste will be processed at the Saltstone Production Facility and disposed of onsite. The project was initiated in June 2001. In January 2004, Parsons was awarded the design and construction contract with provision to operate the facility for one year. At the time of this investigation, the project was 36 percent complete, with construction expected to be completed in October 2012 and operation to begin in July 2013.

Summary Facts and Analysis

On October 6, 2009, lubrication of a mobile crane's boom wire rope was performed by an Apprentice Crane Operator working with a Certified Crane Operator. The Apprentice's left hand and fingers were crushed when they were caught between the wire rope and the sheave over which the wire rope passes when being rolled onto its drum. The evolution had not been identified as a maintenance activity requiring a work order and supporting Job Hazards Analysis. The method of lubricating the wire rope at the time of the event did not comply with directions in the Manitowoc 888 Crane Operators Manual. The Manual describes hand lubrication with the wire rope moving away from the sheave. At the time of the accident, lubrication was being applied in close proximity to the sheave with the wire rope moving toward the sheave. While the root cause of the event was determined to be that an unsafe method was used to apply lubricant to the wire rope, significant contributing causes enabled the event to occur.

The most significant contributing causes were that construction supervision failed to recognize wire rope lubrication as a maintenance activity, did not analyze the associated hazards, and thus did not ensure that appropriate controls were in place for the lubrication activity. Parsons procedure PP-SH-4382, *Mobile Cranes and Hoisting and Rigging,* identifies wire rope lubrication as a maintenance activity. PP-CS-7201, *Construction Work Release Procedure,* requires preparation of a work order for maintenance activities. However, Parsons' supervision did not consider the wire rope activity as maintenance and did not develop a supporting work order. Since a work order was not developed, a Job Hazards Analysis was not performed to analyze hazards and specify appropriate controls for the job. Despite these errors, if the lubricant had been applied in accordance with instructions in the Manitowoc 888 Crane Operators Manual the accident would have been prevented.

Another important contributing cause was that the Safe Work Brief conducted prior to the lubrication activity did not ensure that the workers understood the full scope of the activity, the hazards involved and the exact method to be used while applying lubricant. The Manitowoc 888 Crane Operators Manual shows approved methods of applying lubricant to wire rope, but this was not discussed at the briefing. Additionally, the Certified Crane Operator did not recognize the hazards associated with lubricating the wire rope while raising the boom. Lubricating the wire rope while raising the boom results in the wire rope moving toward the sheave, where the Apprentice's hand was caught. An opportunity was missed to call a "Time Out for Safety" when a lubrication method not in compliance with the Manitowoc 888 Crane Operators Manual was proposed by the Apprentice Crane Operator.

The Board notes that the injured Apprentice declined to be interviewed, did not respond to a written request for information from the Board, and declined to sign medical releases for the Board to obtain the medical records for the treatment of his injuries.

Table ES-1 lists the Board's Conclusions and Judgments of Need that were identified during the course of this investigation. Appendix E lists additional opportunities for improvement the Board identified during the investigation.

Table ES-1: Conclusions and Judgments of Need

Conclusions	Judgments of Need
The facility's immediate response actions were appropriate and in accordance with facility procedures (Section 2.3).	N/A
The emergency response was timely and well-coordinated (Section 2.3).	N/A
The initial accident investigation readiness response was adequate (Section 2.4).	N/A
The accident scene was not preserved and turned over to the Board in accordance with Parson's procedures. As a result of the inadequate accident scene preservation, the Board was required to make assumptions in examining physical evidence and performing follow-up tests on the wire rope (Section 2.4). Despite a recent event at the SWPF construction site in which the incident scene was not properly preserved, implementation of corrective actions was not effective in ensuring proper preservation of the accident scene for this event (Section 3.6).	Parsons needs to reinforce compliance with their established procedures that address accident scene preservation.
The DOE-SR SWPF Project Office failed to ensure that the accident scene was properly preserved (Section 2.4).	The DOE-SR SWPF Project Office needs to ensure both Parsons and DOE-SR compliance with accident scene preservation requirements.

Conclusions	Judgments of Need
The commitment to comply with Integrated Safety Management System (ISMS) and regulatory requirements was adequately captured in contract documents and company-level procedures (Section 3.1).	N/A
Construction supervision failed to recognize that wire rope lubrication was a maintenance activity requiring a work order and a defined scope of work (Section 3.2). A job-specific hazards analysis was not developed for the wire rope lubrication activity (Section 3.3). Construction site supervision failed to ensure the development and implementation of adequate controls to protect workers during the lubrication of the crane boom wire rope (Section 3.4).	Parsons needs to ensure maintenance activities are identified and properly incorporated into the work control process. Parsons needs to ensure that ISMS is effectively implemented for construction site work activities such that work scope is defined in sufficient detail, associated hazards are analyzed, and appropriate controls are implemented.
The Safe Work Brief failed to ensure that the workers understood the scope of work, associated hazards, and their ability to conduct the work activity in a safe and compliant manner (Section 3.5).	Parsons needs to ensure that Safe Work Briefs are conducted such that employees understand work scope and associated hazards, and are ready to conduct work activities in a safe and compliant manner.
Parsons safety personnel were not aware that maintenance activities were being performed by Parsons personnel at the SWPF construction site (Section 3.2).	Parsons needs to ensure that safety personnel are involved in the planning and execution of construction site work activities.
The work activity was not performed in accordance with the guidance provided in the Manitowoc 888 Crane Operators Manual (Section 3.5).	Parsons needs to define and communicate approved method(s) for conducting crane wire rope lubrication.
An opportunity was missed to call a “Time Out for Safety” before proceeding to lubricate the wire rope while the boom was being raised, which is not in accordance with the guidance in the Manitowoc 888 Crane Operators Manual (Section 3.5).	Parsons needs to reinforce the use of “Time Out for Safety,” particularly when work scope or conditions change or when unanalyzed or unmitigated hazards are identified.
The roles and responsibilities of the Certified Crane Operator (journeyman) were not maintained for the task of lubricating the crane’s boom wire rope (Section 3.5).	Parsons needs to reinforce the roles and responsibilities of journeymen in relation to their apprentices.
Corrective actions taken as a result of previous facility events to improve the rigor of ISMS functions related to job scope definition, hazard analysis and hazard controls were not sufficient to prevent this accident (Section 3.6).	Parsons needs to improve the rigor of their methods to ensure the effectiveness of corrective actions.

Conclusions	Judgments of Need
DOE-SR SWPF Construction Representatives were conducting assessments of the contractor's activities that provided the contractor with meaningful feedback through the monthly contractor feedback process (Section 3.6).	N/A
Parsons has implemented an active and credible self-assessment program (Section 3.6).	N/A

ACRONYMS AND ABBREVIATIONS

CCO ……	Certified Crane Operator
DOE ……	U.S. Department of Energy
ESH&Q ……..	Environment, Safety, Health and Quality
JHA ……	Job Hazards Analysis
ISM ……	Integrated Safety Management
ISMS …….	Integrated Safety Management System
OSHA …….	Occupational Safety and Health Administration
SIMTAS ……	Site Integrated Management Total Assessment System
SME ……	Subject Matter Expert
S/RID …….	Standards / Requirements Identification Document
SR ……..…	Savannah River Operations Office
SRNS …….	Savannah River Nuclear Solutions, LLC
SRS ……..…	Savannah River Site
SRSOC ……....	Savannah River Site Operations Center
SWB ……....	Safe Work Brief
SWPF …….	Salt Waste Processing Facility
Apprentice ……..	Apprentice Crane Operator
Board ……..	Accident Investigation Board
Parsons ……...	Contractor for the Salt Waste Processing Facility project

1.0 INTRODUCTION

1.1 Background

At 1850 hours on October 6, 2009, an Apprentice Crane Operator (Apprentice) received a serious injury to the left hand and fingers while performing lubrication of the boom wire rope on a mobile crane. The Apprentice's hand was caught between the wire rope and the sheave over which the rope passes, crushing the left hand and fingers.

On October 15, 2009, the Department of Energy (DOE) Savannah River Operations Office (SR) Manager appointed a Type B Accident Investigation Board (Board) to investigate the event in accordance with DOE Order 225.1A, *Accident Investigations*. The appointment memorandum is included in Appendix A to this report.

1.2 Site/Facility Description

Savannah River Site

The Savannah River Site (SRS) is a 310-square mile government-owned, contractor-managed facility near Aiken, South Carolina. Since August 1, 2008, DOE has contracted with Savannah River Nuclear Solutions, LLC (SRNS) for overall management and operation of Site activities. Some activities, like the Salt Waste Processing Facility construction project, are conducted under separate contracts.

Salt Waste Processing Facility (SWPF)

The SRS SWPF is currently being constructed in J Area. The purpose of the SWPF is to treat high-level radioactive liquid waste stored in underground storage tanks at SRS. The project was initiated in June 2001. In January 2004, Parsons was awarded the design and construction contract with provision to operate the facility for one year. At the time of this investigation, the project was 36 percent complete, with construction expected to be completed in October 2012 and operation to begin in July 2013.

The SWPF will provide the capability to separate tank waste into a small volume of high activity waste and a larger volume of low activity waste. The small volume of high activity waste will be vitrified in the SRS Defense Waste Processing Facility and stored onsite awaiting ultimate disposal. The larger volume of low activity waste will be processed at the SRS Saltstone Production Facility and disposed of onsite. A diagram of the SWPF construction site is provided as Attachment H.

Mobile Crane Use at SWPF

Work at the SWPF construction site requires the use of mobile cranes. The work associated with the event involved a Manitowoc Model 888 Lift Crane (cover photo).

The boom is the extended lattice structure on the front of the crane next to the cab that supports the working load. The boom has a wire rope, called the load line, used to lift the load. There is also a wire rope, called the boom hoist rope, used to raise and lower the boom as needed to move the load. When the boom is raised to its highest point, the boom hoist rope is spooled on to the drum; when the boom is lowered, the boom hoist rope is spooled off the drum.

1.3 Scope and Methodology

The Board began its investigation on October 19, 2009, and submitted the final report to the DOE-SR Manager on November 13, 2009. The scope of the investigation included identifying all relevant facts; analyzing the facts to determine the direct, root, and contributing causes of the incident; developing conclusions; and determining judgments of need that, when implemented, should prevent the recurrence of the accident. The Board's scope also included addressing the role of DOE and contractor organization Integrated Safety Management Systems, as well as an analysis of the application of lessons learned and corrective actions resulting from similar events. The investigation was performed in accordance with Savannah River Implementing Procedure 225.1, *Accident Investigations*, based on the requirements of DOE O 225.1A, *Accident Investigations*, and DOE Workbook, *Conducting Accident Investigations*, Revision 2. In the case of this event, the injured Apprentice declined to be interviewed, did not respond to a written request for information from the Board, and declined to sign medical releases for the Board to obtain the medical records for the treatment of his injuries.

The Board conducted its investigation using the following methodology:

- Facts relevant to the accident were gathered through interviews, document reviews, and examination of physical evidence including inspection of the crane and observation of crane operations.
- Event and causal factor analysis, barrier analysis, and change analysis techniques were used to analyze the facts and identify the causes of the accident.
- Based on the above analyses, judgments of need were developed to identify corrective actions to prevent recurrence of the accident.

Accident Investigation Terminology

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

Events and causal factors analysis includes charting to depict the logical sequence of events and conditions and the use of deductive reasoning to determine the events or conditions that contributed to the accident.

Barrier analysis reviews the hazards, the targets (people or objects) of the hazards, and the controls or physical and/or administrative barriers put in place to separate the hazards from the targets.

