

MIFACE INVESTIGATION: #02MI016

SUBJECT: Rig Hand Entangled In Rotating Drive Shaft While Hanging Light in Rig Substructure

Summary

On February 15, 2002, a 31-year old male rig hand/welder was fatally injured when he was pulled upward and entangled in the rotating drive shaft between the chain case and the rotary table in the substructure of the oilrig derrick. The victim had previously removed a non-working light from the rig substructure and taken it to the doghouse, a general-purpose room that is a combination tool shed, meeting room, office and communications center. The replacement light was a 2-foot, 2-bulb fluorescent light with a 6-8 foot long cord. To attach the light to the rig substructure beam, he stood on either the hydraulic winches that lift the drill pipe, or the winch mounting brackets, or both. The winches/mounting brackets were located about 3 ½ feet above the rotary drive box for the chain case drive unit. Standing on the winches/mounting brackets placed him approximately 3 feet below and to the right of the rotating drive shaft. The 2-foot long drive shaft was approximately 8" in diameter, was located approximately 4-6 inches below the rig floor deck and was rotating at least 70 rpm. The rig was not shut down or locked out during the removal of the defective light or when placing the replacement light. The event was unwitnessed, so it is unknown how the victim became entangled in the drive shaft. A co-worker heard a thumping sound and observed the victim spinning with the drive shaft. The co-worker shut down the rig and emergency services were called. The victim was pronounced dead at the scene.



Another Company Oilrig – Not the rig involved in the incident

RECOMMENDATIONS

- Employers should ensure that workers follow established lockout/tagout procedures for control of hazardous energy prior to service and maintenance of equipment.
- Employers should train workers to recognize potential workplace hazards and participate actively in workplace safety.
- Company management should consider developing a joint health and safety committee.
- The company should develop a written disciplinary procedure for safety and health policy violations.
- Oilrig manufacturers should consider engineering a guard to provide worker protection from rotating drive shafts when working in the derrick substructure.

INTRODUCTION

On February 15, 2002, a 31-year old male rig hand/welder died from injuries sustained when he was pulled upward and entangled in the rotating drive shaft between the chain case and the rotary table in the substructure of the drilling rig. On February 15, 2002, MIFACE investigators were notified of the work-related fatality by the Michigan Occupational Safety and Health Act (MIOSHA) 24-hour-a-day fatality reporting hotline that a work-related death occurred on that day. The drilling company agreed to participate in the MIFACE program, and on March 8, 2002 a MIFACE researcher interviewed the owner of the company at the company headquarters. On March 21, 2002 the MIFACE researcher visited a company oilrig (not the rig involved in this incident) to interview personnel who were working with the victim on February 15, 2002. The pictures in this report are the pictures the MIFACE researcher took at this rig; they are not pictures of the rig involved in the fatality. The death certificate, autopsy results, police report, the MIOSHA narrative, and the MIOSHA citation report were obtained during the course of the investigation.

The MIOSHA investigation resulted in one citation to the company: lack of lockout training for employees during maintenance operations at the drilling rig.

INVESTIGATION

The company coordinates aspects of drilling and related activities for client companies for land-based drilling. The company has been in business for 5 years, employs 75 people and has 13 employees with the same job title as the victim, derrick man. The victim had approximately 2 years experience as a derrick man. He had additional experience with a casing crew at a prior company. As derrick man, the victim was responsible for maintaining pumps and spud mud as well as traditional derrick man responsibilities. He was also responsible for general maintenance.

All new workers receive a day of orientation in the office. The employee then receives training with a rig crewmember and supervisor on the rig. Generally, the firm supplies 30-90 days of training on the rig, with the amount of training dependent on the job the individual was hired to fill. Employee training includes videos, written handouts and on-the-job training. The company had developed a written lockout/tagout procedure. (See Figure 1) The written health and safety policies and procedures are kept at each rig. There was not a written health and safety procedure for changing out a rig light. The company does not have a health and safety committee.

The person primarily responsible for safety, the company owner, has on-the-job experience. The company owner uses training materials from the Accident Prevention Committee of the International Association of Drilling Contractors and from other drilling associations.

