

August 7 1995

FACE AK-94-51

TO: Ted Petit, NIOSH, Division of Safety Research

**FROM: Gary Bledsoe, Manager
Occupational Injury Prevention Program**

SUBJECT: Logging Crane Operator Dies in Crane Tip-Over -- Alaska

SUMMARY

On November 29, 1994, a 46-year-old, male crane operator (victim) died as a result of the tip-over of a crane into an adjacent bay. The crane operator was in the process of lifting a bundle of seven logs from a truck and attempting to place the bundle into the bay. As he swung the load toward the bay, the crane became unbalanced and toppled from a bluff bulkhead. The crane fell into the bay, a distance of approximately 25 feet. The crane cab was submerged, and it required about thirteen minutes to extricate the operator. The victim was transported by boat to a nearby hospital, a trip of approximately 30 minutes. During this time CPR was unsuccessfully attempted. He was pronounced dead at the hospital.

Based on the findings of the epidemiologic investigation, to prevent similar occurrences employers should:

- ensure that all crane operators follow boom loading specifications and be cognizant of boom dynamics at all times when operating cranes.
- ensure that all crane operators have received model-specific training on the cranes they operate. This training must be in addition to on-the-job training.
- ensure that cranes have a mechanism for establishing the approximate weight of the load being lifted and that operators know how to properly use such devices.
- ensure that crane operators know the correct load release procedure for unbalanced cranes.

INTRODUCTION

On November 28, 1994, a 46-year-old male crane operator died after the crane he was operating became unbalanced while lifting a log bundle, and fell into the adjacent bay. The victim was either trapped or knocked unconscious as a result of the tip-over. He was removed from the wreckage, which was under water, approximately 13 minutes after the incident. The Alaska Division of Public Health, Section of Epidemiology was notified via the Chief, Emergency Medical Services on November 30, 1994. An investigation, involving an Injury Prevention Specialist from the Alaska Department of Health and Social Services, Division of Public Health, Section of Epidemiology, ensued on December 1, 1994. Also participating in the investigation were an Environmental Health Specialist from the NIOSH, Alaska Activity, the Alaska Department of Labor Safety Compliance Section, and a mechanical engineer specializing in crane safety and inspections. The incident was reviewed with Alaska Department of Labor officials (AKDOL) and the crane engineer, and statements of witnesses and company officials were obtained. Photographs and video tapes of the incident site were also obtained. Measurements of the log bundle were accomplished by use of a digital dynamometer, and linear measurements were obtained of each log for later weight calculations. The crane pad site was also surveyed and the differences in elevation of the four major pad points determined. Other materials obtained include drawings, engineering diagrams of the crane pad construction area, autopsy report, and AKDOL reports.

The employee was a crane operator working for a logging company. The company had 165 employees, including 34 at the incident site. The company maintained a written safety policy in the main office. However, copies of the plan were not available at the site. A collateral safety duty worker was on the site, but no full-time safety personnel were available. Safety meetings were informally conducted but not always documented. For example, no documentation of safety meeting minutes on log dump operations or truck handling operations could be obtained. Training for crane operation was conducted on-the-job. The victim, a non-union employee, had three months experience at the site but only one month's experience as a crane operator. He previously functioned as a chain saw repairman. No evidence of formal training in crane operations was found during the investigation. An interview of his wife provided no further information on the victim's work-related education, and at this time it is believed the victim had received only on-the-job training in crane operation.

Process Overview: The employer was harvesting Sitka Spruce and Western Hemlock trees for transportation to Japan. After trees were felled, trimmed and bucked, they were transported by truck to a nearby bay. Here they were moved as bundles by a crane into the bay. These logs were formed into log dams and later transported by barges. Specific operation of the logging truck and crane was

as follows. Logging trucks hauled cut timber from the log sort yard, approximately three miles from the dump site at the bay. As the trucks approached the crane, they turned right and backed up alongside the crane. The crane then picked the load up from the truck, and the truck pulled out from under the load. The crane lowered the load as close to the ground as possible. The crane moved the load approximately 90 degrees to the right and down into the water. Operators were instructed not to “boom out” until they were as close to the water as possible. Since this site was on a bay, the boom angle varied as a function of the tides. According to tide tables for the day of the fatality, high tide (13.6 feet) occurred at 8:32 AM and low tide (2.3 feet) occurred at 3:10 PM.