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

Judgments of Need are managerial controls and safety measures necessary to prevent or minimize the probability or severity of accident recurrence.

2.0 THE ACCIDENT

2.1 Accident Overview

On October 6, 2009, a "Tool Box" safety meeting was conducted with all SWPF second shift construction site craft personnel at 1730 hours. At 1745 hours, craft personnel proceeded to their respective work places to begin their craft-specific Safe Work Briefs for the upcoming shift activities. A Safe Work Brief was conducted by the Foreman for the crane crew tasked with performing lubrication of one of the mobile cranes' wire ropes, including the Certified Crane Operator and Apprentice Crane Operator (Apprentice) assigned to the crane involved in the event. At approximately 1830 hours, the Crane Operator and Apprentice were at the crane ready to perform the lubrication of the wire rope. The crane boom had been raised to its highest point. The Apprentice positioned himself to perform the lubrication (Figure 2-1) and gave the boom down hand signal. At this point, the Crane Operator lowered the boom and the Apprentice lubricated the wire rope using a rag in his gloved hand, working the oil into the wire rope. Once the boom was completely lowered, the Crane Operator turned off the crane, exited the cab, and went to the Apprentice's location on the crane to discuss the activity. Upon completion of the initial lubrication, the Apprentice told the Crane Operator that he felt the wire rope needed some additional oil and that he wanted to lubricate the wire while the boom was traveling up, rather than down as it was during the initial lubrication. The Crane Operator returned to the cab, received the "boom up" hand signal from the Apprentice, and started to raise the boom slowly. Almost immediately the Crane Operator heard the Apprentice yell "boom down, boom down".

The Crane Operator boomed down, then locked down the crane and responded to the Apprentice. The Apprentice reported his hand had been caught between the sheave and the wire rope (Figure 2-2). The Crane Operator assisted the Apprentice to the safety trailer. The Shift Safety Representative was contacted and arrived at the safety trailer approximately three minutes after receiving the call from the Crane Operator. The Shift Safety Representative determined that the injury was a compaction-type injury and called Savannah River Site Operations Center (SRSOC) to request emergency services. The Apprentice was transported via ambulance to the Medical College of Georgia Trauma Unit for treatment of injuries to the left hand and fingers.

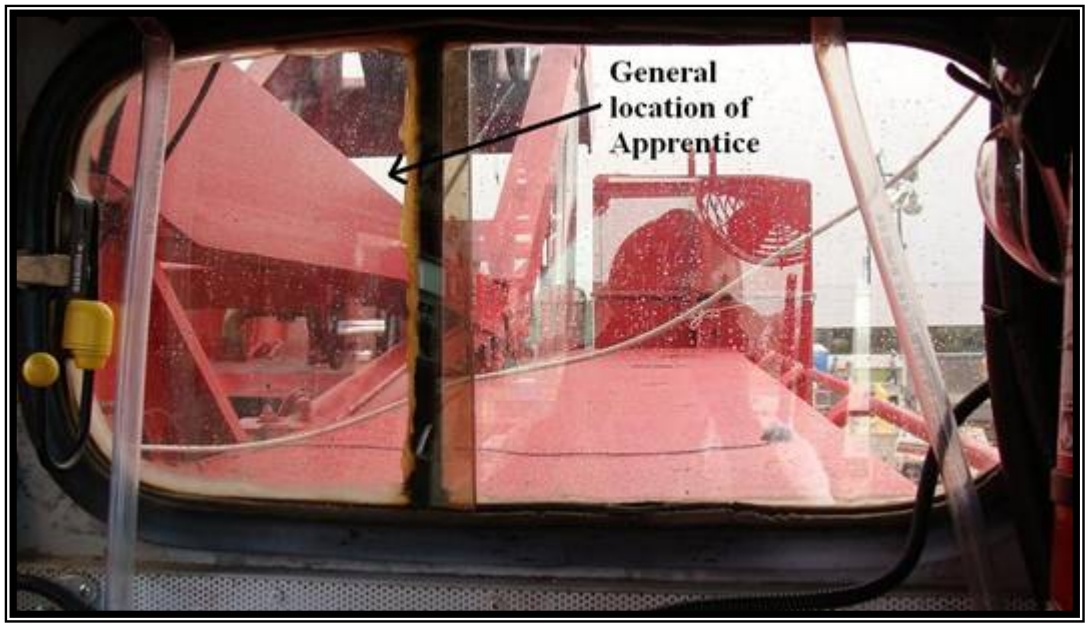


Figure 2-1: View from Inside Crane Cab

2.2 Event Chronology

Timeline	Activity
1600 - 1630 hours	"Form 256" work release meeting held to approve construction work activities for the shift.
1730 - 1745 hours	"Tool Box" safety meeting held in tent with all construction craft.
1745 - 1755 hours	Construction craft proceed to respective work places to start Safe Work Briefs. Crane crew stays in tent for their Safe Work Brief.
	Safe Work Brief performed for crane operations to discuss lubrication of the crane cable. Certified Crane Operator left to go to Manitowoc 888 crane to check the crane while discussions between the Foreman and Apprentice continued about man-lift operations.
1755 hours	Crane Foreman and second apprentice proceed to another crane for other work.
1830 hours	Apprentice Crane Operator arrives at Manitowoc 888 crane to perform wire rope lubrication after obtaining supplies needed to perform task.
	Crane boom has been raised to its highest position in order to boom down while applying the lubricant.
	Certified Crane Operator and Apprentice discuss the wire rope and sheave pinch point prior to starting work.
	Apprentice is on crane wearing gloves and pours lubricant onto rag.
	Apprentice gives Certified Crane Operator hand signal to boom the crane down.
	Certified Crane Operator slowly lowers the boom.
1845 hours	Crane is in the down position. Certified Crane Operator exits the crane cab and goes to the Apprentice's location to discuss the lubrication activity.
	Certified Crane Operator returns to crane cab and awaits hand signal from Apprentice to boom the crane up.
1850 hours	Certified Crane Operator receives hand signal from Apprentice to begin booming up the crane.
	Apprentice's left hand comes in contact with the sheave/wire rope.
	Certified Crane Operator booms down crane, locks crane and goes to Apprentice's location.
	Crane Operator assists Apprentice off the crane and removes rag from the Apprentice's left hand.
	Crane Operator calls the Shift Safety Representative.
	Certified Crane Operator and Apprentice proceed to the safety trailer.

Timeline	Activity
1853 hours	Shift Safety Representative arrives at the safety trailer.
	Shift Safety Representative calls SRSOC and calls second shift General Superintendent to come to the safety trailer.
1902 hours	SRNS Emergency Medical Services arrives at safety trailer.
1905 hours	Emergency Medical Services in route to Medical College of Georgia in Augusta Georgia.
1937 hours	Emergency Medical Services arrives at Medical College of Georgia.

2.3 Emergency Response

Emergency response to the accident consisted of the initial response by the Crane Operator to the Apprentice (injured person); the Shift Safety Representative's response to the safety trailer; SRS emergency medical personnel's response to the safety trailer; and transport of the injured Apprentice to the hospital.

Immediately after the Crane Operator received the hand signal from the Apprentice and started to raise the crane boom, the Crane Operator heard the Apprentice yell "boom down, boom down". The Crane Operator responded to the Apprentice's direction and boomed down. He then locked down the crane, assisted the Apprentice in getting down off the crane, and called the Shift Safety Representative to meet them at the safety trailer. The Crane Operator assisted the Apprentice to the safety trailer. The Shift Safety Representative arrived at the safety trailer approximately three minutes after receiving the call from the Crane Operator. The Shift Safety Representative determined that the injury was a compaction-type injury and called SRSOC to request emergency services. The Shift Safety Representative then called the second shift General Superintendent/designated Emergency Coordinator and reported the injury and that emergency medical personnel were in route.

SRSOC records obtained by the Board indicate that the emergency call was received at 1853 hours, that emergency units were dispatched at 1854 hours, and that the units arrived at the safety trailer at 1902 hours. The emergency coordinator had personnel waiting at the J Area north gate entrance to assist the ambulance in getting to the safety trailer. After the initial assessment of the Apprentice's hand, the emergency medical personnel concluded that it was prudent to immediately escort him (as he was able to walk under his power) into the ambulance to get him to the hospital. According to SRSOC records, the ambulance left J Area for the hospital at 1905 hours. Once in the ambulance the emergency medical personnel called the Medical College of Georgia and told them to have the trauma center ready and to have a hand specialist on standby. While in transport, the emergency medical personnel attempted to cut the glove off the injured hand but determined there was too much damage to do so. The ambulance arrived at the Medical College of Georgia at 1937 hours. The Shift Safety Representative arrived at the Medical College of Georgia at approximately 2015 hours. The General Superintendent/Emergency Coordinator initiated a safety stand-down because no other safety representative would be at the site once the Shift Safety Representative left for the hospital. Before leaving for the hospital, the Shift Safety Representative had the Crane Operator and his Foreman complete personal statements regarding the incident.

The Board evaluated the training and procedures provided to facility personnel assigned to provide emergency response. SWPF procedure PP-SH-4366, *First Aid and Emergency Services*,

Revision 0, provides instructions to all SWPF personnel (including subcontractors) for any incident resulting in injury, illness, fatality or property damage and to seek first aid treatment for injury/illness from trained first aid providers at the construction site. The Board noted that the supervisor of the injured Apprentice immediately notified the Shift Safety Representative and accompanied the individual to the safety trailer in accordance with this procedure. When notified by the Shift Safety Representative, the Emergency Coordinator (second shift General Superintendent) implemented procedure PP-OP-8509, *J-Area Emergency Coordinator*, Revision 1, Section 3.3, *Medical Event*.

The Board concluded that the facility's immediate response actions were appropriate and in accordance with facility procedures.

The Board concluded that the emergency response was timely and well-coordinated.

2.4 Investigative Readiness and Accident Scene Preservation

Contractor Actions

DOE O 225.1A, *Accident Investigations*, requires contractors to establish and maintain readiness to respond to accidents, mitigate the consequences, assist in collecting and preserving evidence, and assist with the conduct of the investigation. This includes preserving the accident scene while it is under the contractor's control and documenting the accident scene through photography and other means. Parsons implements these requirements through a variety of documents, including:

- Project Procedure PP-OP-8504, *Investigation and Critique*, identifies the process for performing fact finding investigations in support of selected events or conditions to determine the need for a critique or a more detailed formal investigation. The procedure also identifies the critique process and requirements and provides tools to use in performing a critique. Section 3.2 of the procedure addresses SWPF field readiness for accident investigations and initial actions after an accident to meet DOE O 225.1A requirements. Section 3.2.3.1, *Readiness Team Actions,* requires the readiness team to preserve the accident scene until it is examined and released by the DOE Accident Investigation Board.

  Departmental Instruction DI-OP-010, *Investigation and Critique*, provides amplifying information to support PP-OP-8504. Section 4.3, *Preserving the Accident Scene*, states that the "accident scene should be isolated as soon as possible until it is turned over to the Board".

- Project Procedure PP-OP-8509, *J-Area Emergency Coordinator*, Section 3.11.2 states that the Emergency Coordinator shall "preserve the event scene per PP-OP-8504, *Investigation and Critique*, until approval to restore is granted by the Contracting Officer Representative".

During the accident investigation, the Board noted the following facts regarding Parson's accident investigative readiness:

- Evidence was collected after the accident on October 6, 2009, and photographs were taken of the accident scene at 1920 hours. The accident scene was barricaded with rope and "Do Not Enter" signs at 1925 hours.