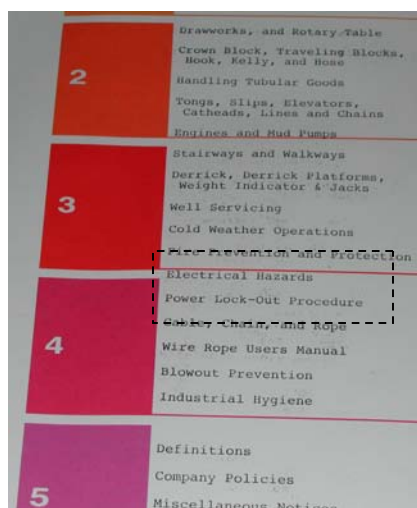


Figure 1

On site, the driller is the shift supervisor and the toolpusher is the location supervisor. The toolpusher lives on-site for the duration of the drilling project. The toolpusher is also responsible for site safety and employee training. At this company, the toolpusher has extensive on-the-job experience; prior to being promoted to toolpusher, the individual had to demonstrate competency in all aspects of all the drilling crew positions. The toolpusher reports directly to the company owner. The toolpusher holds daily 5-minute safety meetings incorporating a specific topic prior to the start of each shift. A safety meeting is also held with all employees prior to the start of a project to discuss safety issues pertaining to the project work. See Figure 2 for company recordkeeping of the safety talks.

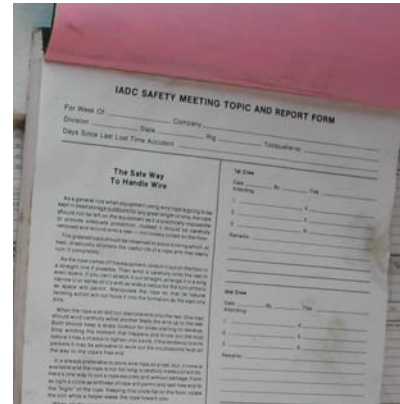


Figure 3

The rig involved in the incident was a Crane Carrier Corsair 500-600 built in 1981. It had been on site for one week. The company was contracted to conduct exploratory drilling for natural gas. The rig had drilled approximately 1/3 of the way to the potential natural gas deposit. On the day of the incident, there were 7 people on site. The rig is staffed 24 hours a day, on six-day rotations. Employees work six days in a row with 2 days off. The victim worked the daylight shift, 7:00am-3:00 pm. He was working on the 3rd day of his six-day rotation. Each shift has 4 people, the driller, derrick hand and 2 floor hands. The shifts are rotating 8-hour shifts.

A typical substructure ranges between 12-15 feet. The substructure height of the rig involved in the incident is unknown. The 2-foot long drive shaft was located approximately 4-6 inches beneath the rig floor deck. The drive shaft was 8 inches in diameter and was rotating at least 70 rpm. The shaft was located approximately 7 feet above the rotary drive box. The drive shaft is powered by a 6-cylinder diesel engine.

The rotary drive box houses the bottom drives, shaft sprocket and the chain driving the rotary table that rotates the drilling pipe. Approximately 3½ feet above the rotary drive box were 2 hydraulic winches mounted to 2 steel mounting plates.

On the day of the incident, there were additional people on site to perform maintenance on the rig. The rig did not have a working light in the substructure. The substructure normally had 2 lights to illuminate the wellbore and the blowoff preventer. During the breakdown of the rig from a previous job, a light was broken. Water had penetrated the remaining light, therefore a replacement light was ordered. The rig was not shut down or locked out when the victim removed the water-damaged light. He placed the defective light into the doghouse, and performed other duties until another individual brought a replacement light from another location. The fluorescent light that the victim was hanging on the substructure's angle iron was a 2-foot long, 2-bulb unit. It had a rear mounting bracket



Figure 4

and a 6-8 foot flexible cord, which was to be plugged into a receptacle located on the doghouse side of the derrick. An example of the light the victim was hanging is shown in Figure 4. Another worker handed the light to the victim while he was in the substructure area, and walked away.

To mount the replacement light, the victim was looking to the south, and was attaching the light to the angle iron in the southwest corner of the substructure. The victim was instructed to place the light on the bottom of the beam approximately 12" below the rig floor. The victim did not use a ladder to climb up so he could hang the light; he climbed on the winches/steel mounting plates. When he climbed on the winches and/or steel plates, the drive shaft was located approximately 2-3 feet to his left and 2-3 feet above his head. Figure 5 shows the prior setup without the drive shaft attached. The white cylinder represents the drive shaft location when installed.



Figure 5

The sequence of events that resulted in the fatal injury was unwitnessed. The victim was wearing a hard hat, safety glasses, winter jacket and bibs. Co-workers heard a thumping sound and saw the victim entangled in the drive shaft. The rig was immediately shut down, but the shaft continued to turn approximately 15 seconds after power was cut off. 911 was called, and emergency personnel arrived. The victim was declared dead at the scene.

