THE UNIVERSITY OF IOWA

COLLEGE OF PUBLIC HEALTH
Department of Occupational and Environmental Health

TO: Director, National Institute for Occupational Safety and Health

FROM: Iowa FACE Program Case No. 1IA021 Report Date: 7/24/03

SUBJECT: Two Railroad Repair Workers Asphyxiated in Damaged Tank Car.

SUMMARY

During the summer of 2001, two experienced railroad foremen, ages 49 and 46, died after entering a railroad tank car that had been involved in a derailment at another location. Both victims worked for a company that specialized in refurbishing and repairing railroad equipment. The empty railroad tank car had been filled with soybean oil, and the headspace (unfilled volume) inside the tank car was filled with a cover gas (in this case nitrogen) to prevent spoilage. Although this was a hazardous condition for workers, at the time of the incident, the tank car did not have any permanent or temporary exterior warning signs or marking to alert workers that a hazardous gas was present.

Photo 1 – Side view of similar rail tank car used to transport vegetable oil.

On the day of the incident, the first foreman (first victim) was attempting to assess the extent of repairs from inside the tank car. He used a portable multi-gas meter (see Photo 2) to measure the air quality inside the car, and reported to a co-worker accompanying him (attendant) that the air inside was fine. He then entered the tank car through the top hatch, while the attendant stayed just outside. A short time later, the attendant heard the foreman drop his flashlight, and looking in, saw him lying on the floor of the car. The attendant assumed the foreman must have bumped his head or experienced a heart attack. In turn, he called local emergency response (911), and also radioed for

UI College of Public Health
100 Oakdale Campus, 124 IREH
Iowa City, Iowa 52242-5000
319-335-4415 *Fax* 319-335-4225
www.public-health.uiowa.edu/oeh

help over the company's radio system. While emergency help was en-route, the second foreman (second victim) arrived at the scene with another company employee. The second victim immediately asked the attendant about the air quality inside the tank car, and was told by the attendant that the air inside was fine. The second victim then entered the tank car followed closely by the other company employee. Once inside the car, the second victim almost immediately collapsed against the other company employee's feet and on to the floor of the tank car. Since the other company employee was still coming down the entry ladder he was able to stop and immediately climbed back outside the tank car to await assistance from emergency personnel, who arrived within a few minutes. The rescue crew first checked the air inside the tank car with their equipment, and found little or no oxygen inside. Then rescuers donned self-contained breathing apparatus and extracted both men, who had died from asphyxiation. Although nitrogen gas occupied the entire interior of the tank car, no permanent or temporary markings or placards were found on the exterior of the tank car to alert workers of this hazard. The portable multi-gas meter used by the first victim was found to be working perfectly after the incident, and also during official tests conducted sometime later.

RECOMMENDATIONS based on our investigation are as follows:

- *1. Employers must ensure that all components of a comprehensive confined space entry program are in place, emphasized, enforced and utilized by workers regardless of a lack of an apparent safety hazard.*
- *2. Employers should provide safety equipment to confined space entrants designed to permit their extraction from outside the confined space, and ensure that workers properly use such safety equipment.*
- *3. Employers must insure that workers testing air quality inside confined spaces are trained not only to conduct these tests, but to conduct them regardless of the situation or lack of an apparent safety hazard.*
- *4. Employers must verify that emergency response services are available and that the means of summoning them is operable before an entry into a confined space is initiated.*
- *5. Transport containers (i.e. railroad tank cars, over-the-road tractor-tanker rigs, etc.) must be marked properly at all times- to alert workers of additional hazardous contents and/or conditions.*

INTRODUCTION

In the summer of 2001, two experienced railroad equipment repair workers, aged 49 and 46, were asphyxiated in a railroad tank car in Iowa. The Iowa FACE program was alerted to this by local news sources and began an investigation. Information was gathered from OSHA, the medical examiner, the county Sheriff, and the company both men were employed by. Later in the fall, two Iowa FACE investigators made a site visit and met with the divisional manager and safety director for the company. A portable multi-gas meter used by one of the victims was demonstrated and photographed.

The employer specialized in repairing, rebuilding, cleaning and painting railroad equipment, and frequently handled railroad cars involved in derailments nationwide. They locally employed a total of 60 hourly and salaried employees. The facility was a regional office of a national company that had been in business since 1936. These were the first fatalities for the national company. The two victims were both employed as foremen, considered highly experienced, with 48 years of combined work experience with this company.