- At 0700 hours on October 7, 2009, the SWPF Construction Manager released the accident scene without the Emergency Coordinator obtaining DOE Contracting Officer Representative approval. The accident scene was never formally turned over to the DOE

SWPF Project Office or the DOE Type B Accident Investigation Board. During an interview, the SWPF Construction Manager indicated that he decided to release the scene and the crane the following day since evidence had been collected and the accident scene could be recreated, if necessary.

The Board concluded that the initial accident investigation readiness response was adequate.

The Board concluded that the accident scene was not preserved and turned over to the Board in accordance with Parson's procedures. As a result of the inadequate accident scene preservation, the Board was required to make assumptions in examining physical evidence and performing follow-up tests on the wire rope.

DOE-SR Actions

DOE-SR Savannah River Implementing Procedure 225.1, *Accident Investigations*, Revision 3, Section 6.1.2 requires the DOE-SR Cognizant Assistant Manager/Office Director to ensure that DOE and contractor readiness response actions taken immediately following an accident will secure, preserve, and document the accident. Because the accident scene was not properly preserved, the Board was required to make assumptions in examining physical evidence and performing the wire rope inspection test described below.

The Board concluded the DOE-SR SWPF Project Office failed to ensure that the accident scene was properly preserved.

2.5 Examination of Evidence

Wire Rope Inspection

The Board developed a Wire Rope Inspection Plan to determine certain physical conditions related to the accident. The Board engaged the SRNS Hoisting and Rigging Subject Matter Expert (SME) to provide independent expert advice on wire ropes and crane operation in developing and executing the inspection plan. The Inspection Plan included determining the time to boom down the crane, which would equate to the time necessary to lubricate the boom wire rope (Figure 2-2). The speed of the wire rope was also determined in the general lubricating location of the sheave on the crane. The Board had an independent SRNS certified wire rope inspector, provided by the SME, inspect a range of wire rope determined by the Board to be involved in the accident for physical condition. The inspection included examination for evidence of burrs, broken wires and proper lubrication.

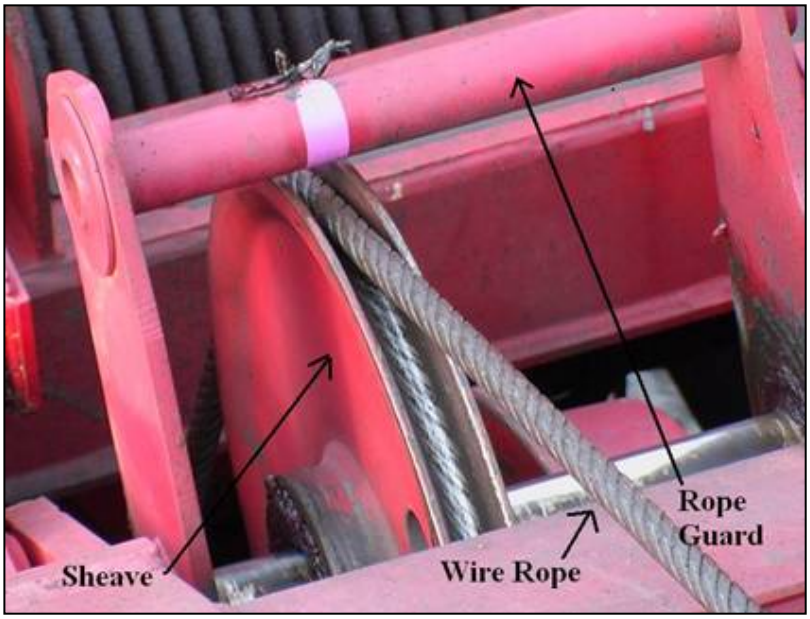


Figure 2-2: Wire Rope, Rope Guard and Sheave

The wire rope inspection was conducted on October 29, 2009, at approximately 0900 hours at the accident scene in J Area on the Manitowoc 888 225-ton mobile crane involved in the accident. Because the accident scene had not been preserved by Parsons and the DOE SWPF Project Office, the Board was required to use photographic evidence taken by Parsons just after the accident in re-establishing accident conditions to conduct the test. The crane cab has instrumentation to indicate the position of boom in tenths of degrees, but Parsons did not record this measurement during their collection of evidence after the accident or prior to releasing the accident scene on October 7, 2009. As a result, the Board used the Parson's accident scene boom photograph and the actual on-scene visual comparison of the relationship between the boom and the crane cab handles to approximate the crane location and the boom position at the time of the accident.

The boom was raised to the full up position, which is 81.5 degrees as indicated in the crane cab, and communicated to the two Board members present during the inspection. The time to boom down the crane from 81.5 degrees to 17.6 degrees (the approximate location of the boom at the time of the accident) was 10 minutes and 7 seconds. An earlier reenactment of the same test conducted by Parsons took 8 minutes and 22 seconds. These times provide an indicator of the time needed to lubricate the boom cable while the crane is at idle speed.

The wire rope speed was determined by measuring a 72-inch length on the crane structure next to the wire rope. A ribbon was tied to the wire rope at the 0-inch position. The wire rope was then moved at engine idle speed for the 72-inch length. The resulting wire rope speed was documented as 7.6 inches per second (9.47 seconds to travel 72 inches).

The inspection of the wire rope was performed by the independent SRNS qualified wire rope inspector. With the ribbon attached to the wire, the boom was raised 1.1 degrees which was measured to equal 6 feet of wire rope travel. The inspection was conducted between 23 degrees and 15.5 degrees by booming the crane down. This was done to ensure that enough wire rope was inspected to encompass the wire rope present at the time of the accident. The wire rope was moved in approximately 1 degree increments. At each increment, the crane was stopped to allow the SRNS qualified wire rope inspector to climb on the crane to perform the physical and visual inspection of the wire rope. In total, approximately 40 feet of wire rope was included in the review to ensure that the length of wire rope contacted by the Apprentice was inspected. The SRNS qualified wire rope inspector stated that the 40 feet of wire rope was found to be in good physical shape, with no burrs or broken wires, and was lubricated satisfactorily.

Additional Evidence Review

The Board examined the evidence removed from the accident scene. The evidence consisted of five individual bags containing an oily rag, a clean rag, a right-hand glove, a wire rope lubrication container, and the Apprentices' left-hand glove which was obtained from the Medical College of Georgia after the accident by Parsons. No conclusion concerning the accident was made by the Board based on examining the material. It was noted that the left-hand glove was damaged and covered in grease. The Board noted that the evidence was properly sealed and controlled and had no reason to suspect the material had been mishandled before securing custody. The material was examined in the presence of a SRNS nurse and medical doctor. The SRNS nurse removed and replaced the material into individual bags as witnessed by the medical doctor and two Board members. The bags were resealed with tamper-proof tape and returned to the Board Chairperson.

3.0 ACCIDENT FACTS AND ANALYSIS

3.1 Parsons Integrated Safety Management Processes

The Board considered the facts related to the accident and its analyses of the accident and has related this information to Integrated Safety Management (ISM) Core Functions. The ISM Core Functions comprise the fundamental DOE safety and health policies that should be incorporated into all work planning and execution activities. The five ISM Core Functions are designed to ensure that safety is effectively considered and implemented during all phases of work activities. The failure of any one of the core functions will result in the failure to effectively accomplish subsequent core functions. For example, if the specific work scope to be accomplished is not clearly and effectively identified, or if work scope changes are not recognized, the task-specific hazards associated with the specific work scope cannot be properly identified.

The DOE Integrated Safety Management System (ISMS) is described in DOE P 450.4, *Safety Management System Policy*. DOE Acquisition Regulations require contractors to manage and perform work in accordance with a documented, site-specific ISMS. These requirements have been incorporated into Parsons' contract for the SWPF (Contract No. DE-AC09-02SR22210). Parson's ISMS implementation is described in Document Number P-EIP-J-00001, *Integrated Safety Management System Description*, Revision 3. Parsons and its teaming partners have declared that they will perform work in compliance with ISMS, and all construction subcontractors must also agree to work in compliance with the Parsons' ISMS. Parsons policy PS-01, *Integrated Safety Management System Policy*, Revision 0, describes the responsibilities of all personnel for ensuring employees embrace ISMS core functions and principles and how the core functions and principles are integrated and flow down throughout their organization (Appendix F).

The principal regulation associated with this event is 10 CFR 851, *Worker Safety and Health Program*, which requires implementation of a Worker Health and Safety Program with respect to a covered workplace for which a contractor is responsible. The Parsons Standards/Requirements Identification Document (S/RID) identifies the two primary implementing mechanisms as S-CIP-J-00003, *SWPF 10 CFR 851 Worker Safety and Health Plan*, Revision 3, and S-CIP-J-00005, *SWPF Construction Health and Safety Plan*, Revision 4. S-CIP-J-00003 further references Project Manual PM-SH-4301, *SWPF Construction Safety Manual*, which contains Construction Safety and Health implementing procedures. It further states that regardless of performer (Parsons or its subcontractors), all construction activities will be covered by the Worker Safety and Health Program, and that construction activities will be conducted in accordance with the safety requirements identified in S-CIP-J-00005 and the implementing procedures documented in PM-SH-4301.

The Board concluded that the commitment to comply with ISMS and regulatory requirements was adequately captured in contract documents and company-level procedures.

3.2 Define the Scope of Work

Effective work execution begins with the development of a well-defined scope of work that translates mission and requirements into terms that those who are to accomplish the work can clearly understand. Defining the scope of work is the first core function of an effective ISMS. A well-defined scope of work is required for successful completion of the ISM core functions that follow, including hazard analysis and development and implementation of controls.

Parsons' work control process is outlined in procedure PP-CS-7201, *Construction Work Release Procedure*, Revision 9. The purpose of the procedure is to establish the means and methods used to identify, package and release work scope at the SWPF construction site. Section 3.9 of the

procedure specifies that work associated with preventive or corrective maintenance of both permanent and non-permanent plant equipment is to be covered by work orders.

Procedure PP-SH-4382, *Mobile Cranes and Hoisting and Rigging,* Revision 1, controls the use of cranes at the SWPF construction site. Section 3.1.7 of the procedure provides guidance for crane maintenance. The procedure requires a preventive maintenance program be established based on requirements and recommendations of the equipment manufacturer, and specifically includes wire rope lubrication as a maintenance activity.

During this investigation, the Board determined that a work order was not developed for conducting maintenance on the wire rope, contrary to the requirements of PP-CS-7201, *Construction Work Release Procedure*. In accordance with this procedure, a construction coordination meeting is conducted prior to each shift. During that meeting, the General Superintendent authorizes each work order on Form SWPF-256, *Construction Coordination Meeting Daily Work Authorization*. Since a work order was not generated for the crane lubrication task, the task did not appear on the list of authorized work for the shift.

Development of the work order would have defined the scope of work. Because the work scope was not defined, the remaining core functions of the ISMS process (beginning with hazards analysis) could not be effectively applied.

The failure to define the scope of work did not allow for the hazards of the wire rope maintenance activity to be analyzed and mitigated. PP-SH-4364, *Job Hazards Analysis,* Revision 1, requires the construction safety manager to review and concur with each Job Hazards Analysis (JHA). Since the scope of work was not defined and a JHA was not developed for the wire rope lubrication, safety personnel were not made aware of the activity through the work control process. Through interviews, the Board discovered that Parsons safety personnel were not aware of any crane maintenance activities being performed by Parsons personnel at the SWPF construction site.

The Board concluded that construction supervision failed to recognize that wire rope lubrication was a maintenance activity requiring a work order and a defined scope of work.

The Board also concluded that Parsons safety personnel were not aware that maintenance activities were being performed by Parsons personnel at the SWPF construction site.