One possible scenario is that the light cord may have been thrown over the victim's shoulder and got caught up on drive shaft, catching victim's clothing and pulling victim into drive shaft, hip first. Another possible scenario is that the victim lost his balance while standing on the mounting plates/winches and when attempting to try to regain his balance, his clothing was caught in the rotating shaft. The light fixture was found in the northwest corner of the substructure; the glass lens was not broken, but the power cord was ripped out.

The company has made several changes to improve the company's health and safety program as well as safety on the rig. To assist with rig safety inspections and enforcement of the company health and safety policy, a safety director position has been established. The individual selected for this position has extensive on-the-job experience as well as formal safety training provided by a previous employer.

The company has also developed metal guard that acts as an effective shield for exposed parts of the shaft located in the rig substructure; thereby reducing the potential for entanglement-related injuries to rig workers. They have also established a safety policy that prohibits servicing the drive shaft from the rig substructure area. A trap door on the rig floor has been installed and all repairs must be performed from the rig floor with the rig shut down and locked out. See Figures 6 & 7 for pictures of the drive shaft guard and trap door. The trap door is outlined with dashed lines.



Figure 6

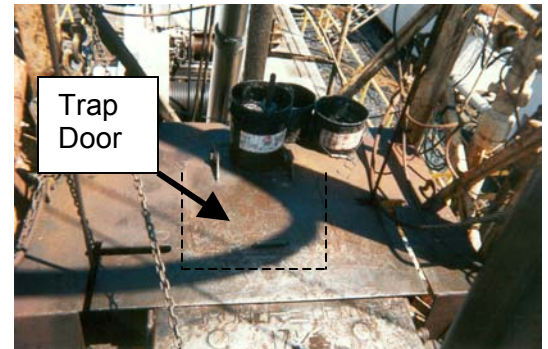


Figure 7

CAUSE OF DEATH

The cause of death as stated on the death certificate was multiple bodily trauma due to high-speed rotational impact with stored shaft sections. An autopsy was not performed so no toxicological information is available.

RECOMMENDATIONS/DISCUSSION

- Employers should ensure that workers follow established lockout/tagout procedures for control of hazardous energy prior to service and maintenance of equipment.

The rig was not shut down or locked out prior to the victim coming in close proximity to the hazardous energy source. The employer has a written lockout/tagout policy and procedure, but it was not possible to follow the written procedure. The necessary parts to provide secure lockout, i.e., locks were not available on site. Interviews with on-site personnel revealed that the rig was often not shut down for servicing and maintenance for routine maintenance. General Industry Safety Standard Part 57, Oil and Gas Drilling and Servicing Operations, Rule 5731 (1) addresses the need for a lockout system for drilling rig equipment as well as the necessity of employee training.

- Employers should train workers to recognize potential workplace hazards and participate actively in workplace safety.

There were no written procedures for the light replacement task. The employer should conduct a job hazard analysis for existing and new work procedures, and for providing employee job hazard analysis training. Job hazard analysis training should be

conducted so employees can recognize unsafe work practices and potentially hazardous work conditions when performing a task. The employer (or outside consultant) can provide hazard analysis training as part of the development and implementation of the company health and safety program.

A hazard analysis may have identified the potential hazard posed by the bulkier, looser winter clothing the victim was wearing. The condition of his clothing is unknown. He was appropriately dressed for the winter weather. All workers should be made aware of the hazard of loose clothing and rotating drive shafts and take appropriate precautions. Clothing should be free of flaps and other potential grab points for machinery so that capture by rotating machinery is prevented.

A copy of the OSHA Job Hazard Analysis publication is included with this report as Attachment A. This document may also be found and downloaded from the OSHA website: www.osha.gov/. Click on the Newsroom Publications link, and scroll down the OSHA publications until the "Job Hazard Analysis" document is found. A job hazard analysis may have identified the potential for employee injury working within close proximity to a rotating drive shaft if the equipment was not shut down and locked out during rig servicing and maintenance.

A hazard-specific training program should be developed. In addition, ongoing hazard recognition and evaluation should be conducted. When new hazards are recognized, effective preventive measures should be included in a formalized safety-training plan. This training should be ongoing, and should be a requirement for journeyman workers as well as for new workers and trainees. The safety-training program could be supplemented using the daily 5-minute safety talks given daily by the toolpusher.

- Company management should consider developing a joint health and safety committee.

The main incentive for developing a Health and Safety (H&S) committee is to encourage and heighten employee involvement in the company safety program. Employee input is a critical part of a successful safety program. An H&S Committee is one way to obtain that input. The level of involvement by employees and degree of management commitment will determine if an H&S Committee is successful.

