FACE Investigation
AK-94-12
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TO: **Ted Petit, NIOSH, Division of Safety Research**

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

SUBJECT: **Welder's Helper Asphyxiated in Argon-Inerted Pipe -- Alaska**

SUMMARY

On April 29, 1994, a 22-year-old, male welder's helper (victim) was asphyxiated after entering an oil pipe section that had been filled with argon. The victim had been assisting in a welding operation to join two sections of pipe for a line currently under construction. The pipeline was being constructed to carry crude oil from an oil field to a flow station. An inerting agent (argon gas) was required to prevent the reactive components of air (oxygen, nitrogen, hydrogen) from contacting molten metal during the welding process. Contact with these gases results in the formation of oxides, nitrites, and undesirable gases. This chemical reaction can result in a weakened weld.

An oxygen purge system was set up in the section of pipes to be joined. This was accomplished by using a "dam system" or "pig" to isolate the pipe interfaces, filling the "pig" with argon, and welding the sections together when the oxygen was purged, as indicated by an oxygen analyzer (see figure 1). On the day of the incident, the work crew discovered that they were unable to maintain an adequate oxygen purge (possibly due to leaks and incidental oxygen in the analyzer's line hose). It is unclear if a member of the crew was assigned the sole duty of reading the oxygen analyzer. Statements by witnesses indicate that this was more likely a collective activity of the crew.

The work crew decided to replace the line to the oxygen analyzer with a shorter line connected through an access port recently welded onto the pipe (see figures 2 and 3). A welder's helper apparently entered the pipe to make this change prior to adequate ventilation. Some time later, other work crew members could not locate the victim and became concerned when the victim's hard hat was noticed on a wooden platform beside the pipe entry point. At approximately 1:45 PM, they realized he was in the pipe and attempted a rescue. After ventilating the pipe, three workers entered a downward sloping segment of the pipeline and attached a rope to the victim. He was removed from the pipe, and CPR was initiated. He was transported to a nearby medical facility by EMTs, where he was pronounced dead at 2:28 PM. As a result of investigations by other agencies, criminal charges of manslaughter have been brought against two individuals in this case.

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

- ensure that all permit-required confined spaces are identified and that an appropriate system for entry/work is in place.

- ensure that all workers use appropriate confined space equipment and procedures. All workers entering a permit-required confined space must have an attached lifeline and a method for communicating with co-workers. Confined spaces must be properly ventilated prior to entry, and a "competent person" must monitor the confined space entry and work operation.

- ensure that workers entering confined spaces know the appropriate procedures to rescue an injured worker in a confined space.

- ensure that emergency medical technicians are fully trained and competent prior to assigning such employees to regular duties

INTRODUCTION

On April 29, 1994, a 22-year-old male welder's helper died after entering an argon-inerted pipe. The victim was asphyxiated in an attempt to modify an oxygen analyzer line. The Alaska Division of Public Health, Section of Epidemiology was notified via the news media on May 1, 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 May 2, 1994. The incident was reviewed with the Alaska Department of Labor officials (AKDOL), and statements of witnesses, company officials, and rescue personnel were also reviewed. Video tapes of the incident site were carefully screened and reviewed. Also, tapes of the optical fiber camera were studied. These were made prior to entry into the pipe by safety officials. The site had been compromised by contractors building a road over the area of pipeline affected. Other materials obtained, include an argon MSDS, engineering diagrams of the area under construction, drawings of witnesses, and AKDOL reports.

The employee was a welder helper working for a oil service subsidiary of a "Regional Corporation." The employer had been in business for over 20 years and had 175 employees, including 20 welder helpers. The employer was performing contract work for major oil-service companies on the North Slope. A full-time safety officer was responsible for multiple job sites, and was not able to be at one site full-time. Safety training in confined space entry and work was accomplished through classroom training, on-the-job training, and manuals/videos. The safety officer specifically noted that discussions on the hazards of argon were carried out. Confined space entry work plans were reviewed and approved by safety and health staff of the major companies which contracted with the oil services subsidiary. The employee was reported to have been earning money for college, and had

worked at the incident site for 7 days. His co-workers described him as knowledgeable about confined space hazards, and he was believed to have been especially safety conscious.