3.3 Analyze Hazards

The objective of the hazards analysis process is to develop an understanding of task-specific hazards that may affect the worker, the public, or the environment. Each level of hazard analysis forms the foundation for a more detailed analysis. Hazard identification and analysis must occur at any phase of the work cycle to which it applies, and is dependent upon the adequate and full definition of the activity or task to be performed. If the activity or task is not fully identified or defined, an adequate task-specific hazard analysis cannot be performed.

The requirement to perform an analysis of the hazards at the highest level is described in S-CIP-J-00003, *SWPF 10 CFR 851 Worker Safety and Health Plan,* and S-CIP-J-00005, *SWPF Construction Health and Safety Plan.* At the next level of control, a JHA for all construction activities is created in accordance with PM-SH-4301, *SWPF Construction Safety Manual*. Procedure PP-SH-4364, *Job Hazards Analysis,* Revision 1, further defines criteria for the development of three types of JHAs:

1. The “Skill of the Craft” JHA applies to all construction craft regardless of trade. This type of JHA identifies, analyzes, and applies controls to low-severity hazards normally associated with the majority of injury types that occur in a construction environment.

The procedure states, "Craft worker experience, training, and qualification (i.e., skill of the craft) provide workers with the proper knowledge, skills, and abilities to adequately protect themselves from the types of hazards identified in the JHA."

2. "Standard Work" JHAs are used to identify the hazards and protective controls associated with the scope of the work defined in a specific construction Work Package.
3. "Specialized Work" JHAs are used to identify the hazards and protective controls associated with the scope of work defined in a specific construction Work Package where the work scope has been declared as very complex or high hazard, or where the protective controls are not within the training and qualification of the worker.

During interviews the board found that Crane Operators, Apprentice Crane Operators, and Crane Foremen understood the crane lubrication activity to be covered by different work packages and JHAs. These included:

(1) Work Package 73 – The Description/Scope of Work for this work package is described as material handling, offloading incoming delivery vehicles, loading and transport of materials from the SWPF laydown/storage areas to designated work areas. This work package has a supporting Standard Work JHA (JHA No. 33).
(2) Work Package 13 – The Description/Scope of Work for this work package is described as assembly of the Link Belt 298 crawler crane and Manitowoc Model 888 crane. This work package has a supporting JHA (JHA No. 15). JHA 15 is not in standard JHA format and is not designated as either Skill of the Craft, Standard or Specialized.
(3) JHA – 54 – This "Skill of the Craft" JHA was written to identify common tasks associated with general construction activities and is applicable to all SWPF construction site work.

The Board reviewed Work Package 73 and Work Package 13 and found that neither work package identified crane wire rope lubrication as a specific activity. The Board also reviewed the associated JHAs and found that none contained a task-specific analysis of the hazards associated with wire rope lubrication.

The Board also noted that the "Skill of the Craft" JHA identifies work activities such as pinch points; tripping hazards; ladders and stairs; slippery surfaces; exposure to insects, wild life, or poisonous plants; and exposure to hot or cold environments that would normally be considered hazards, not work activities. The Board determined that the "Skill of the Craft" JHA should be evaluated to ensure that it contains an accurate and valid description of "work activities."

The failure to develop a specific JHA precluded identification of hazards associated with personnel exposure to moving machine parts during hands-on lubrication of the wire rope. As a result, controls were not implemented to ensure the wire rope was lubricated in a manner consistent with the Manitowoc 888 Crane Operators Manual or best industry practice. Failure to identify the hazards associated with hands-on lubrication of the wire rope precluded implementing controls to properly protect the workers.

The Board concluded that a job-specific hazards analysis was not developed for the wire rope lubrication activity.

3.4 Develop and Implement Hazard Controls

The objective of developing and implementing hazard controls is to identify and provide all engineering, administrative, and personal protective equipment requirements consistent with the hazards to be encountered. To adequately develop and implement hazard controls, the work scope must first be well defined and the hazards thoroughly analyzed. For this accident, the

failure to adequately define the scope of work and then the failure to properly develop and analyze the hazards precluded the development and implementation of hazard controls.

Procedure PP-CS-7201, *Construction Work Release Procedure*, Revision 9, prescribes the means and methods used to identify, package, and release work scopes for the SWPF construction project. Section 2.0 defines activities requiring a work order as follows:

> "Work Associated with preventative/corrective maintenance of permanent and non-permanent plant equipment will be covered by Work Orders (WO), addressed in section 3.9 of this Project Procedure."

Procedure PP-SH-4382, *Mobile Cranes and Hoisting and Rigging*, Revision 1, Section 3.1.7, *Crane Maintenance*, and Section 3.1.7.4, *Wire Rope Maintenance*, indicate that lubricating the wire rope is a maintenance activity. This would have required the work scope to be developed into a work order and either integrated with an existing JHA or require the development of a new JHA.

During the investigation, the Board noted the following regarding the application of procedure requirements and work planning and control requirements:

- Procedure PP-CS-7201, *Construction Work Release Procedure*, requires preventative/corrective maintenance work activities to be controlled through the issuance of a work order. Procedure PP-SH-4382 defines lubricating the wire rope as a maintenance activity. Procedure PP-CS-7201 states, "The Work Order shall contain detailed preventative/corrective maintenance instructions derived from either the manufacturer's Installation and Operation Manual or best industry practice. Work Orders are required to reference or otherwise integrate a Job Hazards Analysis necessary to perform the work steps." No work order was developed for performing the task.
- Procedure PP-SH-4364, *Job Hazards Analysis*, requires the development of a JHA for the hazards associated with the work defined in a specific work instruction. No work instruction was developed, thus no JHA was developed.
- During the Daily Work Authorization review, the work activity of lubricating the wire rope was not included on Form 256, *Construction Coordination Meeting Daily Work Authorization*. The work activity, lubricating the wire rope, did not have a specific work order associated with the task so the activity was not included as part of the work release process.
- The Safe Work Brief conducted the evening of the accident failed to communicate specific work scope, limitations, tasks, and hazards for lubricating the wire rope.
- The Safe Work Brief conducted the evening of the accident did not utilize the Safe Work Briefing Checklist Card (Attachment A of procedure PP-SH-4365). The Board determined this was a missed opportunity to identify hazards associated with the job and fully discuss the details.
- Procedure PP-SH-4365, *Safe Work Brief*, requires personnel involved in the Safe Work Brief to sign their time card acknowledging they understand the scope, hazards, controls, and their role and responsibilities for completing the task safely and compliantly. The time card specifies that: "(1) No injury has occurred; (2) Safety issues have been resolved; (3) Hours worked are correct; (4) Have attended and understand the Safe Work Brief". The Board found that all personnel involved, including the Apprentice (injured employee) had already signed the time card indicating the above conditions were met the evening of the accident.

- Interviews disclosed that the Apprentice (injured worker) was allowed to describe how the job would be performed even though he only had minimal experience. This occurred during the Safe Work Brief with participation from the Certified Crane Operator and Foreman. During subsequent discussions between the Apprentice and the Certified Crane Operator, the Apprentice requested the crane boom to be moved in a direction that was not specified by the Manitowoc 888 Crane Operators Manual for lubricating a wire rope (Appendix G). The *Wire Rope Users Manual*, Fourth Edition, clarifies that the arrows in the figure for wire rope lubrication indicate the direction of wire rope movement.

The Board determined through interviews that many methods are used to lubricate wire rope including spraying lubricant, pouring oil directly on the wire rope, and using a paint brush to apply oil to the wire rope. Table 3-1 displays different methods the Board found to be commonly used in the experience of Parsons, SRS and support personnel. Since the work was not identified in a work order, the method was not specified and appropriate controls from the Manitowoc 888 Crane Operators Manual or industry best practices were not identified prior to performing the work.

Table 3-1. Wire Rope Lubrication Method Experience – Parsons, SRS and Support Personnel

	Hand Lubrication with Wire Rope Moving	Hand Lubrication with Wire Rope Stopped	Lubrication Sprayed/Poured On
Apprentice (Injured)	X		
Forklift Operator		X	
Construction Superintendent	X		
Operator/Foreman #1	X		
Operator/Foreman #2			X
Maxim Representative (mechanic responsible for servicing crane)			X
Union Trainer			X
Apprentice Crane Operator (assigned to a different crane)	X		
SRNS Mobile Crane Crew			X
Certified Crane Operator (CCO)			X
Heavy Equipment Foreman	X		
Former CCO		X	

The Board concluded that construction site supervision failed to ensure the development and implementation of adequate controls to protect workers during the lubrication of the crane boom wire rope.

3.5 Perform Work within Controls

The five ISMS Core Functions are designed to ensure that safety is effectively considered and implemented during all phases of work activities. The failure of any one of the core functions will result in the failure to effectively accomplish subsequent core functions. If the specific work scope to be accomplished is not clearly identified, or if work scope changes are not recognized, the task-specific hazards associated with the specific work scope cannot be properly identified, and controls cannot be put in place to protect employees when work is performed.

On the day of the accident, a mechanic for Maxim Crane Works was at the SWPF construction site performing repairs to the 225-ton Manitowoc 888 crane (the crane involved in the event). While performing the repairs he determined that the boom wire rope on the crane needed to be lubricated. He notified Parsons construction staff and stated that if personnel onsite were unable

to lubricate the wire rope he would lubricate it during his next scheduled service visit. The need to lubricate the boom wire rope was discussed after the meeting held to review activities listed on Form SWPF 256, *Construction Coordination Meeting Daily Work Authorization*, held prior to the start of the second shift. Shift supervision agreed to lubricate the wire rope during the evening shift.

The start of the second shift included a "Tool Box" safety meeting for all craft personnel from 1730 to 1745 hours. At 1745 hours craft personnel proceeded to their respective work places to begin their Safe Work Briefs for the upcoming shift activities. PP-SH-4365, *Safe Work Brief*, Revision 1, states that Safe Work Briefs are conducted to ensure that employees understand work scope and associated hazards and their ability to conduct work in a safe and compliant manner. The crane crew, consisting of Foreman/Crane Operator, Crane Operator, Forklift Operator and two Apprentice Crane Operators (one of whom was assigned to the crane involved in the event) remained in the craft tent to perform their Safe Work Brief.

Through interviews, the Board discovered that the Foreman who conducted the Safe Work Brief had limited experience with wire rope lubrication, and the experience he did have was with spray lubricant. Interviews also disclosed that the Certified Crane Operator's experience with wire rope lubrication occurred while he was working with Bechtel at SRS, and involved iron workers lubricating wire rope using a spray lubricant while the Crane Operator operated the crane. In this case, the Safe Work Brief began with the Foreman stating that the wire rope needed to be lubricated. The Certified Crane Operator responsible for the crane involved in the accident, who had no experience with wire rope lubrication at the SWPF site, asked how it was done at SWPF. The Apprentice Crane Operator assigned to the crane involved in the event stated that he used a rag and poured the oil on the rag while working the oil into the wire. The discussion included use of a man-lift to perform the evolution. While the Foreman and Apprentice continued to discuss the evolution, the Certified Crane Operator left to perform the daily inspection of the crane. Procedure PP-SH-4365, *Safe Work Brief*, requires all personnel involved in the activity to receive the entire Safe Work Brief. The Board found through interviews that the Safe Work Brief did discuss keeping hands away from sheaves and pinch points. However, the Safe Work Brief did not include any discussion of the following topics:

- Guidance provided in the Manitowoc 888 Crane Operators Manual for approved lubrication methods;
- Where the Apprentice would be positioned while lubricating the wire rope near the sheave;
- Whether or not the wire rope would be moving while the Apprentice's hand was in contact with it;
- Whether the lubrication would be conducted only while booming down with the wire rope moving away from the sheave; or
- A review of the Safe Work Brief checklist card as required by procedure PP-SH-4365, *Safe Work Brief*.

