Arms of log processor crush worker during maintenance

A supervisor in a cable logging firm was troubleshooting an electrical problem with the dangle-head of a log processor. The log processor was not shut off or safely de-energized during the troubleshooting process. When the supervisor grabbed some electrical wires, the delimb arms closed on him, causing serious injuries. Air evacuation was not possible because of the approaching darkness and the weather conditions. The supervisor died before he reached the hospital.

Purpose of this report
The purpose of this online incident investigation report is to identify the causes and contributing factors of this incident to help prevent similar incidents and to support preventive actions by industry and WorkSafeBC. This online version is not the official WorkSafeBC report. It has been edited to remove personal identifying information and to focus on the main causes and underlying factors contributing to this incident.

Notice of Incident information
Number: 2006136900511
Outcome: Fatal
Core activity: Cable logging
Region: Northern B.C.
Date of incident: November 2006

Table of Contents

1 Factual Information

1.1 The firms involved

1.1.1 DWD Logging

DWD Logging Ltd. is a logging company that specializes in cable logging methods. The worker who died in the incident was a supervisor who looked after the yarding crew and normally ran the yarder.

The supervisor had extensive experience with cable logging systems in several locations throughout the province. He was heavily involved in performing maintenance work on various types of logging equipment during his career and was considered by his peers to be an excellent mechanic.

1.1.2 Canadian Forest Products

Canadian Forest Products Ltd. (also known as Canfor) is a major licensee licensed by the Ministry of Forests and Range to conduct forestry operations in the Munroe Creek area. Canfor hires several logging contractors (including DWD Logging) to log on Canfor's behalf. The contractors are typically hired on a stump-to-bunk basis, which means the contractor is responsible for falling, yarding, processing, and loading the timber onto trucks. The contractors are also identified as prime contractors within their various cutblocks.

1.2 The worksite

The incident occurred on a cutblock within the operating area of Canfor's Mackenzie Division. The cutblock is located on the west side of Williston Lake in the Munroe Creek area, approximately two hours' travel time by logging road from Mackenzie. Because the area is remote, Canfor provides a camp to accommodate logging crews working in the area.

On the day of the incident, DWD Logging had a small yarding crew and a processor operator (four crew members in total) on-site. The yarding crew was wrapping up the yarding phase and preparing to move the yarder to a new cutblock. The processor operator was assigned to complete the processing phase prior to the arrival of the loading crew.

1.3 The log processing machine

The log processing machine involved in this incident (see Figure 1) was mounted on an excavator-type carrier. The processing head on the machine was a type known as a "dangle head" because it hangs suspended in a horizontal position (or dangles) at the end of an excavator boom and can be rotated 360 degrees in both clockwise and counterclockwise directions.

The machine processes a log by picking it up with the processing head and then using the head to buck out defects, delimb the log, and then measure and buck the log into predetermined lengths. The final step is to place the log in a deck perpendicular to the shoulder of the road in preparation for loading onto a truck.

Figure 1: Taken the day after the incident, this photograph indicates the placement of the head at the time of the incident. However, at the time of the incident, the delimb arms (which the arrow points to) were open. Note that the delimb arms face away from the operator's position.

1.4 Sequence of events

1.4.1 Electrical problems with the log processor

On the day of the incident, the processor operator processed logs until the log processing machine broke down at approximately 11:00. Electrical problems at a major junction box on the boom had caused the processing head to become dysfunctional. The processor operator and one of the hooktenders worked on the electrical problems until around 14:00, when they thought they had everything corrected. The processor operator then attempted to put the processor back into operation. However, although the head itself seemed to be working, the measuring function would not measure logs or recognize the pre-set lengths programmed into the processing computer. The processor operator radioed the supervisor, who offered a few suggestions, including checking the fuses in the engine compartment.

The processor operator did so and found a blown fuse that he suspected had been causing the problem. After installing a new fuse, the processor operator called the supervisor to report that the problem was still not corrected. The supervisor said he was walking the yarder down the hill and would stop and look for himself when he passed by in 15 to 20 minutes.

The supervisor stopped the yarder near the processor at around 15:15. Another hooktender was following in the supervisor's pickup truck. He parked behind the yarder and waited in case the supervisor needed assistance.