INVESTIGATION

At 4:00 PM on November 28, 1994, a crane operator was killed in an industrial incident at an isolated logging camp. The operator was removing a mixed bundle of seven logs, which contained Sitka Spruce and Western Hemlock, from the bed of a logging truck. As he swung the boom and attached load approximately 90 degrees to the right, the crane started to tip over. Witnesses report that it stopped for a moment and then fell over the edge of the bulkhead into the bay, a distance of about 25 feet. Although it was near low tide, the crane landed on its side with the cab under the water. Co-workers immediately went to assist the operator. They found that he was pinned in the cab. They attached a chain and pulled the cab housing out enough to free the victim. This took approximately 13 minutes. CPR was immediately instituted, and he was loaded onto a crew boat for the 20 minute trip to a nearby bay where EMS personnel were waiting. The EMS personnel continued CPR, but the victim was unable to be resuscitated. He was pronounced dead at a nearby hospital. Figure 1 below shows the position of the crane as found at the logging camp. The crane had been moved from the incident site and towed across the bay.

Technical Aspects of the Investigation:

Machine: The victim was operating a P&H 10055B crawler mount crane built in 1964 or 1965. The crane had been most recently certificated on May 25, 1990. The crane had been in operation at the site for one day. Prior to the use of the incident crane, the victim had used a Manitowac 2800 wheel mount crane for approximately one month. The load chart maximum for the P&H crane was 120,000 pounds (a 60,000 ton crane). The Manitowac crane was rated at 90,000 tons. Prior to the shipment of the incident crane, a company mechanic working for the seller had advised that the boom be shortened from 100 feet to 60-70 feet. This proposed modification was based on the estimated load of log bundles of 30,000-50,000 pounds. This modification was not instituted prior to the use of the crane at the logging camp. The crane had an American Hook block attached to the main hoist with three parts line. A homemade spreader bar was also attached to the hook block. A pile-driver hammer was also attached to the boom.

During the initial inspection of the crane, a load chart could not be located in the cab. On the second day of the investigation, the detached load chart was located under the seat (submerged). Whether this chart was actually attached and visible to the operator on the day of the incident is highly questionable. Nevertheless, the crane had no method of testing load weights. Load weights were apparently based on rough estimates prior to a lift. This was accomplished by estimating volume and using assumptions (e.g., tree type, etc.). The weight of the spreader bar and hook block were not included in these estimations.

Other workers reported that incidents of tipping onto the crane's outriggers or tracks had occurred in previous use of the crane. The victim had expressed concern about the crane's stability on the day of the incident. He believed the bundles were too heavy, according to witnesses. He lifted a bundle on the day of the incident that caused the crane to tip up on one track but was able to set the load down.

Crane Platform: The crane was on a wooden platform designed by the U.S. Forest Service. This area was carefully inspected by the investigative team. The grade of the pad was measured using a tripod level. There was a 1.38 percent grade in the direction of the landing point, or the position of the crane at the load lowering point. Thus, the crane was positioned on level ground; the manufacturer allows up to a 2 percent grade. Based on track markings, the center of the crane's last position was determined. The tracks indicated that a minimum of 30 feet of boom would have been required to clear the edge of the unloading platform.

Load: Most of the bundle being lifted at the time of the incident was recovered from the bay. A loader was used to lift each log with a digital dynamometer attached between the log and the loader. The logs had absorbed some water from their exposure in the bay. Figure 2 shows the method for weighing the individual logs of the bundle used during the investigation.

This is accounted for in calculations to follow. Below are the measured dimensions of the logs used in weight calculations:

Log Number	Product Type	Length	End Diameter 1	End Diameter 2
1	Western Hemlock	14.8 feet	28 inches	Fragment
2	Sitka Spruce	27.0 feet	45 inches	44 inches
3	Western Hemlock	41.3 feet	31 inches	22 inches
4	Western Hemlock	23.5 feet	36 inches	23 inches
5	Western Hemlock	12.0 feet	37 inches	26 inches
6	Western Hemlock	15.4 feet	46 inches	30 inches
7	Western Hemlock	41.0 feet	34 inches	20 inches

The average weight of the logs was based on 30 pounds per cubic foot of material, as indicated in the *Standard Handbook for Civil Engineers*. Three methods were used by the consulting crane engineer to calculate the weight of the load. These are described below:

- 1) calculate the area of a vertical plane through the log and multiply by the log length and 30:
$$W = \pi r l p$$
; where $p=3.1416$, r = log radius, l =log length, and 30 =pounds per cubic foot
- 2) Frustum of a Cone:
$$W = \frac{\pi L}{12} (D^2 + d^2 + Dd) p$$
; where $p=3.1416$, L =log length, D =large end diameter, d =small end diameter, 30 =pounds per cubic foot
- 3) Frustum of a Right Cone:
$$W = \frac{\pi L}{12} (R^2 + r^2 + Rr) p$$
; where $p=3.1416$, L =log length, R =radius of large end, r =radius of small end, 30 =pounds per cubic foot

All three methods yielded similar results as indicated in the table below:

Log Number	Method 1	Method 2	Method 3
1	1,899 pounds	1,899 pounds	1,899 pounds
2	8,748 pounds	8,749 pounds	8,749 pounds
3	4,746 pounds	4,791 pounds	4,791 pounds
4	3,346 pounds	3,400 pounds	3,400 pounds
5	1,948 pounds	1,968 pounds	1,968 pounds
6	3,639 pounds	3,692 pounds	3,692 pounds
7	4,891 pounds	5,000 pounds	5,000 pounds
Weight Total	29,217 pounds	29,499 pounds	29,499 pounds

The total dynamometer measured weight was 55,780 pounds. Thus, up to approximately 86 percent of the observed weight may have been due to water absorption and log moisture content. Based on approximately one-half of the measured weight, the probable load weight may be conservatively estimated at about 30,000 pounds. It is important to remember that log number 1 was only a fragment (part of the log had been lost prior to recovery). The weight of the load spreader bar must also be included in the total load weight calculation. The steel spreader bar was 16 feet by 1 foot by 3 inches. Based on 475 pounds per cubic foot of steel, the bar weighed approximately 1900 pounds. Thus, the total load weight was around 32,000 pounds.

The crane load chart was analyzed for weight maximums, which were correlated with appropriate boom angles and lengths. At a 40-foot boom radius the maximum weight allowed is 34,280 pounds. At a 45-foot boom radius the maximum weight allowed is 29,500 pounds. The crane engineer calculated that every 1 foot of radius from 40 to 45 feet decreases the crane capacity by 976 pounds. Every degree of boom angle results in a 1,627 pound effect. The measured distance from the center of the pad to the center of the logging truck tire imprints was approximately 40 feet. The crane appears to have been operated beyond its load limits based on these calculations.

CAUSES OF DEATH

The autopsy indicated “asphyxiation, salt water drowning” as the primary cause of death. Also noted was “blunt trauma to head, subdural hematoma.”

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that all crane operators follow boom loading specifications and be cognizant of boom dynamics at all times when operating cranes

Discussion: The operator in this incident had no mechanism for accurately assessing the weight of loads. Further, the boom loading chart was not mounted in the cab of the crane. During the investigation it was found beneath the operator’s seat. Determination of the appropriate boom angle and length for a specific load is a critical safety measure. The maximum loads stated in the boom loading chart must never be exceeded. As the load increases, the boom angle and length must be adjusted accordingly to maintain the stability of the crane.

Recommendation #2: Employers and should ensure that all crane operators have received model-specific training on the cranes they operate. This training must be in addition to on-the-job training.

Discussion: The victim in this incident had only operated the crane type for one day. All training he had received had been on-the-job. No formal training in crane operation could be documented for this worker. His previous one month of experience had been in operating another crane type. This crane had a greater load maximum (approximately a 1/3 greater lifting capacity). It is possible that the victim overestimated the maximum safe load for the incident crane based on his experience with the other crane. However, it should also be noted that the victim had no method for accurately determining the weight of loads. See recommendation #1 above. Training in the specific type of crane is absolutely essential because of the varying boom characteristics and lifting capacities of different model cranes.

Operators must receive training in correct operation, reading and interpreting load charts, essentials of boom dynamics, and operating load measuring devices. This must be done prior to actually operating the crane at a work site and in a work process. On-the-job training is not an effective substitute for formal training in crane operations. The victim apparently had neither training nor access to critical boom loading information.

Recommendation #3: Employers should ensure that cranes have a mechanism for establishing the approximate weight of the load being lifted and that operators know how to properly use such devices.

Discussion: The crane in this incident was not equipped with a device for measuring loads. Thus, the boom loading chart could not have been accurately interpreted, since any chart weight chosen would have been based on a rough estimate. Therefore, proper boom angles and boom lengths could not have been properly chosen. All cranes should have a device for measuring loads to be lifted that has a cab-mounted readout. If such devices are used, loads can be lifted to the point at which the load engages the cable and is moved free of the ground. The weight of the load can be read by the operator prior to further lifting. With an accurate load weight, the operator can then correctly use the boom loading chart to set the crane's maximum boom angle and length. Consideration should be given to retrofitting older cranes that currently lack load measuring devices.

Recommendation #4: Employers should ensure that crane operators know the correct load release procedure for unbalanced cranes.

Discussion: Witnesses indicated that the operator did not drop the load when the crane began to become unbalanced. While it is possible that the operator in this case did not have time to react to the unbalanced position of the crane, all crane operators should be aware of the fastest and safest way to get rid of a load when the crane is unbalanced and may tip over. This procedure must include training to properly assess the safety of loads prior to lift, mechanical indications of crane overloading, assessing the environment of the emergency dropping point for safety, and fast load release techniques. Other workers must receive training on safe distances to be from a suspended load, so that they do not place themselves in jeopardy or delay a crane operator from emergency release of a load.

REFERENCES

- 1) Final Report of Consulting Engineer, 1995.