H&S committees have many benefits; identify safety and health concerns that workers/management consider most critical, help find creative solutions, shows a good faith effort toward health and safety regulations, boosts coworker loyalty, morale and enthusiasm by getting involved in an issue that's important to everyone, and if new safety rules are needed, an H&S committee can help make sure employees accept and follow them. A sample mission statement is contained in Attachment B.

- The company should develop a written disciplinary procedure for safety and health policy violations.

The employer's lockout/tagout policy stated that it was the company's responsibility to inform and train workers in lockout/tagout procedures and to supervise work practices to assure that these procedures were followed. However, the company does not have a

written disciplinary policy to address violations of the lockout/tagout policy or any written health and safety policy.

The company should develop a written disciplinary policy for failure to follow written health and safety policies and procedures. The discipline procedure should provide for timely disciplinary action when any employee acts or performs work in an unsafe manner and/or does not follow the established health and safety policy procedures. Management representatives on-site (in this case, the toolpusher and driller) should have a thorough understanding of all aspects of the health and safety policies, and ensure that compliance with these policies occurs during task performance. The disciplinary policy should ensure that the employee knows what the problem is as well as understand what a supervisor's expectations are in order for him/her to correct the problem. The policy should also provide appropriate disciplinary action of consequences for unsafe work behavior/conduct and provide a record of corrective action taken.

- Oilrig manufacturers should consider engineering a guard to provide worker protection from rotating drive shafts when working in the derrick substructure.

The rotating drive shaft of the rig involved in the incident is normally guarded on the topside by the rig floor; there was no guarding of the underside of the rotating drive shaft to provide protection for individuals working in the derrick substructure. Guards should cover all moving parts in such a way that no part of the operator's body can come into contact with them. All rotating equipment parts have inherent dangers. Even slowly rotating equipment can grip material it contacts. Where there are protrusions, the potential for catching increases, and the travelling motion of a rotating piece of equipment is a cause for yet greater vigilance.

Oilrig manufacturers should consider developing a machine guard that would prevent inadvertent contact with the shaft. Although the primary prevention strategy for this fatality should be shutting down and locking out the rig prior to performing service and maintenance, guarding of the drive shaft would provide an added level of protection for individuals who cannot entirely avoid exposure to rotating equipment.

REFERENCES

All MIOSHA Standards cited in this report can be found at the Consumer and Industry Services, Bureau of Safety and Regulation Standards Division website at www.michigan.gov/cis. Follow the links *Workplace Safety & Health* then *Standards & Legislation* to locate and download MIOSHA Standards. The Standards can also be obtained for a fee by writing to the following address: Department of Consumer and Industry Services, MIOSHA Standards Division, P.O. Box 30643, Lansing, MI 48909-8143. MIOSHA phone number is (517) 322-1845.

1. General Industry Safety Standard Part 57, Oil and Gas Drilling and Servicing Operations.
2. Occupational Safety and Health Administration (OSHA) website: <http://www.osha.gov>
3. Schlumberger Oilfield Glossary, <http://www.glossary.oilfield.slb.com>

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ATTACHMENT A
JOB SAFETY ANALYSIS

ATTACHMENT B

HEALTH AND SAFETY COMMITTEE MISSION STATEMENT

Prior to forming the H&S committee, management should:

- Define the H&S committee's Mission Statement,
- Define the role/function of the Committee,
- Determine the meeting schedule, and
- Determine the length of the meeting.
- Identify H&S Committee members from management and employees.
 - Members should be interested in safety issues and have direct knowledge of the company's operations.

Sample Mission Statement

The mission of the (Company Name) Health and Safety Committee will be to provide leadership in safety and work toward the elimination of workplace injuries and illnesses. The H&S Committee will work to:

1. Assist the company to identify, evaluate and resolve workplace health and safety concerns.
2. Assist in developing and distributing health and safety policies and procedures.
3. Conduct periodic surveys and inspections to identify hazards and recommend corrective actions.
4. Consider recommendations or suggestions concerning health and safety issues.
5. Help to identify employee training needs.

MIFACE

Investigation Report # 02 MI 016

Evaluation

To improve the quality of the MIFACE program and our investigation reports, we would like to ask you a few questions regarding this report.

Please rate the following on a scale of:

Excellent	Good	Fair	Poor
1	2	3	4

What was your general impression of this MIFACE investigation report?

1 2 3 4

Was the report...

Objective?	1	2	3	4
Clearly written?	1	2	3	4
Useful?	1	2	3	4

Were the recommendations ...

Clearly written?	1	2	3	4
Practical?	1	2	3	4
Useful?	1	2	3	4

How will you use this report? (Check all that apply)

- ☐ Distribute to employees/family members
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- ☐ Other (specify) _____

Thank You!

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