When the supervisor approached the processor, the processing head was resting on the ground in a horizontal position. The supervisor instructed the processor operator to start the machine and stand the head up in a vertical position (as shown in Figure 1). This would provide a better view and access to the measuring wheel, positioned within the processing head on the inboard side of the delimb arms (see Figure 2). Once the head was vertical, the processor operator left the cab and walked to the head to assist the supervisor. The processor operator left the engine running and the pilot control lever in the locked, or safe, position. (The pilot control lever is sometimes referred to as the hydraulic safety lever because it disconnects the hydraulic power.)

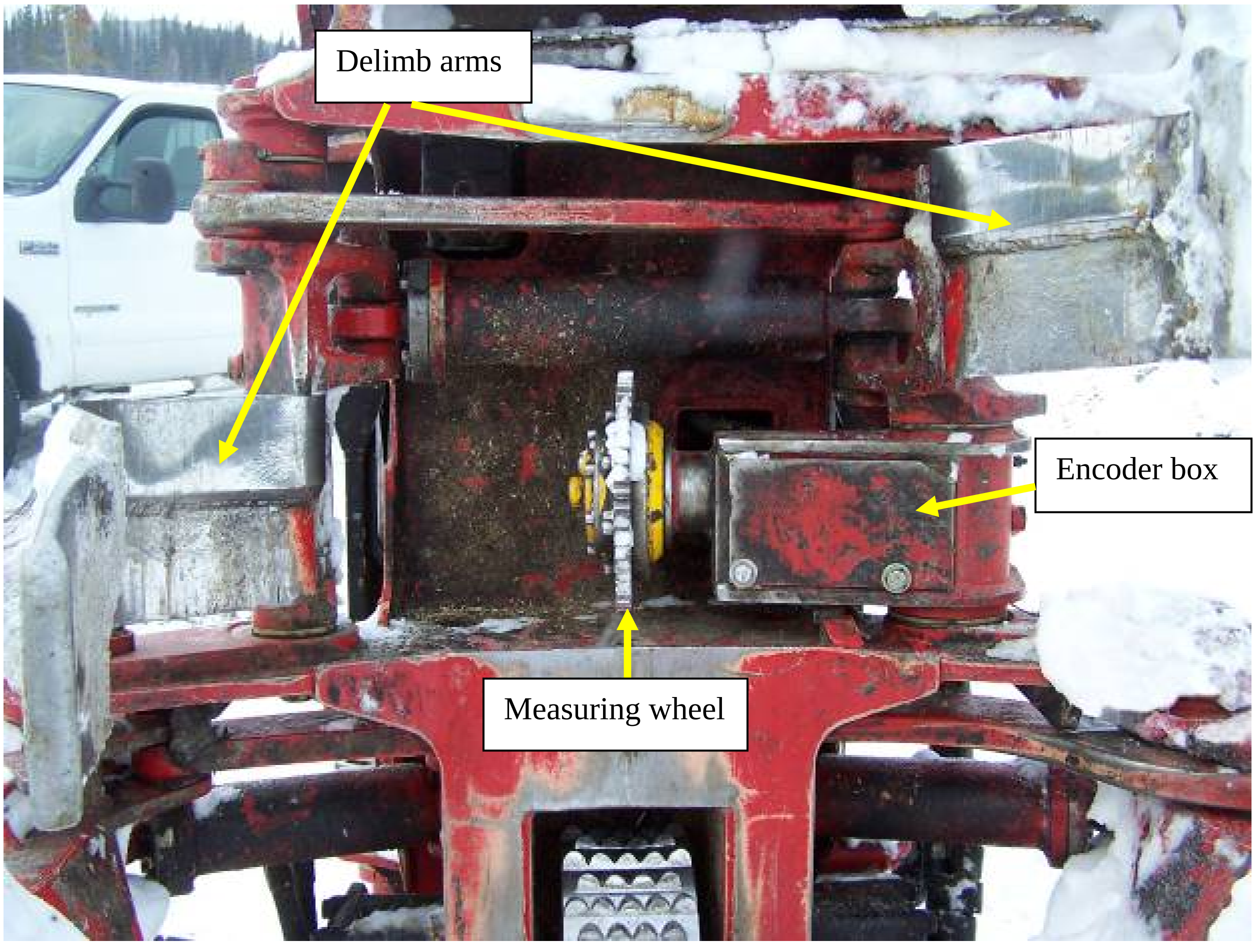

Figure 2: The delimb arms are in the open position. This is not the actual head involved in the incident but an identical one. The photograph shows what the supervisor could have seen before he removed the cover of the encoder box while standing within the grab zone of the arms.

