

FATALITY INVESTIGATION REPORT

INCIDENT FACTS

DATE:

May 17, 2012

TIME:

5:34 p.m.

VICTIM:

25-year-old boat maintenance crew supervisor

INDUSTRY/NAICS CODE:

Ship building and repairing
NAICS 336611

EMPLOYER:

Repair, restoration, cleaning, and painting services to commercial ships and boats

SAFETY & TRAINING:

Company had a safety program

SCENE:

Fishing boat moored at a dock

LOCATION:

Washington State

EVENT TYPE:

Poisoning



REPORT #: 52-44-2018

REPORT DATE: 08/02/2018

A Boat Maintenance Crew Supervisor Dies of Carbon Monoxide Poisoning While Using a Gasoline-Powered Pressure Washer

SUMMARY

On May 17, 2012, a 25-year-old boat maintenance crew supervisor died from carbon monoxide poisoning while using a gasoline-powered pressure washer to strip paint from a boat.

On the day of the incident, he was supervising a crew using a pressure washer and disc grinders to remove old paint from the exterior of a 162-foot steel hulled fishing boat moored at a dock. The six crew members were working on the boat in different areas that were covered with plastic tarps in order to prevent paint chips and dust from entering the water.

At the start of the day, the gasoline-powered pressure washer was positioned on the dock. Later, employees of another contractor moved the pressure washer onto the boat to clear the way for supply deliveries. Shortly before the end of the work day, the victim moved the pressure washer onto a side deck passageway that was fully enclosed by plastic tarps. Working alone, he used the pressure washer for about 20 minutes. A co-worker went to look for the victim and found him unconscious on top of the pressure washer. Emergency responders arrived and determined that the victim was deceased. The medical examiner reported the cause of death as “carbon monoxide intoxication due to inhalation of engine exhaust.”

RECOMMENDATIONS

Washington State Fatality Assessment and Control Evaluation (FACE) investigators concluded that to protect employees from the hazard of carbon monoxide (CO) poisoning from small gasoline-powered engines and tools, employers should:

- Ensure that gasoline-powered pressure washers or other fuel-powered tools are not used in enclosed or partially enclosed areas where CO can build up.
- Train employees on the hazards, sources, symptoms, and control of CO exposure from fuel-powered equipment and tools.
- Ensure that personal CO detectors equipped with audible alarms are used by employees when working with small gasoline-powered engines in locations where CO may build up.
- Coordinate work activities at job sites where there are multiple contractors and their employees to ensure safe work.
- Ensure that CO safety warning labels are attached to pressure washers and that they are replaced when no longer readable.
- Consider using alternatives to fuel powered equipment and tools.



DEFINITIONS

APP	Accident Prevention Program
CO	Carbon Monoxide
COHb	Carboxyhemoglobin
DOSH	Division of Occupational Safety and Health
HP	Horsepower
IDLH	Immediately Dangerous to Life and Health
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PSI	Pounds per Square Inch
STEL	Short-Term Exposure Limit
TWA	Time-Weighted Average
WA FACE	Washington State Fatality Assessment and Control Evaluation program

WASHINGTON STATE FACE PROGRAM INFORMATION

The Washington State Fatality Assessment and Control (WA FACE) program is one of many workplace health and safety programs administered by the Washington State Department of Labor & Industries' Safety & Health & Research for Prevention (SHARP) program. It is a research program designed to identify and study fatal occupational injuries. Under a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH grant# 5 U60OH008487), WA FACE collects information on occupational fatalities in WA State and targets specific types of fatalities for evaluation. WA FACE investigators evaluate information from multiple sources. Findings are summarized in narrative reports that include recommendations for preventing similar events in the future. These recommendations are distributed to employers, workers, and other organizations interested in promoting workplace safety. NIOSH-funded, state-based FACE programs include: California, Kentucky, Massachusetts, Michigan, New York, Oregon, and Washington. WA FACE does not determine fault or legal liability associated with a fatal incident. Names of employers, victims and/or witnesses are not included in written investigative reports or other databases to protect the confidentiality of those who voluntarily participate in the program.

Additional information regarding the WA FACE program can be obtained from:

www.lni.wa.gov/Safety/Research/FACE

PO Box 44330

Olympia, WA 98504-4330

1-888-667-4277



CONTENTS

BACKGROUND..... 4

INTRODUCTION..... 4

EMPLOYER..... 4

WRITTEN SAFETY PROGRAMS and TRAINING..... 4

WORKER INFORMATION 5

EQUIPMENT 5

EXPOSURE 5

INCIDENT SCENE..... 6

WEATHER 6

INVESTIGATION 6

CAUSE OF DEATH 7

CONTRIBUTING FACTORS..... 7

RECOMMENDATIONS/DISCUSSION 9

REFERENCES..... 10

ADDITIONAL RESOURCES 11

INVESTIGATOR INFORMATION 12

ACKNOWLEDGEMENTS..... 12

DISCLAIMER..... 12



BACKGROUND

Carbon monoxide (CO) is a colorless, odorless, tasteless, nonirritating toxic gas that is produced by burning fuel, such as gasoline, wood, coal, propane, oil, or kerosene. It is found in engine exhaust. When fuel burning equipment, tools, and appliances are used in enclosed or semi-enclosed spaces, CO levels can quickly build to dangerous or fatal concentrations. Hazardous CO levels can build up even in spaces that appear to be well ventilated.