During the Safe Work Brief neither the Foreman nor the Certified Crane Operator questioned the method planned for lubricating the wire rope even though both had prior experience only with the spray method of applying oil.

The Board concluded that the Safe Work Brief failed to ensure that the workers understood the scope of work, associated hazards, and their ability to conduct the work activity in a safe and compliant manner.

The Safe Work Brief concluded at 1755 hours at which time the Apprentice went to the crane and began preparations for lubricating the wire rope. In interviews, the Crane Operator stated that after discussions with the Apprentice, they decided not to use the man-lift. During interviews, personnel stated that even if a man-lift had been used, entry to the area near the sheave would still have been required to complete the wire rope lubrication. The Apprentice obtained the supplies needed to lubricate the wire rope including rags, oil, and radios for communication, and returned to the crane at approximately 1830 hours. The boom had already been raised in preparation to perform the lubrication activity. The Apprentice positioned himself near the sheave in preparation for lubricating the wire rope. Interviews disclosed that other Apprentice Crane Operators performed this activity while positioned by the muffler, which is a greater distance from the sheave in question (Figure 3-1). Once in the cab, the Crane Operator received the boom down signal from the Apprentice and started slowly lowering the boom. While the boom was being lowered, the Apprentice applied oil to the rag and worked the oil into the wire rope. Lubricating while booming down has the rope moving away from the sheave, which is the method shown in the Manitowoc 888 Crane Operators Manual. At approximately 1845 hours, the boom was completely lowered. The Crane Operator turned off the crane, exited the cab and went back to discuss with the Apprentice whether the lubrication was successful. The Apprentice indicated the wire rope needed some additional oil and that he wanted to lubricate the wire rope while booming up. The Crane Operator did not find it unusual to lubricate while booming up since in his experience using a spray lubricant, it did not matter whether the crane was booming down or booming up as there would be no contact with the wire rope. However, booming up causes the wire rope to move toward the sheave. Lubricating in this direction is contrary to guidance shown in the Manitowoc 888 Crane Operators Manual. The Board determined that an opportunity was missed to call a "Time Out for Safety" in accordance with Section 3.1 of PP-SH-4356, *Stop Work Orders*, Revision 0, when the Apprentice suggested performing the lubrication with a method not shown in the Manitowoc 888 Crane Operators Manual. The Crane Operator agreed to continue the evolution while booming up and returned to the cab. He received the boom up hand signal from the Apprentice and started to raise the boom slowly. Almost immediately the Crane Operator heard the apprentice yell "boom down, boom down". The Crane Operator boomed down, locked down the crane, and responded to the Apprentice. The Crane Operator stated during interviews that the Apprentice told him the rag caught on the wire rope and pulled his hand into the sheave. The Crane Operator assisted the Apprentice in getting down off the crane and called the Shift Safety Representative to meet them at the safety trailer. The Apprentice asked the Crane Operator to remove the rag from his injured hand and the Crane Operator did so, leaving the oily rag on the crane. The Crane Operator assisted the Apprentice to the safety trailer.

Figure 3-1: Crane Muffler Location

The Board concluded that the work activity was not performed in accordance with the guidance provided in the Manitowoc 888 Crane Operators Manual.

The Board concluded that an opportunity was missed to call a "Time Out for Safety" before proceeding to lubricate the wire rope while the boom was being raised, which is not in accordance with the guidance in the Manitowoc 888 Crane Operators Manual.

Roles and Responsibilities

Crane operators (journeymen) are qualified as Certified Crane Operators (CCO) in accordance with "The CCO Certification Program", which is accredited by the National Commission for Certifying Agencies. The National Commission for the Certification of Crane Operators is an independent not-for-profit organization formed to establish and administer a nationwide program of certification for crane operators. The Commission sets standards for measuring the knowledge and proficiency required for the safe operation of cranes. According to the Commission, extensive discussions with representatives from all segments of business and industry impacted by construction safety issues resulted in identifying the following potential benefits of operator certification:

- Reduced risk of loss;
- Fewer accidents, injuries and fatalities;
- Assurance of operator's abilities;
- Less property damage;
- Improved safety records; and
- Enhanced public image of crane operators.

Apprentices, who are hired to learn the trade as a crane operator and ultimately become certified, work under the supervision of a skilled journeyman. This relationship is described in the document, "*Standards of Apprenticeship, Developed by IUOE, Local 470, JAC, for the Occupation of Operating Engineer*." This standard states, "During the apprenticeship the apprentice shall receive such on the job training and skill training (seat-time) in the occupation necessary to develop the skill and proficiency of a skilled journeyworker. The on the job training shall be under the direction and guidance of qualified journeyworkers."

Interviews conducted with two Certified Crane Operators, two apprentices not involved with the accident, and a Certified Crane Operator previously employed by Parsons, disclosed that the relationship of the Certified Crane Operator to the apprentice, with the Crane Operator being in charge and instructing the apprentice, was well understood. The day of the accident, this working relationship was not maintained. Personnel attending the Safe Work Brief reported that the Apprentice (injured worker) described how the work evolution was to be performed. The Certified Crane Operator failed to recognize the hazards associated with the method described by the Apprentice and failed to maintain a trainer/trainee working relationship.

The Board concluded the roles and responsibilities of the Certified Crane Operator (journeyman) were not maintained for the task of lubricating the crane's boom wire rope.

3.6 Provide for Feedback and Improvement

Feedback and improvement processes should be designed and implemented to provide information on the adequacy of work controls, to identify and implement opportunities for improving the definition and planning of work, and to utilize line and independent oversight processes to provide information on the status of safety. The feedback and improvement function is intended to identify and correct processes or conditions that lead to unsafe or undesired work outcomes, confirm that desired work outcomes were arrived at in a safe manner, and provide managers and workers with information to improve the quality and safety of subsequent, similar work.

In evaluating how DOE and Parsons had analyzed performance information as part of lessons learned, feedback, and improvement, the Board reviewed DOE and SRS lessons learned, feedback provided by DOE and Parsons assessments, and Site Occurrence Reporting and Processing System reports.

Lessons Learned

An Operating Experience and Lessons Learned Report from January 2004, *Department of Energy Hoisting and Rigging Events*, summarized several hoisting and rigging events and provided general guidance to avoid future events. Although none of the specific events described in the report were similar to this accident, the report did identify a need to ensure that applicable repair and lubrication procedures have been reviewed for understanding of the work scope and to ensure the work can be properly executed. The Board determined that the recommendations in this report were relevant to crane maintenance programs and should be reviewed for applicability to SWPF crane maintenance.

Previous Occurrence Reports and Events

The Board identified two previous incidents at the SWPF work site that are relevant to the current investigation.

On October 7, 2008, two SWPF craft personnel drilled approximately 30 one-inch diameter holes, two feet deep, in the SWPF concrete mud-mat using a pneumatic operated sinker drill, commonly referred to as a rock drill. During the pre-job briefing, workers were instructed to use a 1.5-inch diameter hose supplied from a water truck (water hose) to spray the drill site to minimize airborne dust generation. When the workers reached a drill site beyond the reach of the water hose, they changed their dust control scheme and used a portable, compressed air, hand tank water sprayer as the dust control method. Air samples showed that the workers' respirable silica quartz exposure exceeded Occupational Safety and Health Administration (OSHA) and American Conference of Governmental Industrial Hygienists limits. When the event was analyzed, the root cause was determined to be that the craft workers did not clearly understand that the prescribed control and criteria in the JHA meant no visible airborne dust. The hazard mitigation for this activity was not properly identified in the JHA and Safe Work Plan. As a result, the consequences associated with changing the equipment from the water hose to a hand held tank sprayer were not fully understood. Corrective actions taken included revision of the specific JHA used for concrete drilling identified in the event to clearly identify the hazards and mitigation methods. Corrective actions also included conducting a pre-use review of current JHAs for hazard identification, control and mitigation and revising the JHAs as needed.

On January 24, 2009, a fire occurred at the SWPF construction site. A concrete pour for a cell placed as part of base mat construction was undergoing a thermally-controlled curing process. A thermal blanket tent was constructed over and around the concrete slab. The thermal blanket tent was used in conjunction with propane heaters to control the concrete surface temperature. One of the propane heaters was placed near wood bracing and shoring, causing ignition and subsequent fire. Both the Parsons and DOE investigation of the fire found that less than adequate application of ISM principles for the work scope led to the event. The hazards presented by the configuration of heaters inside the thermal blanket tent in close proximity to wood shoring were not properly identified, analyzed and controlled. As a result, the JHA for the activity did not fully address the configuration of heaters and blankets being used. After the fire was extinguished, Parsons did not maintain the integrity of the incident scene. As a result, clean-up activities were initiated and evidence was removed before the scene was adequately investigated. Parsons developed and implemented an extensive corrective plan in response to the event.

The Board concluded that corrective actions taken as a result of previous facility events to improve the rigor of ISMS functions related to job scope definition, hazard analysis and hazard controls were not sufficient to prevent this accident.

The Board concluded that despite a recent event in which the incident scene was not properly preserved, implementation of corrective actions was not effective in ensuring proper preservation of the accident scene for this event.

DOE-SR Assessment Activities

The DOE-SR SWPF Federal Project Director is responsible for oversight of SWPF activities. The DOE-SR Federal Project Director is supported by a Construction Manager whose staff includes a federal Facility Representative and contractor specialists (two construction specialists, an electrical inspector, and a piping/welding expert). The DOE-SR SWPF Federal Project Director uses an annual plan to schedule assessments. The FY2009 Annual Assessment Plan identifies both quarterly and monthly construction assessments (shown in Table 3-2).

Table 3-2: DOE-SR SWPF Construction Assessments

Frequency	Topic	Assessments Planned	Assessments Completed
Quarterly	Security Program	4	4
Quarterly	ISMS Implementation	4	3
Quarterly	Environmental Compliance	4	3
Monthly	OSHA/Fire Protection	12	14
Monthly	Construction Procedure Compliance	12	21
Monthly	Quality Assurance	12	26
Totals		48	71

Records in the DOE-SR Site Integrated Management Total Assessment System (SIMTAS) indicate that DOE-SR completed a total of 71 assessments in these topic areas, exceeding the planned number in the schedule. The Facility Representative, the Construction Manager or both participated in these assessments. DOE-SR Subject Matter Experts in the areas of Industrial Safety and Fire Protection also participated in some of these assessments. Specific DOE-SR SWPF Construction Assessments that are documented in SIMTAS for FY2009 include such topics as:

- Fire Protection
- Electrical Safety
- Work Practices During Concrete Pouring
- Work Practices During Rebar Placement
- Fall Protection
- Safety Program Compliance

The DOE-SR SWPF FY2009 Annual Assessment Plan also included twelve Management Walkthrough assessments, with two such assessments being documented in SIMTAS. The Board

determined that DOE-SR SWPF management has not documented completion of scheduled walkthrough assessments.

The Board concluded that DOE-SR SWPF Construction Representatives were conducting assessments of the contractor's activities that provided the contractor with meaningful feedback through the monthly contractor feedback process.

Contractor Assessment Activities

Parsons has established a self-assessment process described in document PL-AS-1001, Revision 1, *Salt Waste Processing Facility Project Integrated Assessment Program Plan.* The program consists of line management and support organization self-assessments and internal independent assessments and audits. It requires eleven organization-specific plans be developed and implemented, including the areas of Construction; Environment, Safety, Health and Quality (ESH&Q); and Assurance. During this investigation, the Board reviewed the self-assessment programs described in PL-CS-7201, *Construction Self-Assessment Plan for 2009*, and in PL-SH-4302, *Environmental Safety Health and Quality Internal Independent Assessment Plan*. The Construction Self-Assessment plan identifies two types of assessments: Ongoing Assessments of Work Control, Safety Management and Material Management; and Focused Assessments that are based on review and analysis of the Ongoing Self-Assessments. The Environmental Safety Health and Quality plan outlines a program consisting of daily field oversight, weekly trending analysis, scheduled walkthrough surveillances, programmatic assessments and unscheduled focused assessments.