The supervisor used a wrench to remove the steel cover of the box that protects the length-measuring encoder. Looking inside the box, the supervisor and the processor operator observed a bundle of wires from the sending unit that had several soldered connections that were bare and exposed (see Figure 3). The supervisor instructed the processor operator to get back in the cab to see whether any log lengths registered on the computer screen when the supervisor spun the measuring wheel.

Figure 3: Taken at the scene to illustrate the connections the supervisor saw in the encoder box. The delimb arms are obstructing the photograph because they were not functioning and could not be opened. Note that some of the wires have poor connections made with electrical tape, and some connections are completely exposed.

As the processor operator got into the cab, he verified that the pilot control lever was in the safe position. Once the processor operator was in the cab, the supervisor stepped into the grab zone of the delimb arms and started turning the measuring wheel. The head was oriented so that the grab zone faced directly away from the cab; therefore, the supervisor had to lean around the head to be seen or heard by the processor operator. The processor operator could not see anything on the computer monitor.

The supervisor then pulled himself up onto the track of the carrier and looked into the cab at the monitor, confirming that nothing was being displayed. He then noticed that the pilot control lever was in the safe position and told the processor operator, “Oh, let’s try this,” while lowering the lever into the operating position. The supervisor then walked back to the front of the head.

1.4.2 The incident

Because of the orientation of the processing head, the processor operator could not see the supervisor when the latter stepped in front of the head. However, the two hooktenders saw him step into the grab zone of the delimb arms, reach toward the measuring wheel, and grab something (later determined to be the exposed wire connections in the encoder box). The delimb arms immediately closed around the supervisor’s upper body and one arm. This occurred at approximately 15:30.

The two hooktenders started pulling on the delimb arms to free the supervisor. When they realized they could not budge the arms, they yelled at the processor operator—who was unaware of what had happened because of his obstructed view—to open the arms. The processor operator immediately did so and the supervisor fell to the ground.

Within a few minutes, the supervisor had recovered enough to talk; however, he was seriously injured and needed to get to hospital as soon as possible.

1.4.3 Emergency evacuation

Because of the small size of the crew, neither an emergency transportation vehicle (ETV) nor oxygen therapy equipment was available on-site. The evacuation procedures established by Canfor for this operating area required contractors to call the camp if they need assistance. The camp manager would coordinate an evacuation if a helicopter or other means was required to evacuate an injured worker to hospital.

One of the hooktenders used the radio in the supervisor's pickup, but he was unable to reach the camp. An unidentified person on the road channel heard the call and relayed the message to the camp. The hooktender then was given instructions to get on the right channel and to switch to the repeater channel so that he could talk directly to the camp.

Meanwhile, a logging crew working nearby heard the initial call for help and reached the site in 10–15 minutes. They did not have an ETV or oxygen therapy equipment, again because of their size, but one crew member had first aid experience and concluded that the supervisor needed to be evacuated by air as soon as possible.

The camp manager began trying to organize a helicopter. When he asked for the crew's exact location, there was some confusion in determining the site's longitude and latitude or block number. In accordance with the evacuation procedures for this area, this information was to be provided on plasticized maps supplied to the contractors by the licensee. The crew tried to find the information in the supervisor's pickup; however, they found four different maps and could not determine if one was for this location. It was later confirmed that one of the maps did contain the evacuation procedure and the location information, but the supervisor was the only person on-site familiar enough with the maps to have chosen the correct one in an emergency.

While the camp manager was gathering information, it was determined that a helicopter could not be used in the evacuation for the following reasons:

- It was getting dark.
- It was extremely windy.
- It was overcast, with cloud ceilings too low to permit flying directly to the site, which was located in hilly terrain (see Figure 4).