The company had an extensive safety program with written requirements and documentation for annual training, reviews, etc. Attendants were also specifically trained one-on-one in the areas they would work, including confined space entry. At the time of our investigation, the company was reviewing and updating all of its confined space entry requirements. Also, the company had not entered or worked on a railroad tank car since the incident occurred.

INVESTIGATION

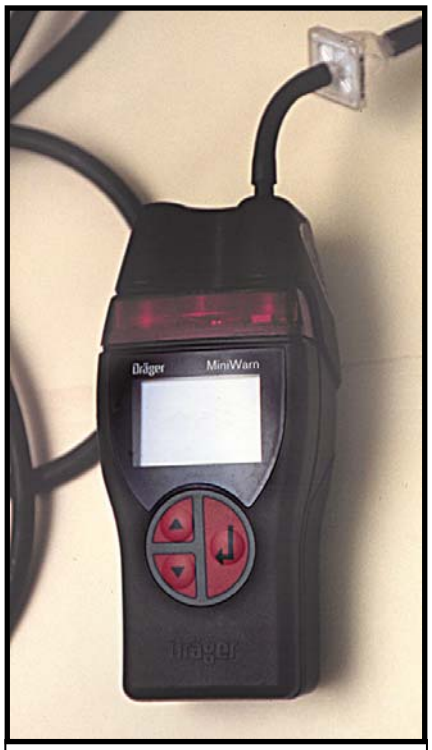

Photo 2 – Portable multi-gas meter.

The employer was a national corporation with eight regional offices that mechanically serviced railroad equipment of all types. Typical work involved the renovating, repairing and re-painting of derailed railroad cars. This facility was the only one of the eight that worked on railroad tank cars, and only tank cars labeled as food grade. Damaged tank cars were always empty on arrival, but not necessarily clean. Industrial tank cars containing chemicals or toxic substances were not handled by this company. In turn, workers at this facility were not trained to work with toxic agents.

The railroad tank car involved in this incident was transporting soybean oil at the time it was involved in a derailment. A cover gas (nitrogen gas) had been added to the head space (unfilled volume) inside the tank car to prevent spoilage during transport. This is a common practice used by producers of vegetable oils that ship their product by railroad tank car or over-the-road tractor-tanker rigs. After the derailment the soybean oil had been removed and the tank car transported to the company facility for inspection and subsequent repairs. Normally, railroad tank cars like this one, which were filled with a cover gas, would be delivered with a permanent exterior warning sign (i.e. stencil, placard, etc.) affixed to alert workers that a hazardous condition existed inside. Also, company policy required that a temporary exterior warning sign (‘red tag” constructed of heavy red paper with wire tie-straps) be affixed to the exterior of such tank cars as an added precaution to insure that workers would be alerted that a hazardous gas or material was inside. Further, a written permit to enter the car was required and additional safeguards were to be followed. This type of hazardous tank car was received infrequently at this facility, this one being the 10th received that year. To the company’s knowledge, this was the first tank car received that was filled with nitrogen gas and lacked a permanent exterior warning sign to alert workers.

The company’s confined space entry procedures, in place at the time of the incident, deem stenciled railroad tank cars as Permit Required Confined Spaces (PRCS). Workers were required to obtain a permit before entering stenciled (or red tagged) tank cars, and the procedure was to place these cars away from main work areas and ventilate them for a full day. After ventilation, the air quality inside would be tested with a portable multi-gas meter (see Photo 2). This consisted of inserting a sampling probe (via plastic tubing) into the tank car at three different levels, and taking multiple readings, the entire procedure taking roughly 5 to 6 minutes to complete. If readings from the meter were outside acceptable limits, ventilation of the tank car was continued. Only when acceptable readings were obtained would entry be approved. Un-stenciled (or non-red tagged) tank cars (or those assumed to

not contain additional hazardous conditions) were not ventilated, but according to procedures, the air inside was tested by the same procedure for stenciled tank cars (multiple readings at three levels for several minutes, etc.). As with stenciled tank cars, entry into an un-stenciled tank car would be permitted only if measured air quality was found to be within acceptable limits.

