TO: Director, National Institute for Occupational Safety and Health

FROM: California Fatality Assessment and Control Evaluation (CA/FACE) Program

SUBJECT: A Crew Leadman and a General Foreman Die from Burns Sustained in a Fire at Sanitation Plant in California

SUMMARY
California FACE Report #94CA002
November 30, 1994

A 38-year-old white, non-Hispanic crew leadman (decedent #1) and a 33-year-old white, non-Hispanic general foreman (decedent #2) died from burns sustained while working in a hydraulic concrete channel ("mixed-liquors channel"). Both decedents were working for a subcontractor and were installing a large butterfly valve (gate valve) in an hydraulic channel where oxygen was pumped into sludge. The oxygen content of the air in the channel was elevated because of an operation which took place just prior to the incident.

Decedent #1 was using a pneumatic hammer to chip away the sidewall of the cement channel, when he struck something causing a spark. The decedents' oxygen-enriched clothes caught fire and a second worker (decedent #2) jumped into the channel to help. Decedent #2's clothing also caught on fire and both workers were observed running through the channel on fire. Co-workers at the scene stated that when they saw the victims on fire they yelled at them to roll on the ground. The victims were transported by ambulance to a regional burn center where both decedents died. The CA/FACE investigator concluded that, in order to prevent similar future occurrences, host employers and employers should:

- inform contractors of the existence of any confined spaces on the worksite, the hazards presented by this, and the host employer's experience with the confined space.
- inform the contractor of precautions or procedures that the host employer has implemented for the protection of employees in or near permit spaces
- inform employees of the existence and location of confined space hazards
- develop a comprehensive rescue plan to be used in the event of an emergency.
- provide employees who work in potentially oxygen-enriched atmospheres with flame-resistant clothing.
- provide specific fire safety training for employees so that in the event of a fire, employees know how to extinguish flames from their clothing.

INTRODUCTION

On February 1, 1994, a 38-year-old crew leadman (decedent #1) and a 33-year-old general foreman (decedent #2) were severely burned in a fire that occurred in a concrete hydraulic channel

where they were at work. The CA/FACE investigator was informed of this incident by an investigator from the California Occupational Safety and Health Administration's (Cal/OSHA) Bureau of Investigation's (BOI) office on February 9, 1994. The CA/FACE investigator conducted an interview with the contractor on February 23, 1994. A copy of the Cal/OSHA Report, the Sheriff/Medical Examiner's Report, and the local Fire Department's Investigation Reports were all obtained by the CA/FACE investigator.

The employer in this incident was a general engineering contractor under contract with the county sanitation district (the host employer) to install a new butterfly valve in an hydraulic channel. The contractor had been in business for approximately 18 years under its current name and an additional 12 years under another name. Decedent #1 had worked for the contractor for 6 years and decedent #2 had worked with the firm for 10 years. Both victims were union employees. There were approximately 80 employees working for the contractor at the time of the incident, 15 individuals with the same job title as decedent #1 (crew leadman) and 5 individuals with the same job title as decedent #2 (general foreman). The contractor had a written safety plan and a safety officer on staff. This individual only devoted part of his time to safety issues and was not present at the time of the incident. There were written safety rules in place applied to the work being conducted at the time of the incident. Employees were also given training in confined space entry procedures.

INVESTIGATION

The general engineering contractor had been hired by the county sanitation district to install a new butterfly valve (gate valve) in an open hydraulic (effluent) channel at the sanitation district plant. The channel is below ground level, and access is through a three foot wide gap which runs the length of the channel. The effluent channel was described by sanitation plant personnel as being a "semi-confined space," and was used as a mixed-liquors channel (see exhibit 1A). Access to the channel is restricted and entry requires a ladder. The channel's cross sectional dimensions are 6 feet x 6 feet. Its three-foot wide opening on top is also located below ground level. Under Title 8 of the California Code of Regulations (CCRs), the effluent channel fits the definition of a confined space. A "mixed liquors channel" is an area where sludge is activated by aeration tanks. Oxygen is pumped into the sludge to create a bubbling effect to keep solids from accumulating within the channel. According to management officials with the sanitation district the sludge had been pumped out so that only three to four inches remained in the channel prior to the contractor beginning work. Sand bags were placed around the work area so that a dry area was provided for the workers installing the butterfly valve. The same procedure had been used on three prior occasions. The contractor's project engineer stated that, at the time of the incident, they were in the final phase of the operation.