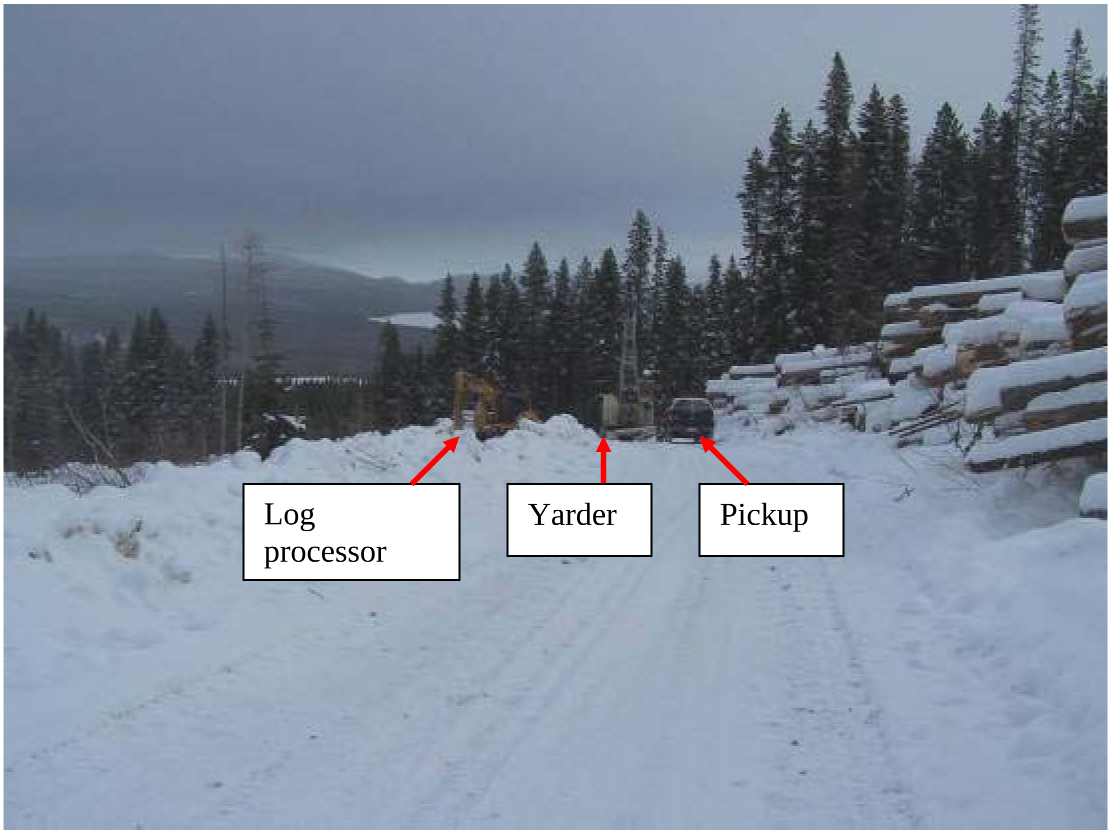

Figure 4: Photograph taken the day after the incident. Note that the cloud ceiling is lower than some of the hill tops. Ceilings the day before were reported as even lower and were a factor in preventing a helicopter evacuation.

An Emergency Health Services (EHS) ambulance was then dispatched from Mackenzie. In addition, two ETVs with Level 3 first aid attendants were simultaneously dispatched from the camp and another logging contractor in the area. The first ETV arrived approximately 45 minutes after the incident. The second ETV arrived a few minutes later.

The first aid attendants performed first aid and prepared the supervisor for transport. He was transported in an ETV, with first aid administered until the ETV met the EHS ambulance from Mackenzie. The EHS attendants assumed care of the supervisor, who was transferred to their vehicle and transported to the hospital in Mackenzie. The supervisor was pronounced dead on arrival.

1.5 Operation and maintenance manuals

1.5.1 Carrier

The manufacturer's manual for the carrier was in the carrier at the time of the incident. The manual includes instructions on how to prepare the machine for any maintenance work: the instruction clearly states that the pilot control shut-off lever must be in the locked position and the engine shut off (see Figure 5). The manual also states that the key must be removed.

Figure 5: The cab of the carrier. The pilot control shut-off lever is in the locked position. In this position, the machine will not move if a lever or pedal is inadvertently moved. To operate the machine, the lever is pulled forward, in the direction of the arrow. It was in the forward position at the time of the incident.