The work crew was constructing a pipeline from a "gathering center" or flow station and continuing under a road bed. The crew was welding together sections of pipe, using an argon dam to purge air at the welding points (see below for details of this process). Witnesses report that welders entered the pipe to "back-weld" on a regular basis. A fan (1/3 horsepower, 1725 RPM) located at the opposite end of the pipeline (a distance of approximately 70 feet) was used to ventilate the space prior to entry. Oxygen concentration in the pipe was monitored using the oxygen analyzer. According to company records, the work crew on the day of the incident consisted of the following:

Pipefitter Foreman - 1 (in charge of overall work operations)
Welding Foreman - 1
Welder - 2
Operator - 2
Laborer - 1
Welder Helper - 3 (includes victim)

Argon was used to improve weld stability by preventing the formation of chemicals (oxides, nitrites) when ambient air came into contact with heat from the welding process. Argon, a nonreactive gas, displaces air in the area to be welded. A "pig" was placed into the 33 inch pipe to act as an argon dam (see figures 1, 2, and 3). The pig consisted of two foam inserts with a nine inch separator. The dam was filled with argon, and an oxygen analyzer was monitored to ensure that an oxygen purge was maintained. An increase in the oxygen registered on the analyzer indicated an ineffective oxygen purge. That is, oxygen remaining in the dam could potentially create oxides and nitrites, resulting in weak welds. This could happen if the oxygen analyzer cable had undetected holes allowing incidental oxygen into the line.

Argon is an inert gas capable of displacing the ambient air in confined spaces. It is an odorless, tasteless, and colorless gas that acts as a simple asphyxiant in humans. Symptoms of exposure range from immediate unconsciousness to dizziness, rapid respiration and pulse, air hunger, reduced awareness, tightness in the head, tingling, faulty judgment, emotional instability, rapid fatigue, nausea, and vomiting.

INVESTIGATION

A welder's helper entered an argon-inerted confined space to change the cable of an oxygen analyzer. The work crew had been experiencing problems maintaining the oxygen purge for a welding job on the outer surface of the pipe joint. The crew believed that the oxygen analyzer cable was too long and that splices were allowing oxygen to enter the cable from outside of the purged area in the pipe. The previous day, a flange had been welded on the outside of one of the pipe sections being joined (see figure 2). The flange allowed a shorter cable to be used because it could be placed into the side of the pipe instead of at the front of the pipe. The crew believed that the

reduction in splices would possibly fix the problem. They thought the purge was working, but ambient air was entering the cable was causing a false oxygen analyzer reading.

During discussion of the modification to the analyzer cable, they began looking for the welder's helper. When they noticed his hard hat at the wooden platform by the pipe entry point, they realized he had entered the un-ventilated pipe. They immediately began ventilating the pipe, but did not monitor the analyzer for a safe oxygen atmosphere. When they "felt" it was safe (approximately 2 minutes), a worker entered the pipe. He found the victim lying face down with his palms tucked under his thighs. He appeared to have contacted the argon as he broke the plane of the pipe at the intersection of the horizontal segment and the beginning of the 45 degree sloped section (see figure 4). His position indicated that he may have become unconscious immediately upon breathing the argon that had seeped through the dam. The victim was too far away for the co-worker to reach, so two other workers entered the pipe and formed a "human chain" by interlocking their hands and feet. The worker at the end of the chain was able to get a rope around the victim, and they began pulling him out. They noticed that his face was "purple," and began CPR as soon as they were out of the pipe. At that time the victim did not have a pulse. They also called for EMT assistance by radio, and held the victim head down to attempt to drain the argon from his lungs (argon is heavier than air). The EMTs arrived with an ambulance approximately 20 minutes later. Witnesses report that the rescue personnel appeared to be confused and unclear about what to do. They advised the crew to continue CPR. Approximately 5 minutes later, one of the EMTs began assisting with mouth-to-mouth respiration. The other EMT was reading the defibrillator manual. Witnesses report that neither EMT apparently knew how to use the equipment. The victim was transported to the local clinic by ambulance, where he was declared dead. Discussion of whether or not the victim was directed to enter the pipe will be addressed in the discussion of recommendation #2.