According to the company's confined space protocol, the more experienced foreman operated the portable multi-gas meter to conduct air quality testing, while the lesser-trained attendant remained at his station near the top hatch to confirm meter readings and provide assistance. There were three foremen at this company facility, and all were trained to operate the portable meter. The first victim was the employee with the most experience using this meter, and had used it 150 times in the past. This portable multi-gas meter was only used to test tank cars at this facility. It was equipped with four (4) different electro-chemical sensors: [oxygen (%), combustible gases (% Lower Explosive Limit), hydrogen sulfide (ppm), and carbon monoxide (ppm)]. The meter also featured a digital readout, built-in (automatic) data logger, and an audible alarm to warn users when measurements outside pre-set limits were detected.

The railroad tank car involved in this incident did not have a permanent warning sign or stencil on its exterior. Only the wire tie-straps were found still affixed to the exterior of the car. By report, a temporary exterior warning sign (red tag) was affixed to the car after its arrival to the facility. Unfortunately, by the time of the incident this temporary warning sign had been accidentally torn off . In turn, workers assumed the tank car was not hazardous, and did not ventilate the inside of the car. Instead, workers went through their normal routine of opening the top hatch and checking air quality inside before entry. A short time into this process, the first victim told the co-worker accompanying him (attendant) that the air inside was fine, stating it was *"better than the air outside",* and *"everything is zeros"*. The attendant did not hear any audible alarm from the meter, nor did he recall anything out of the ordinary. Results from these readings were normally recorded on paper forms, however, forms found later that day on a clipboard at the scene, were blank.

To properly determine the extent of needed repairs, damaged railroad tank cars must be examined from both the outside and inside. The first victim entered the tank car through the top hatch, carrying a flashlight, while the attendant remained near the opening on top of the tank car. Suddenly the attendant heard the flashlight drop to the floor and peered into the car to see the foreman lying on the floor. He assumed he had bumped his head or lost consciousness from a heart attack, and telephoned 911. He also radioed for help over the company's radio system.

First on the scene was another company employee accompanied by another foreman (second victim) who was a long-time friend of the first victim. This second foreman immediately asked the attendant about the air quality inside the tank car, and heard what the first victim had stated: *"better than the air outside"* and *"everything is zeros"*. Since there was no permanent or temporary exterior warning sign prohibiting entry, the second foreman entered the tank car, followed closely by the other company employee. Once the second foreman had entered the tank car, he collapsed against the other company employees feet as he was coming down the entry ladder, then fell to the floor of the car. Seeing this, the other company employee climbed back outside the tank car and waited with the attendant for the emergency crew to arrive.

Members of the local rescue squad arrived within five minutes and used their own multi-gas meter to measure air quality inside the tank car. Their tests showed a complete lack of oxygen inside, so they

donned self-contained breathing apparatuses and retrieved both men from inside the tank car. Unfortunately, both men had been inside the car for 20 – 30 minutes, and had died from asphyxiation.

The company's portable multi-gas meter that was used by the first victim was tested at the scene by the emergency crew and the county Sheriff. It was found to be in normal operating condition. This testing was begun roughly 10 minutes after the men were removed, in the same railroad tank car. The meter functioned properly, and the audible alarm sounded due to the lack of oxygen. The county Sheriff confiscated the gas meter at this point. A short time later, the same meter was tested at its manufacturer's service and repair facility, and was again found to be working properly.

The tank car involved in this incident was not inspected, nor repaired at this facility. Instead, it was transported to a different company where it was properly repaired and placed back in service. Since the time of this incident, the company has not inspected, repaired, or refurbished any railroad tank cars at this particular facility.

CAUSE OF DEATH

The medical examiner listed the cause of death for both men as, *"asphyxia due to air displacement / hypoxia due to nitrogen gas."* Autopsies were performed.

RECOMMENDATIONS / DISCUSSION

Recommendation #1: *Employers must ensure that all components of a comprehensive confined space entry program are in place, emphasized, enforced, and utilized by workers, regardless of an apparent lack of safety hazard.*

Discussion:

It is unclear at this point, what exactly transpired while air quality tests were being conducted by the first victim. Based upon our investigation, the gas meter was found to be functioning properly a very short time after the incident (i.e. operated by the emergency rescue workers in the same tank car where the incident occurred). Also, the meter was found to be functioning properly during official tests conducted by its manufacturer some time after the incident. It does not appear that the multi-gas meter malfunctioned while making the air quality tests. Moreover, had this testing been conducted properly, it is reasonable to assume the portable meter would have functioned properly and sounded its audible alarm. This condition would have alerted both men that the air quality inside the tank car was unacceptable. Then the entry process would likely have been halted until more information was obtained about the meter or the contents of the tank car. In this case it is highly likely the company would have discovered the missing exterior warning sign (i.e. red tag) or would have applied ventilation to this tank car in the same manner as tank cars stenciled or red tagged as hazardous. Retesting of the air quality and subsequent ventilation of the tank car would have occurred until air quality testing reached acceptable levels.