CO combines with hemoglobin to form carboxyhemoglobin which interferes with the oxygen-carrying capacity of blood, resulting in a deficiency in the amount of oxygen reaching body tissue.¹ The common mild-to-moderate viral-like symptoms of CO exposure such as fatigue, headache, nausea, confusion, and dizziness may be easy to overlook. Severe health effects of CO exposure include disorientation, unconsciousness, long-term neurologic disabilities, coma, cardiorespiratory failure, and death.

CO is a leading cause of death due to poisoning in the United States.² From 1999 through 2010, the National Center for Vital Statistics reported a total of 5,149 unintentional, non-fire related deaths from CO poisoning, an average of 430 deaths per year.³ A separate study found 374 occupational CO exposure fatalities during the period 1992 through 2008.⁴ A study of occupational carbon monoxide poisoning in Washington State found that for a 6-year period there were 221 different exposure incidents resulting in 345 individual worker injury claims comprising. The distribution of exposure incidents occurred in numerous industry sectors, with the highest numbers in construction 43 (20%), wholesale trade 32 (15%), and agriculture 27 (12%).⁵

INTRODUCTION

In May of 2012, the Washington State Fatality Assessment and Control Evaluation (WA FACE) Program noted a news article about the death of a 25-year-old boat maintenance crew supervisor who died from CO poisoning while using a gasoline-powered pressure washer to strip paint from a boat exterior.

Washington State FACE investigators interviewed the incident company owner. Documents reviewed during the course of this investigation included the OSHA inspection file, the victim's death certificate, police report, and medical examiner's report.

EMPLOYER

The employer provided repair, restoration, cleaning, and painting services to commercial ships and boats. The business, a sole proprietorship, had been operating for 17 years. The employer directly oversaw his employees and provided daily task-based support. The employer had 20 fulltime employees at the time of the incident. There were four employees who, like the victim, worked as supervisors.

WRITTEN SAFETY PROGRAMS and TRAINING

The employer/owner had a written accident prevention program (APP), a respiratory protection program, and a confined space program. These programs were in both English and Spanish. The APP did not include information about CO exposure from the use of gasoline-powered pressure washers; the employer stated that he provided this information verbally.

The employer was in charge of safety for the company. He provided employees with hands-on training in how to perform job tasks and how to work safely. He or an experienced employee would watch a new worker performing a task to see that they did it correctly and safely. The employer used a contractor to do training for employees in fall protection, CPR, and other safety matters. He was a shipyard competent person, meaning he was responsible for

determining whether a space was safe for workers and prescribing and implementing the appropriate safety measures.^{6,7}

Safety and health meetings were held every two weeks. Before each job the employer held a meeting at the job site where he explained to employees what they were going to be doing and what safety measures they needed to take.

WORKER INFORMATION

The 25-year-old victim supervised a crew of boat painters. In addition to supervising a crew, he also performed all the tasks that his crew performed in the process of painting steel hulled vessels, such as removing old paint by using a grinder, pressure washing, priming, and applying a finish coat of paint. He had been hired as a laborer three years prior and had worked his way up to the position of supervisor. He was trained on-the-job by his employer in how to perform the various required tasks and supervisory responsibilities. Previously, he had worked as a landscaper. His native language was Spanish, which he used to communicate with his Spanish speaking crew and employer. He spoke some English, it is unknown how well he read English.

EQUIPMENT

The piece of equipment was a 24 HP, 5,000 PSI maximum pressure gasoline-powered pressure washer. The engine was mounted on a roll cage frame with tires. Its engine was an air-cooled, 4-stroke overhead valve, 2 cylinder, V-Twin. The manufacturer states that this small engine has common applications in powering pressure washers, commercial lawn and garden equipment, tillers, generators, small vehicles, water pumps, and forestry, construction, industrial and agricultural equipment.⁸

The employer stated that there was a manufacturer's user manual available to employees, and that some workers had reviewed the manual. User manuals are available in English and Spanish from the manufacturer.

The user manual for the pressure washer contained warnings about CO exposure, symptoms in those exposed, and to only operate out of doors away from openings where the exhaust gas could enter enclosed areas.