The Board reviewed records documenting the ESH&Q daily and weekly trend assessments for the period June 23, 2009, through October 2, 2009. The daily records of the Site Safety Representatives documented frequent attendance at daily work planning meetings and Safe Work Briefs as well as observations of site construction activities. Numerous safety issues were identified, indicating significant and critical oversight of work activities. Issues identified in daily assessments were analyzed for trends in the weekly trend analysis reports. When adverse trends were identified, Condition Reports were generated that resulted in corrective actions being taken. Focused assessments of crane, aerial lifts, and hoisting and rigging operations were conducted. The reports of these assessments show that issues with inspection, recordkeeping and procedures were identified and corrected. Representative construction self-assessments for Material Management and Safety Management were also reviewed and were found to identify meaningful issues and corrective actions.

The Board concluded that Parsons has implemented an active and credible self-assessment program.

3.7 Summary of Analytical Methods and Results

Barrier Analysis

Barrier Analysis is based on the premise that hazards are associated with all tasks. A barrier is any management or physical means used to control, prevent, or impede the hazard from reaching the target (i.e., persons or objects that a hazard may damage, injure or harm). Appendix B contains the Board's complete Barrier Analysis of the physical and management barriers that did not perform as intended and thereby contributed to the accident. The results of the barrier analysis were integrated into the Events and Causal Factors Analysis to support the development of causal factors.

Change Analysis

Change analysis examines planned or unplanned changes that cause undesirable results related to the accident. This process analyzes the difference between what is normal, or expected, and what actually occurred before the accident. Appendix C contains the Board's detailed Change Analysis. The results of the Change Analysis are integrated into the Events and Causal Factors to support the development of causal factors.

Events and Causal Factors Analysis

An Events and Causal Factors Analysis was performed following the processes described in the DOE Workbook *Conducting Accident Investigations*, Revision 2. The Events and Causal Factors Analysis is a systematic process that uses deductive reasoning to determine which events and/or conditions contributed to the accident. Causal Factors are significant events and conditions that produced or contributed to the accident and include direct, contributing, and root causes. The direct cause is the immediate event or condition that caused the accident. Root causes are causal factors that, if corrected, would prevent recurrence of the same or similar accidents. Contributing causes are events or conditions that collectively with other causes increased the likelihood of the accident, but that individually did not cause the accident. The Events and Causal Factors Table is included as Appendix D of this report.

- The **direct cause** of the October 6, 2009, accident was that the Apprentice Crane Operator's left hand was caught between the wire rope and the crane sheave.
- The **root cause** was that an unsafe method was used to apply lubricant to the wire rope.
- **Contributing causes** were identified as follows:
    - Construction supervision failed to recognize wire rope lubrication as a maintenance activity as described in procedure PP-SH-4382, *Mobile Cranes and Hoisting and Rigging*, which requires a work order per procedure PP-CS-7201, *Construction Work Release Procedure*.
    - A task-specific Job Hazards Analysis was not developed for implementing controls to mitigate hazards associated with the wire rope lubrication activity.
    - The Safe Work Brief failed to ensure that the workers understood the scope of work, associated hazards, and the methods specified in the crane operating manual to perform the work activity in a safe and compliant manner.
    - The roles and responsibilities of the Certified Crane Operator (journeyman) were not maintained for the task of lubricating the wire rope.
    - The Certified Crane Operator (journeyman) failed to recognize the hazards associated with lubricating the wire rope while it was traveling toward the sheave and did not initiate a "time out for safety".
    - A work activity, lubricating the wire rope while the rope was moving toward the sheave, was performed not in accordance with the guidance in the Manitowoc 888 Crane Operators Manual.
    - Corrective actions taken as a result of previous facility events to improve the rigor of ISMS functions related to job scope definition, hazard analysis and hazard controls were not sufficient to prevent this accident.

4.0 CONCLUSIONS AND JUDGMENTS OF NEED

Judgments of Need are managerial controls and safety measures believed necessary to prevent or minimize the probability of a recurrence. They flow from the conditions and are designed to guide managers in developing effective corrective actions. The Board's Conclusions and Judgments of Need are provided below in Table 4-1. Additional opportunities for improvement are documented in Appendix E.

Table 4-1: Conclusions and Judgments of Need

Conclusions	Judgments of Need
The facility's immediate response actions were appropriate and in accordance with facility procedures (Section 2.3).	N/A
The emergency response was timely and well-coordinated (Section 2.3).	N/A
The initial accident investigation readiness response was adequate (Section 2.4).	N/A
The accident scene was not preserved and turned over to the Board in accordance with Parson's procedures. As a result of the inadequate accident scene preservation, the Board was required to make assumptions in examining physical evidence and performing follow-up tests on the wire rope (Section 2.4). Despite a recent event at the SWPF construction site in which the incident scene was not properly preserved, implementation of corrective actions was not effective in ensuring proper preservation of the accident scene for this event (Section 3.6).	Parsons needs to reinforce compliance with their established procedures that address accident scene preservation.
The DOE-SR SWPF Project Office failed to ensure that the accident scene was properly preserved (Section 2.4).	The DOE-SR SWPF Project Office needs to ensure both Parsons and DOE-SR compliance with accident scene preservation requirements.
The commitment to comply with ISMS and regulatory requirements was adequately captured in contract documents and company-level procedures (Section 3.1).	N/A
Construction supervision failed to recognize that wire rope lubrication was a maintenance activity requiring a work order and a defined scope of work (Section 3.2). A job-specific hazards analysis was not developed for the wire rope lubrication activity (Section 3.3). Construction site supervision failed to ensure the development and implementation of adequate controls to protect workers during the lubrication of the crane boom wire rope (Section 3.4).	Parsons needs to ensure maintenance activities are identified and properly incorporated into the work control process. Parsons needs to ensure that ISMS is effectively implemented for construction site work activities such that work scope is defined in sufficient detail, associated hazards are analyzed, and appropriate controls are implemented.

Conclusions	Judgments of Need
The Safe Work Brief failed to ensure that the workers understood the scope of work, associated hazards, and their ability to conduct the work activity in a safe and compliant manner (Section 3.5).	Parsons needs to ensure that Safe Work Briefs are conducted such that employees understand work scope and associated hazards, and are ready to conduct work activities in a safe and compliant manner.
Parsons safety personnel were not aware that maintenance activities were being performed by Parsons personnel at the SWPF construction site (Section 3.2).	Parsons needs to ensure that safety personnel are involved in the planning and execution of construction site work activities.
The work activity was not performed in accordance with the guidance provided in the Manitowoc 888 Crane Operators Manual (Section 3.5).	Parsons needs to define and communicate approved method(s) for conducting crane wire rope lubrication.
An opportunity was missed to call a "Time Out for Safety" before proceeding to lubricate the wire rope while the boom was being raised, which is not in accordance with the guidance in the Manitowoc 888 Crane Operators Manual (Section 3.5).	Parsons needs to reinforce the use of "Time Out for Safety," particularly when work scope or conditions change, or when unanalyzed or unmitigated hazards are identified.
The roles and responsibilities of the Certified Crane Operator (journeyman) were not maintained for the task of lubricating the crane's boom wire rope (Section 3.5).	Parsons needs to reinforce the roles and responsibilities of journeymen in relation to their apprentices.
Corrective actions taken as a result of previous facility events to improve the rigor of ISMS functions related to job scope definition, hazard analysis and hazard controls were not sufficient to prevent this accident (Section 3.6).	Parsons needs to improve the rigor of their methods to ensure the effectiveness of corrective actions.
DOE-SR SWPF Construction Representatives were conducting assessments of the contractor's activities that provided the contractor with meaningful feedback through the monthly contractor feedback process (Section 3.6).	N/A
Parsons has implemented an active and credible self-assessment program (Section 3.6).	N/A

5.0 BOARD SIGNATURES

Signature on File	*11/13/2009*
Larry Hinson DOE Accident Investigation Board Chairperson Trained Accident Investigator U.S. Department of Energy Savannah River Operations Office Assistant Manager for Waste Disposition Project	Date
Signature on File	*11/13/2009*
Mark A. Smith Trained Accident Investigator/Analyst U.S. Department of Energy Savannah River Operations Office Office of Safety and Quality Assurance	Date
Signature on File	*11/13/2009*
D. Scott Nicholson U.S. Department of Energy Savannah River Operations Office Assistant Manager for Waste Disposition Project	Date
Signature on File	*11/13/2009*
Robert D. Yates U.S. Department of Energy Savannah River Operations Office Assistant Manager for Nuclear Material Stabilization Project	Date
Signature on File	*11/13/2009*
Scottie Fryar U.S. Department of Energy Savannah River Operations Office Assistant Manager for Closure Project	Date

6.0 BOARD MEMBERS, ADVISORS, AND STAFF

Board Chair	Larry Hinson U.S. Department of Energy Savannah River Operations Office Assistant Manager for Waste Disposition Project Facility Representative
Member (Investigator/Analyst)	Mark A. Smith U.S. Department of Energy Savannah River Operations Office Office of Safety and Quality Assurance Nuclear Safety Program Manager
Member (Investigator)	D. Scott Nicholson U.S. Department of Energy Savannah River Operations Office Assistant Manager for Waste Disposition Project Facility Representative
Member (Investigator)	Robert D. Yates U.S. Department of Energy Savannah River Operations Office Assistant Manager for Nuclear Material Stabilization Project Facility Representative
Member (Investigator)	Scottie Fryar U.S. Department of Energy Savannah River Operations Office Assistant Manager for Closure Project Facility Representative
Legal Advisor	Lucy Knowles U.S. Department of Energy Savannah River Operations Office Office of Chief Counsel
Advisor	Robert M. Cutshall Savannah River Nuclear Services, LLC Hoisting and Rigging Subject Matter Expert
Review Coordinator	Rylinda Felton U.S. Department of Energy Savannah River Operations Office Assistant Manager for Closure Project
Technical Editor	Lauren Wabbersen National Nuclear Security Administration NA-262 Site Engineering & Project Integration Division

Board Appointment Memorandum

10/16/2009 12:09 FAX 002/002

DOE F 1325.8

United States Government — Department of Energy (DOE)

Savannah River Operations Office (SR)

memorandum

DATE: OCT 15 2009

REPLY TO ATTN OF: MGR (Thomas, 803-952-8187)

SUBJECT: Type B Investigation of Hand Injury at the Salt Waste Processing Facility on October 6, 2009

TO: Larry Hinson, Assistant Manager for Waste Disposition Project Facility Representative

You are hereby appointed Chairperson of the Type B Accident Investigation Board I have convened to investigate the subject incident. The investigation and report shall conform to requirements detailed in the Department of Energy (DOE) Order 225.1A, *Accident Investigations* and DOE G 225.1A-1, *Implementation Guide for Use with DOE O225.1A, Accident Investigations*. The Board will be comprised of the following members:

- Mark A. Smith, DOE-SR – Investigator/Analyst
- Scott Nicholson, DOE-SR – Investigator
- Dennis Yates, DOE-SR – Investigator
- Scottie Fryar, DOE-SR - Investigator

The scope of the Board's investigation is to include, but not limited to, identifying all relevant facts; analyzing the facts to determine the direct, contributing, and root cause of the incident; developing conclusions; and determining judgments of need that, when implemented, should prevent the recurrence of the incident. The Board will focus on and specifically address the role of DOE and contractor organizations and Integrated Safety Management Systems, as they may have contributed to the overall accident. The scope will also include an analysis of the application of lessons learned from similar accidents within DOE. If additional resources are required to assist you in completing this task, please let me know and it will be provided.