Had the company ensured that workers entering or working around confined spaces adhered to all the items listed in the supplement, these two workers would likely still be alive. For example, the first victim should have been wearing either a safety belt or body harness that was attached to a lifeline. The other end of the lifeline should have been connected to a mechanical device (winch) outside the confined space (29 CFR 1910.146 (k)(3)(i) & (ii)). If

this was the case, moments after the first victim collapsed, he could have immediately been extracted from the tank car. Unfortunately, the attendant was not properly trained to be an attendant for confined space entries or knowledgeable about air quality testing procedures. Even if he had been properly trained, one cannot assume the first victim would have been extracted before the second victim arrived on the scene. On the other hand, had the other company employee continued to climb down the entry ladder into the tank car it is likely that three fatalities would have occurred.

Recommendation #2: *Employers should provide safety equipment to confined space entrants designed to permit their extraction from outside the confined space, and ensure that workers properly use such safety equipment.*

Discussion: As stated previously, the company should have ensured that the first victim was wearing either a safety belt or body harness that was attached to a lifeline and a mechanical lifting device (winch) outside the confined space (29 CFR 1910.146 (k)(3)(i) & (ii)). Use of this equipment by the attendant may have enabled the first victim to be extracted from the tank car before the second victim or emergency personnel arrived on the scene. The moment the first victim collapsed, he could have been removed from the tank car from the outside and minimized risk to other workers. Had the other company employee continued to climb down the entry ladder this incident could easily have involved three fatalities.

Recommendation #3: *Employers must insure that workers testing air quality inside confined spaces are trained not only to conduct these tests, but to conduct them regardless of the situation or lack of an apparent safety hazard.*

Discussion: As stated above, the company is responsible for seeing that air quality tests inside tank cars are conducted properly. Had these tests been completed as required by the company's existing confined space program, it is reasonable to assume the portable multi-gas meter would have functioned properly and sounded its audible alarm. These routine air quality tests must be performed on a regular basis as redundant safety measures, even if there is no perceived risk, and employees should be monitored and disciplined for any non-compliance in this duty. In this case, the missing warning sign or placard was coupled with an insufficient air-quality testing protocol, and workers were not alerted to potential hazards.

Recommendation #4: *Employers must verify that emergency response services are available and that the means of summoning them are operable before an entry into a confined space is initiated.*

Discussion: Neither the entry supervisor, entrant or co-workers contacted the local emergency response service before entry into the tank car occurred. In turn, the means of communication with the emergency help was not tested, nor was their availability to respond to an incident confirmed prior to the confined space entry, which is counter to the OSHA requirements (29 CFR 1910.146 (j)(4)).

Recommendation #5: *Transport containers (i.e. railroad tank cars, over-the-road tractor trailer rigs, etc.) must be marked properly at all times to alert workers of additional hazardous contents and/or conditions.*

Discussion: Ensuring that transport containers or vessels have proper markings or warning signs at all times is an extremely important responsibility that rests with the employer. Further, evaluating a workplace to identify all Permit-Required Confined Spaces (29 CFR 1910.146 (c) (1)) also rests with the employer. Employers should implement programs and procedures to test the air quality inside every railroad tank car no matter if they are marked/tagged/placarded as containing a hazardous environment or not. In turn, the employer should develop redundant methods to ensure railroad tank cars are properly marked and/or tagged at all times during transit, before, and after cars have arrived for refurbishing and/or repair.

Martin L. Jones, PhD, CIH, CSP
Co-Investigator (FACE)
Institute for Rural & Environmental Health
University of Iowa -- Iowa City, Iowa

Wayne Johnson, M.D.
Chief Trauma Investigator (FACE)
Institute for Rural & Environmental Health
University of Iowa -- Iowa City, Iowa

Confined Space Supplement

Confined space entry procedures should be specific to each type of confined space anticipated (i.e. tanks, vessels, silos, pits, etc.). Employers should develop, implement and enforce a confined space entry program as outlined in National Institute for Occupational Safety and Health (NIOSH) publications 80-106, "Working in Confined Spaces," and 87-113, "A Guide to Safety in Confined Spaces." According to OSHA (29 CFR 1910.146), a confined space…..