CAUSE OF DEATH

The victim's death was determined to be "asphyxia by environmental suffocation."

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers and contractors should ensure that all permit-required confined spaces are identified and that an appropriate system for entry/work is in place.

Discussion: This work site was not considered to be a permit-required confined space. However, investigation revealed that workers routinely entered the pipe to do back welding operations. Although some controversy surrounds this issue, either the site was incorrectly evaluated as a confined space hazard or the job was modified without the knowledge of safety and health personnel. Employees must understand what constitutes a confined space. Any modification to a job requiring confined space entry must be re-evaluated as a potential hazard. When sites are identified as permit-required confined spaces, an appropriate protocol for entry and work must be instituted.

Recommendation #2: Employers and contractors should ensure that all workers use appropriate confined space equipment and procedures. All workers entering a permit-required confined space must have an attached lifeline and a method for communicating with co-workers. Confined spaces must be properly ventilated prior to entry, and a "competent person" must monitor the confined space entry and work operation.

Discussion: No permit-required confined space entry or work procedures were used in this incident. The site had been evaluated as non-permit required because the job was described as not requiring the entry of workers at any time. Standard confined space entry and work procedures may have prevented this fatality from occurring. Use of appropriate atmospheric testing prior to entry would have revealed an oxygen deficient atmosphere. Use of intrinsically-safe radio transceivers would have allowed ongoing communications during the operation. Any problem experienced by a worker would be identified earlier through requests for assistance by the worker, or lack of response by the worker.

General communications appear to have been flawed in some manner in this incident. The victim was apparently knowledgeable about the hazards of argon, yet he entered the inerted space. He seems to have believed that the space had already been ventilated. Investigators suspect that the Pipefitter Foreman directed the victim to enter the pipe. However, this assertion is denied by the employee. Given that there are no direct witnesses to the conversation of the foreman and the victim prior to the incident, it currently is unclear why the victim believed the pipe to be safe.

Use of a "competent person" in a confined entry procedure could have prevented this fatality. A "competent person" is capable of concentrating only on the confined space task. Thus, divided attention difficulties are reduced. Also, a "competent person" can quickly respond to any problems encountered during the operation, such as activating a winch to rescue an injured worker. The use of a lifeline would have permitted safe retrieval of the victim, which would have been faster and not required unorthodox retrieval methods.

Recommendation #3: Employers and contractors should ensure that workers entering confined spaces know the appropriate procedures to rescue an injured worker in a confined space.

Discussion: Entry prior to atmospheric testing is extremely hazardous. The use of guesswork to estimate appropriate ventilation times is a dangerous procedure. Also, the use of a "human chain" is not recommended. All of these problems could have been avoided through use of appropriate confined space entry, work, and rescue as described above. The procedures used in this incident could have resulted in the deaths of three "would-be rescuers." Adherence to standard methods results in quicker and safer retrieval of injured workers in confined spaces. The use of a retrieval harness attached to a (prior to routine entry) winch would have resulted in a fast, safe retrieval, and would not have required the entrance of additional personnel into a hazardous situation.

Recommendation #4: Employers and contractors should ensure that emergency medical technicians are fully trained and competent prior to assigning such employees to regular duties.

Discussion: Witnesses described the EMTs called to the scene as confused. They did not appear to want to assist the victim's co-workers in performing CPR. They were unfamiliar with the operation of the defibrillator in the ambulance. One EMT was reading the defibrillator manual while CPR was being conducted. Investigation revealed that the two EMTs had just reported to work on the day of the fatality. Although responding to an industrial injury of this magnitude is a challenge for workers on the first day of a job, all EMT's must be fully trained and experienced prior to their assignment of sole responsibilities for emergency medical procedures. An alternative may be to assign new EMT's with experienced EMTs. It may be risky to assign two new EMT's such responsibilities in an isolated environment, where access to a physician is extremely limited.

REFERENCES

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4. *Permit-Required Confined Spaces for General Industry; Final Rule (29 CFR Parts 1910),* Occupational Safety and Health Administration, !/14/93.