The Board will provide my office with weekly reports on the status of the investigation but will not include any findings or arrive at any premature conclusions until an analysis of all the causal factors has been completed. Draft copies of the factual portion of the investigation report will be submitted to my office and to Parsons for factual accuracy review prior to the report finalization.

The final investigation report should be provided to me by November 13, 2009. Any delay in the date shall be justified and forwarded to this office. Discussions of the investigation and copies of the draft report will be controlled until I authorize release of the final report.

Jeffrey M. Allison
Manager

MGR:MJT:dmy

MGR-10-005

cc:
Robert Goldsmith, EM-62, HQ
Steven L. Krahn, EM-60 (acting), HQ
Ines Triay, EM-1, HQ
Dae Chung, EM-2, HQ
C. Lewis, HS-31, HQ
G. Podonsky, HS-1, HQ

Barrier Analysis

Hazard: Sheave/Wire Rope **Target: Apprentice Crane Operator's Hand**

What Were the Barriers?	How Did Each Barrier Perform?	Why Did the Barrier Fail?	How Did the Barrier Affect the Accident?
Work Planning and Control	Work order not developed for crane maintenance.	Wire rope lubrication not recognized as preventive maintenance therefore work order not developed.	Missed opportunity for task-specific hazard analysis and development/ implementation of controls.
Job Hazard Analysis (JHA)	Task-specific JHA not developed for lubricating the wire rope.	Wire rope lubrication not recognized as preventive maintenance therefore work order not developed with associated JHA. JHAs associated with work packages cited by personnel did not address the wire rope lubrication activity.	Allowed work to occur without analysis of hazards and development/implementation of mitigating controls.
Safe Work Brief	Personnel did not discuss full scope of lubricating the wire rope. Checklist card not used.	Personnel did not recognize and/or discuss hazards associated with the manual lubrication method chosen. Foreman did not have a Safe Work Brief Checklist Card.	Missed opportunity for hazard identification and control.
Certified Crane Operator (Foreman)	Did not ensure Safe Work Brief was conducted in accordance with the Safe Work Brief procedure.	Work order/JHA not developed for task. Did not ensure Safe Work Brief discussed full work scope and associated hazards.	Missed opportunity for task-specific hazard analysis and development/ implementation of controls.
Certified Crane Operator (Journeyman)	Agreed to contact method of lubricating wire rope used by Apprentice. Agreed to Apprentice lubricating while booming up.	Certified Crane Operator did not exercise supervisory role/responsibility to ensure work conducted on the crane was safe.	Allowed Apprentice's hand to come into contact with sheave/wire rope.
Safety Representative Oversight	Safety Representative not present at Safe Work Brief or at job site during lubricating activity.	Safety Representative not informed that maintenance was occurring on the crane.	Missed opportunity to identify an unsafe work practice.
Line Management	Line Management did not ensure a work order/JHA was developed for the lubrication activity (preventive maintenance).	Line Management did not recognize the activity as preventive maintenance, which requires a work order.	Missed opportunity to define the scope of work, identify hazards and develop/implement controls.

What Were the Barriers?	How Did Each Barrier Perform?	Why Did the Barrier Fail?	How Did the Barrier Affect the Accident?
Manitowoc 888 Crane Operators Manual	Manual properly identified that lubrication should be done while wire rope is moving away from sheave.	Certified Crane Operator and Apprentice deviated from guidance in the Manitowoc 888Crane Operators Manual.	Allowed Apprentice's hand to come into contact with sheave/wire rope.
Moving Equipment Guard	Not in place.	Need not identified.	Allowed Apprentice's hand to come into contact with sheave/wire rope.
Apprentice Crane Operator	Performed lubrication not in accordance with Manitowoc 888 Crane Operators Manual	Inadequately supervised.	Allowed Apprentice's hand to come into contact with sheave/wire rope.
Use of a no-contact method of applying oil to the wire rope (e.g., spray, brush, roll-on)	Not used.	Apprentice Crane Operator used a contact method to lubricate the wire rope.	Allowed Apprentice's hand to come into contact with sheave/wire rope.
Time Out	Not used.	Need for time out not recognized by Certified Crane Operator when Apprentice wanted to use a method not in accordance with the Manitowoc 888 Crane Operators Manual.	Missed opportunity to prevent the unsafe work practice.
Lessons Learned from Previous Events	Corrective actions from previous events were not effective in identifying job scope and analysis of hazards.	Corrective actions from previous events did not identify maintenance activities being performed at SWPF.	Missed opportunity to identify scope of work, hazards and hazard controls.

Change Analysis

Accident Situation	Prior/Ideal Condition	Difference	Evaluation of Effect
No work order developed to lubricate wire rope.	Work order was developed to lubricate wire rope (required for preventive/ corrective maintenance).	Work order not developed	Specific scope, hazards and controls applicable to the task were not identified.
Task-specific Job Hazard Analysis (JHA) not developed	Task specific JHA was developed/used.	No task specific JHA developed/used	Specific scope, hazards and controls applicable to the task were not identified.
Safe work brief discussed lubricating the cable but did not fully discuss the method to be used to accomplish the task.	Safe Work Brief fully discussed the work task, hazards and mitigation controls. Brief included reminder to call timeout if scope/conditions change.	There was an incomplete discussion of hazards and controls necessary to perform work safely.	Specific scope, hazards and controls applicable to the task were not identified.
Safe Work Brief Checklist not used as required by procedure.	Safe Work Brief Checklist used.	Safety discussion was not complete.	Questioning attitude could have potentially identified hazards and necessary controls to perform work safely.
Worker exposed to moving machinery.	Parts were stationary, moving machinery was inaccessible (barricade, guard, warning signs).	Apprentice Crane Operator was able to contact moving machinery.	Apprentice Crane Operator hand injury occurred.
Wire lubrication method used was not in accordance with the Manitowoc 888 Crane Operators Manual	Wire rope was lubricated in accordance with the Manitowoc 888 Crane Operators Manual.	An unsafe method was used to lubricate the cable.	Apprentice Crane Operator hand injury occurred.
Certified Crane Operator (CCO) responsible for the crane agreed to boom up following instructions from the Apprentice Crane Operator.	CCO would not boom up while Apprentice was lubricating the wire rope.	CCO booming up was not in compliance with the Manitowoc 888 Crane Operators Manual.	Apprentice Crane Operator hand injury occurred.
CCO Foreman allowed work to proceed per Apprentice Crane Operator's recommendation.	CCO Foreman ensured the entire scope of work was discussed, hazards were analyzed, and mitigation controls were identified.	The CCO Foreman's Safe Work Brief did not address what to do when there are changes in the scope of work. Supervision did not ensure that the method being recommended for the work was appropriate.	Specific scope, hazards and controls applicable to the task were not identified. An opportunity for a "Time Out for Safety" was missed. An unsafe method of conducting work was allowed to proceed.

Accident Situation	Prior/Ideal Condition	Difference	Evaluation of Effect
Safety personnel were unaware of maintenance activities being performed.	Safety personnel were aware of maintenance activities being performed and challenged any maintenance activity without a work order or JHA.	Safety representative not at Safe Work Brief.	Missed opportunity to identify an unsafe work activity.
Construction Supervision not directly involved.	Construction Supervision was aware of the scope of maintenance activities and ensured that hazard controls were adequate.	Construction Supervision was less than adequate.	Missed opportunity to identify an unsafe work activity.
No standard method used for lubricating wire rope.	Standard method(s) for lubricating wire rope were identified and personnel were trained on those method(s).	Manitowoc 888 Crane Operators Manual recommended methods to lubricate wire rope were not used.	Apprentice Crane Operator hand injury occurred. Work was performed not in accordance with the Manitowoc 888 Crane Operators Manual or best industry practices.
Feedback and Lessons Learned (extent of condition review) from previous events did not identify issues with ISMS in other work activities.	Corrective actions from previous events corrected ISMS issues with properly identifying work scope, need for JHAs, identification of controls, and safe performance of work.	Corrective actions were not effective.	ISM was not applied to this work activity (work scope not identified, hazards not identified, hazard mitigation controls not developed/ implemented).

Events and Causal Factors Chart

Date/Time	Event	Comments/Conditions	Causal Factors (Key below)
10/06/2009 Morning	Maxim Technician informed SWPF personnel that the Manitowoc 888 crane wire rope needed lubrication.		

1600 hours	"Form 256" work release meeting held to approve construction work activities for the shift.	• "Form 256" did not identify lubrication of the crane wire rope as a planned work activity.
		  • Lubrication task required a work order for performing preventative maintenance.
		  • Lubrication was not considered maintenance by the general superintendent.
			CC1
			CC2
			CC7

1630 hours	"Form 256" work activities were approved.		
1730-1745 hours	"Tool Box" safety meeting held in tent with all construction craft/ "stretch and flex" exercise performed.	• Craft had no questions • Topics were Material Safety Data Sheets and hazard communication.	
1745 hours	Construction craft proceeds to respective work places to start Safe Work Briefs. Crane crew stayed in tent for their Safe Work Brief.	Crane crew consisted of the Crane Foreman (a Certified Crane Operator), Certified Crane Operator responsible for the crane involved in the event, a Fork Lift Operator, and two Apprentice Crane Operators.	
	Safe Work Brief was performed for crane operations to discuss lubrication of the crane wire rope.	• Two Certified Crane Operators (Foreman and Operator responsible for the crane involved in the event) were present at the Safe Work Brief (SWB) • Questions from SWB Checklist Card were not asked to work crew • No work order or Job Hazard Analysis was discussed • Crew discussed pinch points and maintaining 3-point contact while on crane • Neither Certified Crane Operator had performed this task at SWPF • Apprentice Crane Operator explained the lubrication method was to use a rag on the wire rope while applying lubricant • Crew discussed keeping hands away from sheave • Apprentice stated that a man-lift would be used to lubricate the cable (continued next page)	CC2 CC3 CC4

Date/Time	Event	Comments/Conditions	Causal Factors (Key below)
		• Crane Foreman told Apprentice to notify him when man-lift is needed and the other apprentice would assist • Work activity was considered routine • Safety Representative not present	
	Certified Crane Operator left to go to Manitowoc 888 crane to check the crane while discussions between the Foreman and Apprentice continued about man-lift operations.		CC3
1755 hours	Crane Foreman and second apprentice proceed to another crane for other work.		
1830 hours	Apprentice Crane Operator arrives at Manitowoc 888 crane to perform wire rope lubrication after obtaining supplies needed to perform task.	• Apprentice and Certified Crane Operator decide not to use the man-lift • Crane Foreman not contacted about decision not to use man-lift.	
	Crane boom has been raised to its highest position in order to boom down while applying the lubricant.		
	Certified Crane Operator and Apprentice discuss the wire rope and sheave pinch point prior to starting work.		
	Apprentice is on crane wearing gloves and pours lubricant onto rag.		
	Apprentice gives Certified Crane Operator hand signal to boom the crane down.	Apprentice is in vicinity of the sheave.	CC2
	Certified Crane Operator slowly lowers the boom.	• When booming down the cable is moving away from the sheave pinch point. • This method of lubrication is an approved method in the Manitowoc 888 Crane Operators Manual; is a safe method of lubrication. • Lubrication took approximately 10 minutes.	CC2
1845 hours	Crane is in the down position.		
	Certified Crane Operator exits the crane cab and goes to Apprentice's location to discuss the lubrication activity.	• Apprentice is unsure if the cable has been lubricated satisfactorily. • Apprentice discusses lubricating the cable as the crane is boomed up with Certified Crane Operator. • Lubricating the cable in the boom up method is not an approved method in the Manitowoc 888 Crane Operators Manual • Opportunity for a "Time Out for Safety" was missed.	CC4 CC5