(1) Is large enough and so configured that an employee can bodily enter and perform work;
(2) Has limited or restricted means of access or egress (tanks, vessels, silos, pits, etc.); and
(3) Is not designated for continuous employee occupancy.

At a minimum, a comprehensive confined space program should address the following for each type of confined space present:

a.) Is it necessary to enter the confined space or can the required operation or activity be completed from the outside?
b.) Is the confined space a Permit-Required Confined Space (PRCS)? Note that PRCS are confined spaces that have one of the following conditions or characteristics:
    i.) Contain or has the potential to contain a hazardous atmosphere;
    ii.) Could contain a substance that has the potential to engulf an entrant;
    iii.) Has an internal space that could trap or asphyxiate an entrant by inwardly converging walls or a floor that slopes downward and tapers to a smaller cross-sectional area; or
    iv.) Contains any other recognized serious safety or health hazard.
c.) Has a confined space entry permit been issued by the appropriate party within the company before the confined space is entered?
d.) Are all confined spaces properly identified and posted with warning signs and proper procedures to alert workers and emergency personnel?
e.) If an entry into a confined space occurs, has the air quality inside the confined space been tested to insure that it is with in acceptable limits, such as:
    i.) Oxygen supply is at least 19.5%.
    ii.) Combustible gases are less than 10% of the lower explosive limit (LEL).
    iii.) Other toxic air contaminants are not present.
f.) Are workers and their supervisors being continuously trained in the selection, proper use, storage and maintenance of:
    i.) Respiratory protection and other forms of personal protective equipment.
    ii.) Air quality testing equipment, including charging and calibration.
    iii.) Body harnesses, safety belts, lifelines (or retrieval lines), etc.
    iv.) Emergency rescue procedures and equipment.
g.) Are the workers that work in and around confined spaces properly trained?
h.) Are confined space entry practices and procedures, including emergency rescue procedures discussed in safety meeting or general training sessions?
i.) Is the appropriate ventilation equipment available and/or used before and during entry into a confined space?
j.) Is the air quality inside the confined space monitored while the ventilation system is operating?
k.) Is an outside observer posted at the entry into the confined space?
l.) What are the appropriate rescue equipment (safety belt or body harness with lifeline) that are to be used during every confined space entry?
m.) Are employees continuously trained in confined space rescue procedures?

Fatality Assessment and Control Evaluation

FACE

FACE is an occupational fatality investigation and surveillance program of the *National Institute for Occupational Safety and Health* (NIOSH). In the state of Iowa, *The University of Iowa*, in conjunction with the *Iowa Department of Public Health* carries out the FACE program. The NIOSH head office in Morgantown, West Virginia, carries out an intramural FACE program and funds state-based programs in: Alaska, California, Iowa, Kentucky, Massachusetts, Minnesota, Nebraska, New Jersey, New York, Ohio, Oklahoma, Texas, Washington, West Virginia, and Wisconsin.

The purpose of FACE is to identify all occupational fatalities in the participating states, conduct in-depth investigations on specific types of fatalities, and make recommendations regarding prevention. NIOSH collects this information nationally and publishes reports and Alerts, which are disseminated widely to the involved industries. NIOSH FACE publications are available from the NIOSH Distribution Center (1-800-35NIOSH).

Iowa FACE publishes case reports, one page Warnings, and articles in trade journals. Most of this information is posted on our web site listed below. Copies of the reports and Warnings are available by contacting our offices in Iowa City, IA.

The Iowa FACE team consists of the following from the University of Iowa: Craig Zwerling, MD, PhD, MPH, Principal Investigator; Wayne Johnson, MD, Chief Investigator; John Lundell, MA, Coordinator; Risto Rautiainen, PhD, Co-Investigator, Martin L. Jones, PhD, CIH, CSP, Co-Investigator, and John Kraemer, PA. From the Office of The State Medical Examiner.

Additional information regarding this report or the Iowa Face Program is available from:

Iowa FACE Program
105 IREH, Oakdale Campus
The University of Iowa
Iowa City, IA. 52242-5000

Toll Free 1-800-513-0998
Phone: (319)-335-4351 Fax: (319) 335-4225
Internet: http://www.public-health.uiowa.edu/face
E-mail: wayne-johnson@uiowa.edu