On the day of incident, at 11:00 a.m., decedent #1 was working in the hydraulic channel using a pneumatic hammer. The pneumatic hammer was used to chip the concrete sidewall so that the new butterfly valve could be installed. Witnesses stated that shortly after decedent #1 began using the pneumatic hammer his clothes caught on fire. Decedent #2 jumped into the channel to try and help decedent #1 and was engulfed in flames. Co-workers saw the two workers running through the channel on fire and yelled at them to roll on the ground, which they eventually did. A third co-

worker leaned over the channel and his shirt caught fire.

Fire department personnel stated that upon arrival they saw two men sitting on 5-gallon cans with all of the visible skin areas sloughed from burn exposure. It also appeared that they had no or minimal amounts of clothing remaining on their bodies. A local ambulance company was already on the scene after being flagged down by sanitation plant workers shortly after the incident occurred. Fire Department personnel called a second ambulance to the scene and a request was made for an air ambulance.

Paramedics from the fire department confirmed the victims to have second and third degree burns to over 80% of their bodies. Both victims were considered critical burn patients and were therefore given clearance to be transported to the regional burn center. At the time the burn victims were being put into the ambulances, plant personnel informed the medics and fire department personnel that there was a third victim. This third victim was given an initial evaluation which placed him in stable, and most probably, mild status, and he was loaded in the front seat of the ambulance and transported with the critical patients to the burn center. The air ambulance was canceled by fire department personnel.

An examination of the scene was conducted by fire department personnel to determine the cause of the fire. It appeared that the fire occurred as a result of an oxygen enriched atmosphere. A sanitation instrument foreman for the county sanitation district stated that a procedure had been performed in the channel prior to this incident. This initial procedure required that approximately 60 percent oxygen be injected into the sludge in the channel. This earlier operation was part of normal operating procedures in the hydraulic channel. Under usual conditions as stated earlier in this report, oxygen is pumped into the sludge to keep solids from sinking or accumulating in one area of the channel.

The work area at the base of the channel had a large area of sewage liquor into which 60% oxygen had been injected. This sewage liquor would have emitted oxygen until it reached a point of equilibrium with the surrounding atmosphere (20.9%). The pattern of fire indicated that decedent #1's clothes were saturated with oxygen, and when the spark was generated by the pneumatic hammer a flash fire occurred. Decedent #2 had been working above and outside of the channel near the crane and oxygen vent pipes. Interview statements support the conclusion that once he jumped into the channel he then, and only then, caught on fire. This indicates that his clothing must have been contaminated and saturated with oxygen and when it came in contact with the source of ignition it created a very severe, hot, fast fire.

CAUSE OF DEATH

The Sheriff-Coroner's Autopsy Report stated the cause of death for decedent #1 was cardiac and respiratory failure due to second and third degree burns over 60% of the body. The cause of death for decedent #2 was cardiopulmonary arrest due to second degree burns over 80% of the body.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Host employers should inform contractors of the existence of any confined space(s) on the worksite, including the hazards identified and the host employer's

experience with the confined space.
Discussion: There was no confined space entry program in effect at the hydraulic channel where the contractor was working at the time of the incident. The atmosphere was not tested prior to entry, no mechanical ventilation or respiratory protection was provided, and no rescue plans were developed. Host employers, and subcontractors who work in these types of hydraulic channels should develop and implement a written confined space entry program to address all provisions outlined in the following NIOSH Publications: Working in Confined Spaces: Criteria for Recommended Standard (Pub. No. 80-110); NIOSH Alert, Request for Assistance in Preventing Occupational Fatalities in Confined Spaces (Pub. No. 86-110); A Guide to Safety in Confined Spaces (Pub. No. 87-113); and NIOSH Guide to Industrial Respiratory Protection (Pub. No. 87-116).