It is not known whether there was a label attached to the pressure washer engine warning of the danger of carbon monoxide from engine exhaust. The engine manufacturer owner's manual indicates that a CO warning label should have been attached by the manufacturer. This label would have this warning: "the engine emits toxic carbon monoxide – do not run in an enclosed area." The engine appears dirty in photos; if there was a warning label, it may have been difficult or impossible to read. The owner's manual indicates that if a label comes off or is hard to read, to contact the manufacturer's servicing dealer for a replacement. Warning labels are available in English and Spanish.

The company owned eleven gasoline-powered pressure washers: four were 5,000 PSI and seven were 4,000 PSI.

EXPOSURE

The employer estimated that the victim was exposed to carbon monoxide from the pressure washer's exhaust gas inside the boat's plastic tarped companion way deck for about 20 minutes before his death. The medical examiner reported the toxicological analysis of the victim's blood showed a peak blood carboxyhemoglobin (COHb) level of 63.2%. The typical blood COHb level for a non-smoker is between 0.5% and 1.5%.⁹



Photo 1: Incident gasoline-powered pressure washer.



Based on the victim's COHb level, OSHA's Salt Lake Technical Center calculated the victim's CO exposure averaged approximately 1100 parts per million (ppm). For perspective, the OSHA Immediately Dangerous to Life or Health (IDLH) exposure concentration is 1200 ppm.¹⁰ The victim's 8-hour time-weighted average exposure was 556 ppm, which is 11 times the OSHA PEL of 50 ppm for CO.

INCIDENT SCENE

The incident took place aboard a longline fishing boat. The 162-foot-long boat was moored at a city owned short-term moorage and maritime industrial facility for fishing and commercial vessels. The facility had 1,518 linear feet of concrete dock space for vessel loading and repair/maintenance work. The moorage was located on a freshwater bay near locks leading to a larger saltwater bay.

WEATHER

During work hours on the day of the incident, there was a mixture of clouds and sun with temperatures ranging from 48 to 61 degrees; wind speeds ranged from calm to 8 mph.¹¹

INVESTIGATION

For several weeks, the employer's work crew had been performing painting preparation work on the exterior of a 162-foot steel-hulled fishing boat. The painting process involved several procedures. First, the workers would use gasoline-powered pressure washers to wash the boat's metal exterior to remove old paint. Next, they would use hand-held disc grinders to further remove old paint and smooth the steel surface. Then they would rewash, followed by a primer coat of paint, and, lastly, a finish coat.

On the day of the incident, the crew of six employees started work at 7 a.m. The victim was supervising two crewmembers working from a scaffold using grinders to remove paint from the front exterior of the boat's wheelhouse. He was also overseeing three workers who were cleaning the inside the boat's engine room. The victim's task, in addition to supervising, was to sweep up paint chips so that they would not leave the boat and go into the water. The victim was working on the starboard (right side of boat) companion way deck alongside the wheelhouse. The companion way deck was approximately 80 feet long. In addition to the employer's workers, there were other contractors and their employees on the boat doing repair and maintenance work. The boat's chief engineer was in charge of the boat. He was employed by the boat's owner.

In order to prevent paint chips and dust created by grinding and pressure washing from entering the lake water, the workers had put up plastic tarping covering the front and right side of the boat's wheelhouse.

According to the employer, when his workers were pressure washing a boat, the pressure washer would be left on the dock and a hose run from it to where the worker needed to use it.

During the day of the incident, workers from other companies were delivering supplies to the boat. The pressure washer was in their way on the dock, so they used the boat's crane to lift the pressure washer onto the boat, placing it on the deck towards the bow.

The employer's crew worked through the day, performing their assigned tasks of grinding, cleaning, and sweeping up. Shortly after 4 p.m., the employer stopped by to check with the crew to see if they needed anything. His workers assured him that they did not need anything and that work was going fine. The employer then left to check on another job, saying that he would see them in the morning.

When the employer left, the victim was sweeping up paint chips and dust created by the grinders. This is what the employer expected him to continue to do until the end of the work day at 5:30 p.m. Instead, he decided to use the pressure washer to clean the wall of the wheelhouse companion way deck, located near the boat's stern. The victim moved the pressure washer into the companion way deck under the enclosure of the plastic tarping where he was working alone. The companion way deck was fully enclosed along the side and both ends by the plastic tarping. The workers would duck under the plastic to get in and out of the area. This enclosed space was not ventilated. The pressure washer had a 50-foot long hose. The victim was working near the stern and the pressure washer was positioned alongside the wheelhouse near its front, not far from where the other two workers were working from a scaffold grinding on the front of the wheelhouse.