Date/Time	Event	Comments/Conditions	Causal Factors (Key below)
	Certified Crane Operator returns to crane cab and awaits hand signal from Apprentice to boom the crane up.		
1850 hours	Certified Crane Operator receives hand signal from apprentice to begin booming up the crane. Apprentice's left hand comes into contact with the sheave/wire rope.	• Apprentice's left hand is in the vicinity of the sheave/wire rope. • Unsafe method of wire rope lubrication is used, not identified as an approved method in the Manitowoc 888 Crane Operators Manual. • Crane wire rope is moving towards the sheave. • Apprentice yells to crane operator to boom down several times.	RC DC CC6
	Certified Crane Operator booms down crane, locks crane and goes to Apprentice's location. Crane Operator assists Apprentice off the crane and removes rag from the Apprentice's left hand. Crane Operator calls the Shift Safety Representative.	• Apprentice states to Crane Operator that his hand was caught between the wire rope and the sheave.	
	Certified Crane Operator and Apprentice proceed to the safety trailer.	Apprentice walks under his own power.	
1853 hours	Shift Safety Representative arrives at the safety trailer.	• No blood is evident at this time • Shift Safety Representative concludes the Apprentice's left hand has received a serious injury.	
	Shift Safety Representative calls SRSOC and calls second shift General Superintendent to come to the safety trailer.		
1902 hours	SRNS Emergency Medical Services arrives at safety trailer.		
1905 hours	Emergency Medical Services in route to Medical College of Georgia (MCG) in Augusta Georgia		
1937 hours	Emergency Medical Services arrives at MCG.	• Approximately 35 minute trip from SRS J Area to MCG.	

Causal Factors Key:

DC = **Direct cause** = The Apprentice Crane Operator's left hand was caught between the wire rope and the crane sheave.

RC = **Root cause** = An unsafe method was used to apply lubricant to the wire rope.

CC = **Contributing Causes**:

CC-1: Construction supervision failed to recognize wire rope lubrication as a maintenance activity as described in procedure PP-SH-4382, *Mobile Cranes and Hoisting and Rigging*, which requires a work order per procedure PP-CS-7201, *Construction Work Release Procedure*.

CC-2: A task-specific Job Hazards Analysis was not developed for implementing controls to mitigate hazards associated with the wire rope lubrication activity.

CC-3: The Safe Work Brief failed to ensure that the workers understood the scope of work, associated hazards, and the methods specified in the crane operating manual to perform the work activity in a safe and compliant manner.

CC-4: The roles and responsibilities of the Certified Crane Operator (journeyman) were not maintained for the task of lubricating the wire rope.

CC-5: The Certified Crane Operator (journeyman) failed to recognize the hazards associated with lubricating the wire rope while it was traveling toward the sheave and did not initiate a “time out for safety”.

CC-6: A work activity, lubricating the wire rope while the rope was moving toward the sheave, was performed not in accordance with the guidance in the Manitowoc 888 Crane Operators Manual.

CC-7: Corrective actions taken as a result of previous facility events to improve the rigor of ISMS functions related to job scope definition, hazard analysis and hazard controls were not sufficient to prevent this accident.

Opportunities for Improvement

- An opportunity exists for Parsons to improve the "Skill of the Craft" Job Hazards Analysis by ensuring that it contains an accurate and valid description of "work activities" versus work hazards.
- An opportunity exists for Parsons to review the Operating Experience and Lessons Learned Report from January 2004, *Department of Energy Hoisting and Rigging Events,* for applicability to the SWPF crane maintenance program.
- An opportunity exists for DOE to improve completion of Management Walkthroughs in accordance with the DOE-SR SWPF Annual Assessment Plan.

Salt Waste Processing Facility Project Integrated Safety Management System Policy

PS-01
Revision 0

SALT WASTE PROCESSING FACILITY PROJECT

INTEGRATED SAFETY MANAGEMENT SYSTEM POLICY

Parsons is committed to protecting workers, the public, and the environment by designing, constructing, and operating the Salt Waste Processing Facility (SWPF) to the highest levels of Environmental, Safety, Health, and Quality (ESH&Q) performance. It is Parsons' policy to systematically integrate ESH&Q into management and work practices at all Project levels (site, facility, and task), and to maintain a Safety Conscious Work Environment (SCWE) whereby SWPF Project personnel are encouraged to bring up issues, concerns, ideas, and suggestions and exercise Stop Work Authority without fear of reprisal or management apathy.

All Project personnel must embrace the Integrated Safety Management System (ISMS) as a priority and assume personal responsibility and accountability for its implementation. All Project personnel must focus on an aggressive and sustained effort to achieve zero accidents, work related injuries and illnesses, regulatory enforcement actions, and reportable environmental releases.

A successful and robust ISMS centered safety culture is contingent on all Project personnel ascribing to the effective implementation of the following safety management core functions, guiding principles, and safety culture elements.

CORE FUNCTIONS

1. Define the Scope of Work: Missions are translated into work, expectations are established for satisfactorily accomplishing the work, tasks are identified and prioritized, and resources are allocated.
2. Analyze the Hazards: Hazards associated with the work are identified, analyzed, and categorized. This includes "latent" hazards identified during facility design and site-, facility-, and activity-level hazards associated with the work being accomplished during construction, commissioning, and operations.
3. Develop and Implement Hazard Controls: Applicable standards and requirements are identified and agreed upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.
4. Perform Work within Controls: Readiness is confirmed and work is performed safely.
5. Provide Feedback and Continuous Improvement: Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and all Project personnel actively participate.

GUIDING PRINCIPLES

1. Line Management Responsibility for Safety: Line Management and supervisors shall be directly responsible for protection of the public, workers, and the environment, and shall be held accountable by Parson Senior Management.
2. Clear Roles and Responsibilities for Safety Management: Clear and unambiguous lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels.
3. Competence Commensurate with Responsibilities: All Project personnel shall possess the experience, knowledge, skills, and abilities necessary to discharge their responsibilities.
4. Balanced Priorities: Resources shall be effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, workers, and the environment shall be a priority whenever activities are planned and performed.
5. Identification of Safety Standards and Requirements: Before work is performed the associated hazards shall be evaluated and an agreed-upon set of safety standards and requirements shall be established that, if properly implemented, provide adequate assurance that workers, the public and the environment are protected from adverse consequences.
6. Hazard Controls Tailored to Work Being Performed: Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.
7. Operations Authorization: The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed upon.
8. Worker Involvement: Workers shall be directly involved in the preparation and review of planning documentation and job hazard analyses, and planners shall incorporate input from workers on proposed work methods and hazard controls.

SAFETY CULTURE ELEMENTS

1. Individual Attitude and Responsibility for Safety: All Project personnel must accept responsibility for safe mission performance and demonstrate a questioning attitude by challenging assumptions, investigating anomalies, and considering potential adverse consequences of planned actions. All Project personnel must be mindful of work conditions that may impact safety, and assist each other in preventing unsafe acts or behaviors.
2. Operational Excellence: All Project Organizations must strive for sustained high levels of operational performance through a focus on operations, conservative decision making, deference to expertise, and systematic approaches to eliminate or mitigate error-likely situations.
3. Oversight for Performance Assurance: The Project must use competent, robust, periodic and independent oversight as an essential source of feedback to verify whether standards and requirements are being met and to bring fresh insights and observations when considering safety and performance improvements.
4. Organizational Learning for Performance Improvement: The Project must strive for excellence in performance monitoring, self assessment, problem analysis, solution planning, and solution implementation. The Project must cultivate an environment of openness, trust, and continuous learning.

The mechanisms, responsibilities, and implementation for these Functions, Principles, and Safety Culture Elements shall be established for all work and shall be tailored based on the nature and hazard of the work.

Compliance with this ISMS Policy is fundamental to SWPF's Workplace Priorities of Safety, Quality, Schedule and Cost, and its effective implementation is expected by all Project personnel at all levels.

Mark R. Breor — Date
SWPF Project Manager

Manitowoc 888 Crane Operators Manual Wire Rope Guide Lubrication Instructions

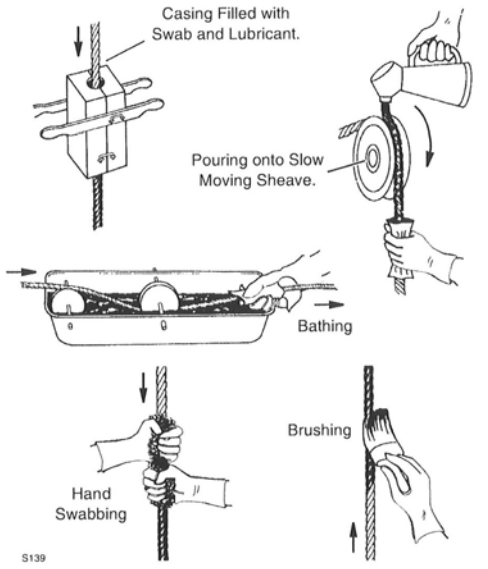
WIRE ROPE LUBRICATION

Wire rope is a complicated piece of machinery, and its lubrication is just as important as it is for the gears and chains in the drive train.

New wire rope is lubricated during manufacturing, but this lubricant is only adequate for initial storage and the early stages of operation. To prevent the damaging effects of corrosion and to reduce wear, the wire rope must be lubricated at regular intervals.

Contact your wire rope manufacturer/dealer for lubrication recommendations. The lubrication interval and the type of lubricant used depends on the type of wire rope, the severity of duty, and the type of corrosive elements the wire ropes is subjected to.

The wire rope must be properly protected at all times. The lubricant must be fluid enough to fully penetrate the strands and rope core. Use one of the methods shown in Figure 10 to lubricate the wire rope. For maximum penetration, apply lubricant where the wire rope "opens up" as it travels around a sheave or winds onto a drum.



WARNING

Moving Rope Hazard!

Take every precaution to protect hands from injury when rope is moving. Wear heavy gloves and move rope as slowly as possible.

FIGURE 10

The wire rope must be clean and dry before applying lubricant; an air jet, or wire brush are some cleaning methods.

Do not use grease to lubricate wire rope. Grease will not penetrate rope properly and will buildup in valleys between wires and strands. This buildup will inhibit rope inspection and could trap moisture in rope's interior.

WIRE ROPE INSPECTION AND REPLACEMENT

General

The inspection and replacement guidelines which follow comply with United States regulations.

It is impossible to predict when a wire rope will fail; however, frequent and periodic careful inspection by a qualified inspector will indicate when the potential for failure exists.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this folio. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Inspecting Wire Rope

Frequent Inspection

Visually inspect all running ropes in service once each work shift and observe the rope during operation. Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-Up Points — sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
- End attachments — the point where a fitting is attached to the wire rope or the point where the wire rope is attached to the drum.
- Abuse points — the point where the wire rope is subjected to abnormal scuffing and scraping.

Inspect all rope which can be reasonably expected to be in use during operation for obvious damage which poses an immediate hazard, such as the following:

1. Rope distortion such as kinking, crushing, unstranding, bird caging, main strand displacement, and core protrusion.

   Loss of rope diameter and unevenness of the outer strands indicate that the rope should be replaced.

2. Corrosion (clean and lubricate).

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SWPF Construction Site Area Map