1.5.2 Processor head

The manufacturer's safety, operation, and maintenance manual for this series of processor head was in the firm's field office at the camp. This manual included safety precautions for servicing the equipment. These included turning off the carrier engine and removing the key.

The manufacturer has a more detailed and recent manual that includes procedures for testing and replacing the encoder. However, DWD Logging did not have a copy of this more up-to-date manual.

1.6 DWD Logging's safety program

At the time of the incident, DWD Logging had a safety program in place.

1.6.1 Written safety program

A copy of a written safety program was kept in the supervisor's pickup. The program appeared to be a generic one that was provided to the employer and was not updated or tailored to be specific to DWD Logging. For example, there were blanks where the company's name was to be filled in, but this had not been done. Other sections indicated that this was actually the safety program for another forestry company, not DWD Logging.

1.6.2 Safe work procedures

The generic safety program includes a few general procedures. A work procedure for mechanics included the following instructions:

- Read the lockout procedures in the safety program.
- Control devices must be tagged in an inoperative position before commencing maintenance or repair work on any power-driven machinery or equipment.

The section on basic lockout procedures stated:

> **The four steps in a basic lockout procedure should be followed:**
> 1. Identify the equipment to which the lockout is to be applied.
> 2. Ensure the running/operating equipment/machine/process is de-energized/stopped.
> 3. Identify the main isolating devise(s) for the energy source(s) and lock out and tag the equipment.
> 4. Test to ensure that the lockout is effective. (Try to start the equipment to ensure it will not start.)

The safety program included some specific safety breakdowns for jobs such as rigging slinger, hooktender, chokerman, landing man, log loader, and mobile swing yarder, but it did not include job safety breakdowns for supervisor, mechanic, or processor operator.

1.6.3 Safety meetings

The company kept minutes of safety meetings for this crew. The last recorded safety meeting was held a couple of weeks before the incident. As well as the supervisor, three workers attended, none of whom was on-site the day of the incident. The topics covered during the meeting included:

- Start-up in a new block—review harvest plan.
- Review evacuation procedures—coordinates, contact the camp.
- Read and review job safety breakdowns for hooktender, chokerman, and buncher operator.

1.6.4 Investigation into previous incident

DWD Logging experienced a similar incident in 2000. A worker was seriously injured when the delimb arms and feed arms on a processing head closed while he was standing in the grab zone performing maintenance on the measuring wheel. The machine was running at the time and was not locked out or de-energized in accordance with regulatory requirements or the manufacturer's instructions.

1.7 Evacuation procedures

The evacuation procedures for this operating area were developed by Canfor and are included in Canfor's handbook titled *2006 Emergency Preparedness and Response Plan*. Canfor gives each contractor several copies of the plan so that there is one for the supervisor and every piece of equipment.

Before work begins on a new cutblock, Canfor also gives every contractor a harvest plan map. The map includes information that supplements the *Emergency Preparedness and Response Plan*, such as the location of the cutblock (including the longitude and latitude) and the first aid contact for the area.

Again, Canfor provides enough copies to ensure that the supervisor and every piece of equipment have a copy.

The log processor in this incident did not have on-board a copy of the *2006 Emergency Preparedness and Response Plan* or a harvest plan map. Copies were later found in the supervisor's pickup. When interviewed, crew members said they were not aware of the specific emergency evacuation procedure for this location.

2 Analysis

This analysis examines two main issues: (1) the reason the delimb arms closed and (2) the procedural errors that occurred during maintenance on the processing head. From a health and safety perspective, understanding the procedural errors is the key to understanding the root cause of this incident. The analysis also considers the emergency evacuation actions taken after the incident.

2.1 What caused the delimb arms to close?

During the investigation, numerous theories were voiced as to what caused the delimb arms to close on the supervisor. One theory was that the arms closed when the supervisor spun the measuring wheel. Other witnesses stated that the measuring wheel had no influence and suggested a second theory, that the processor operator must have inadvertently closed the arms while sitting at the controls.

Several people familiar with this type of processing head were interviewed in an attempt to answer this question. In the end, the issue was resolved through an inspection by the manufacturer's representative (also a qualified heavy-duty mechanic) and a review of schematic drawings provided by the manufacturer.

The two theories above were both incorrect. Rather, the arms closed because the supervisor grabbed the bundle of exposed wires in the encoder box. When he squeezed the bare connections together, a dead short occurred in the electrical system of the processing head and caused the delimb arms to close. To explain how the dead short caused the arms to close, a brief description of the computer system is necessary.