A confined space entry program should include the following:
1. written confined space entry procedures;
2. evaluation to determine whether entry is necessary;
3. issuance of a confined space entry permit;
4. evaluation of the confined space by a qualified person;
5. testing and monitoring the air quality in the confined space to ensure:

a) that the oxygen level is at least 19.5%;
b) that the flammable range is less than 10% of the LFL (lower flammable limit); and
c) the absence of toxic air contaminants.

6. training of workers and supervisors in the selection and use of:

a) safe entry procedures;
b) respiratory protection;
c) lifelines and retrieval systems; and
d) protective clothing.

7. training of employees in safe work procedures in and around confined spaces;
8. training of employees in confined space rescue procedures;
9. conducting safety meetings to discuss confined space safety;
10. availability and use of proper ventilation equipment; and
11. monitoring of air quality while workers are in the confined spaces.

Under Title 8 of the California Code of Regulations section 5157 (c)(8)(b) When an host employer arranges to have employees of a contractor perform work that involves permit space entry, the host employer shall apprise the contractor of the elements, including the hazards identified and the host employer's experience with the space, that make the space in question a permit space.

Recommendation #2: Employers should inform the contractor of precautions or procedures that the host employer has implemented for the protection of employees in or near permit spaces where contractor's employees will be working.
Discussion: Under Title 8 of the CCRs section 5157 (c)(8)(c), when an host employer arranges to have employees of a contractor perform work that involves permit space entry, the host employer shall apprise the contractor of any precautions or procedures that the host employer has implemented

for the protection of employees in or near permit spaces where contractor personnel will be working.

Recommendation #3: Employers should inform employees of the existence and location of confined space hazards by posting signs or by other means.
Discussion: Under Title 8 of the CCRs section 5157(c)(2) employers must inform exposed employees, by posing danger signs or by any other effective means, of the existence and location of any danger posed by the permit space. In this situation, no type of warning was provided to employees to inform them of the dangers imposed by the effluent channel that contained activated sludge (40-60% oxygen) once it has been emptied or pumped down.

Recommendation #4: Employers should implement written, understandable operating rescue procedures prior to entry into a confined space.
Discussion: Under Title 8 of the CCRs, section 5158(c)(1)(A) employers must implement a written, understandable operating procedure prior to entry into a confined space. Employees were working in the effluent channel and had not received any written instructions or procedures on the accepted operating and/or rescue operations in this channel area.

Recommendation #5: Employers should provide employees who work in potentially oxygen enriched atmospheres with flame-resistant clothing.
Discussion: Flame-resistant work clothing is designed to minimize burn injuries and provide workers several seconds to escape either a flash fire or an electrical arc. To be effective, flame-resistant clothing must not ignite or continue to burn after a flash fire. In this situation, most of the clothing worn by the fatally injured workers was completely burned. Had the workers in this situation been wearing flame-resistant clothing, their clothing would have been less likely to have been burned as quickly and as thoroughly as it was. It is likely these workers would still have sustained serious burns, but they may have escaped fatal injury.

Recommendation #6: Employers should provide specific fire safety training for employees so that in the event of a fire, employees know how to extinguish flames from their clothing.
Discussion: Co-workers and witnesses stated that they saw the victims running through the channel on fire during this incident. The victims were convinced by co-workers to roll on the ground to extinguish the flames. If the victims had rolled on the ground immediately after their clothes caught fire they may have survived.

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FATALITY ASSESSMENT AND CONTROL EVALUATION PROGRAM

The California Department of Health Services, in cooperation with the Public Health Institute and the National Institute for Occupational Safety and Health (NIOSH), conducts investigations of work-related fatalities. The goal of this program, known as the California Fatality Assessment and Control Evaluation (CA/FACE), is to prevent fatal work injuries in the future. CA/FACE aims to achieve this goal by studying the work environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact. NIOSH-funded, state-based FACE programs include: Alaska, California, Iowa, Kentucky, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Oklahoma, Oregon, Washington, West Virginia, and Wisconsin.

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Additional information regarding the CA/FACE program is available from:

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