The processing machine is controlled by a PC-based computer platform called a controller. The controller has two separate modules: the cabin module and the head module. The latter is located in the processing head and controls the head's operation.

The head module supplies electrical power to, among other things, two proximity switches that detect whether the two saws in the head are fully retracted (in the home position) or are extended. This feature is designed to protect the saws from damage that would occur if the head attempted to feed or move a log when the saws were not fully retracted.

When the head module receives a signal from both proximity switches, it concludes that both saws are fully retracted and it is safe to perform functions such as measuring or delimbing a log. If the head module does not receive a signal from both proximity switches, it concludes that one of the saws has left the home position. The head module then closes the delimb arms to secure any logs within the grab zone, which protects the saw before a cut is started.

When the supervisor squeezed the wires in the encoder box, the resulting dead short disrupted the power supply to the proximity switches. The head module did not receive a signal from the switches, concluded that the saws were not fully retracted in the home position, and signalled the delimb arms to close.

2.2 Working on energized equipment

Safety standards in British Columbia require all energy sources that may cause the inadvertent movement of equipment or machinery to be effectively controlled prior to any maintenance work being performed. In this incident, potential energy sources were not controlled. The following unsafe conditions existed while maintenance work was performed on the processing head:

- The carrier engine was left running.
- The pilot control lever was placed in the operating position to engage the hydraulics.
- A person was allowed to sit at the controls of the machine while the machine was energized and maintenance was being performed in a hazardous area. (This was hazardous but was not a contributing factor in this incident.)
- The head was not pinned to prevent it from tipping when it was placed in the vertical position. (This was hazardous but was not a contributing factor in this incident.)

The manufacturer's manuals for the carrier and the processing head both stipulate that the engine must be shut off and the hydraulics deactivated before any maintenance of the type performed at the time of the incident is carried out. If these procedures had been followed, the incident would not have occurred, as the delimb arms could not have closed.

2.3 Safe work procedures

DWD Logging's generic safety program contained a basic lockout procedure, but it was not adhered to on the day of the incident. The safety program did not contain specific lockout procedures for each machine. There is no evidence of written instructions telling workers to adhere to the manufacturer's recommendations for safely securing equipment prior to performing maintenance.

The supervisor was a very experienced logger and mechanic. He was aware of the requirement to lock out or de-energize equipment before performing maintenance. We do not know whether it was some time constraint (or some other reason) that resulted in the supervisor working on the equipment when it was not locked out.

2.4 Emergency evacuation

The investigation analyzed Canfor's evacuation procedures, as well as the response from the DWD Logging crew and other workers who assisted in the rescue, to determine if the evacuation stage was a factor in the outcome of this incident.

The evacuation procedures developed by Canfor were appropriate for this type of operation and were published in the handbook *2006 Emergency Preparedness and Response Plan.* The procedure was well communicated and numerous copies of the handbook were provided to all logging contractors to distribute to their workers. The procedures were supplemented by critical information (longitude and latitude, emergency contact information, radio channels) on logging maps that were made available for every piece of equipment working on the Canfor cutblocks.

However, neither the Canfor handbook nor the supplemental logging map was found in the cab of DWD Logging's log processor. Canfor advised that sufficient copies of both were provided to the supervisor for every machine on the block. It was determined that the supervisor had the information in his pickup but had not distributed it to his crew.

The crew of DWD Logging was very responsive to the incident and made a strong effort to comfort the supervisor and get help as soon as possible. There were some minor delays in contacting the camp and providing the location details because the evacuation procedures provided by Canfor were not readily available to the crew.

No emergency transportation vehicle was available on-site, but one was not required because of the small size of the crew. Therefore, ETVs were dispatched from the camp and another contractor. Both arrived in approximately 45 minutes, and the Level 3 first aid attendants initiated transport to the hospital immediately. However, the incident site was more than two hours' drive from the nearest hospital (in Mackenzie). Travelling by road, an ETV transporting the supervisor could not have reached a hospital in time to save him under any circumstance.

Transportation by helicopter was considered but was not possible for several reasons. By the time a helicopter arrived, it would be too dark to land. As well, high winds and low cloud ceilings made a helicopter approach at night impossible.

In the end, the evacuation procedures and the workers' responses were not factors in the inability to get the supervisor to a hospital in enough time to save him. The critical factors were the remote location of the incident, the time of day, and the weather.

3 Conclusions

3.1 Findings as to causes

3.1.1 Dead short caused delimb arms to close

The supervisor died from injuries sustained when the delimb arms on the log processing head he was working on closed on him. The arms closed as a result of a dead short in the electrical system, which occurred when the supervisor squeezed together the bare connections of wires inside the head's encoder box.

3.1.2 Work performed on energized equipment

The primary cause of this incident was the failure to properly de-energize the equipment being worked on. De-energizing of equipment was required by the company's safe work procedures and by the manufacturer's instructions. If the carrier engine had been shut down and the hydraulics deactivated, the delimb arms could not have closed.

3.2 Findings as to underlying factors

3.2.1 Remote location, time of day, and weather

The supervisor's injuries might have been survivable if he had reached hospital within a short time. However, because the worksite was over two hours' drive from the nearest hospital, it was impossible to transport him in time by road. Air evacuation was not possible because of the approaching darkness and the weather conditions.

4 Health and Safety Action Taken

In addition to the specific actions below, employers, workers, or others in industry may have taken measures to prevent a recurrence of this type of incident. Employers are expected to comply with any orders issued. At WorkSafeBC, the Lessons Learned committee examines recommendations from incident investigations to see what can be done to prevent similar incidents.

4.1 Action taken by Canfor

Canfor's Mackenzie Division met with all its logging contractors and reviewed the details of this incident to ensure that the contractors had the necessary information to prevent a similar incident in the future.

Canfor's Mackenzie Division also implemented a lockout program for mobile equipment that was made mandatory for all of the company's contractors. The program was also adopted by Canfor's Prince George and Plateau Divisions.

The implementation of this program resulted in one Canfor contractor working with a heavy equipment supplier to develop a hydraulic lockout valve system that isolates all of the machine's hydraulics. This system allows operators to keep the engine running during cold weather and darkness, so they can warm the engine and hydraulic fluid and turn on the lights and still perform maintenance safely. The equipment supplier is considering making this system an option on all mobile equipment it sells across Canada.

5 Orders Issued after the Investigation

WorkSafeBC issued three orders after the investigation. An order requires an employer to take steps to comply with the *Workers Compensation Act* or Occupational Health and Safety Regulation, to take measures to protect worker health and safety, or to fix a hazardous condition. An order is not intended to identify fault on the part of the employer but to ensure that unsafe conditions are identified and corrected and that the employer complies with the Act and the Regulation. An employer may ask the Review Division to review an order; the Review Division may confirm, vary, or cancel an order.

In addition to issuing orders, WorkSafeBC may recommend proceeding with an administrative penalty against an employer. Penalties are fines for health and safety violations of the *Workers Compensation Act* and/or the Occupational Health and Safety Regulation. For information on when penalties are considered and how the amount of the penalty is calculated, see the penalty FAQs on WorkSafeBC.com. Companies that have been penalized are also listed on the web site.

5.1 Orders to DWD Logging Ltd.

This section summarizes three orders to the logging contractor:

- The investigation found that this employer was in contravention of the Occupational Health and Safety Regulation, section 10.2, which states that if the unexpected energization or start-up of machinery or equipment or the unexpected release of an energy source could cause injury, the energy source must be isolated and effectively controlled. In this incident, the engine was left running and the hydraulics were live on an excavator that provided the energy to the processing head.

- The investigation found that this employer was in contravention of the Occupational Health and Safety Regulation, section 4.3(2)(a), which states that unless otherwise specified by this Regulation, the installation, inspection, testing, repair, and maintenance of a tool, machine, or piece of equipment must be carried out in accordance with the manufacturer's instructions and any standard the tool, machine, or piece of equipment is required to meet. In this incident, the manufacturer's instructions for the maintenance procedure were not followed.

- The investigation found that this employer was in contravention of the *Workers Compensation Act*, section 115(1)(a)(i), which states that an employer must ensure the health and safety of all workers working for that employer. In this incident, the employer failed to ensure that the safe work procedures for lockout are consistently followed, particularly when performing maintenance work on mobile equipment.