After approximately 20 minutes, the victim stopped pressure washing and walked along the companion way deck in the direction of the bow where the pressure washer was located, about 50 feet away. As it was now 5 p.m., their work day was nearly finished and they needed to start putting equipment away, a co-worker went to look for the victim. He found him inside the tarped area, about 10 feet to the stern from the wheelhouse front. He was unconscious and collapsed face-down on top of the pressure washer which had been turned off. Another co-worker called the employer, who then summoned emergency first responders. A carpenter who worked for another contractor performed CPR. None of these workers knew what had happened to the victim. City police and firefighters responded to the site. He was pronounced dead at the scene by the medical examiner.

CAUSE OF DEATH

According to the death certificate, the medical examiner reported the cause of death as "carbon monoxide intoxication due to inhalation of engine exhaust."

CONTRIBUTING FACTORS

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. Washington FACE investigators identified the following factors that may have contributed to the death of the boat maintenance crew supervisor:

- Using a gasoline-powered pressure washer in an enclosed, unventilated area.
- Victim's apparent lack of awareness of the consequences of CO exposure.
- Air monitoring was not used to ensure that carbon monoxide levels were kept below the permissible exposure level.
- Lack of coordination among multiple contractors at the job site may have caused the pressure washer to be placed in an unsafe location.



Photo 2: The yellow arrow indicates where the victim had been pressure washing the exterior of the wheelhouse. The red arrow indicates where the victim was found unconscious on top of the pressure washer. Plastic sheeting covered the entire area. [Photo not at incident scene.]



Photo 4: The boat's wheelhouse companion way where the victim was found slumped on top of the pressure washer (red "X"). Temporary plastic sheeting enclosed the area (it was cut open by EMS responders). The hose on the deck leads to the stern where the victim had been pressure washing.



Photo 3: Exterior of the boat covered with a plastic tarp located near the stern where the victim was pressure washing.



Photo 5: Exterior of fishing boat showing plastic sheeting covering the front of the boat's wheelhouse.

RECOMMENDATIONS/DISCUSSION

Recommendation 1: Employers should ensure that gasoline-powered pressure washers or other fuel-powered equipment and tools are not used in enclosed or partially enclosed areas where CO can build up.

Discussion: When planning work projects, employers should ensure that workers are not exposed to dangerous levels of CO during performance of tasks requiring the use of fuel-powered equipment and tools. Periodic spot checks should be made by the employer or a designated competent person to ensure that safe work procedures are being followed so that workers are not being overexposed to CO.

The National Institute for Occupational Safety and Health has issued an alert “Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines and Tools” with this warning: “Do not use equipment and tools powered by gasoline engines inside buildings or other partially enclosed spaces unless the gasoline engine can be placed outdoors and away from air intakes”.¹²

Recommendation 2: Employers should train employees on the hazards, sources, symptoms, and control of CO exposure from fuel-powered equipment and tools.

Discussion: Employers should train employees who use fuel-powered equipment and tools about CO exposure. This should include recognition of:

- **Hazards of CO exposure.** CO is a poisonous gas that is colorless, odorless, tasteless, and nonirritating. It can cause illness, permanent neurological damage, and death. Exposed persons can be overcome without warning. Depending on the amount being emitted from equipment or tools, it can build up quickly or accumulate over a longer period of time in enclosed or partially enclosed areas.
- **Sources of exposure.** CO is produced by gas-powered engines and anything that uses combustion to operate, including fuel-powered engines, pressure washers, generators, pumps, compressors, welding equipment, and space heaters.
- **Symptoms of exposure.** Early symptoms of CO intoxication are confusion, headache, dizziness, fatigue, and weakness. Employers should train workers to recognize the early symptoms of CO intoxication and direct workers to seek fresh air upon first noticing symptoms and to warn other workers in the area at risk of exposure.
- **Control of exposure.** Do not use gas powered equipment or tools inside buildings or areas that are enclosed or semi-enclosed. Place pressure washer outdoors and keep away from building air intakes, so as to not expose workers inside the building. Provide continuous ventilation at volumes and flow rates sufficient to ensure that workers are not overexposed to CO. Use personal CO monitors with alarms to provide warning of high levels of CO air concentrations. When feasible, substitute nonfuel burning technologies, such as electricity.

Recommendation 3: Employers should ensure that personal CO detectors equipped with audible alarms are used by employees when working with small gasoline-powered engines in locations where CO may build up.

Discussion: Workers using gasoline-powered equipment should wear personal exposure real-time monitors with response times in seconds, not minutes, and audible alarms that correspond to OSHA’s Immediately Dangerous to Life and Health (IDLH), Short-Term Exposure Limit (STEL), and Time-Weighted Average (TWA) for CO. Similar monitors should also be used in the general work area around gasoline-powered equipment to warn workers in the area of CO exposure hazards.

Recommendation 4: Employers should coordinate work activities at job sites where there are multiple contractors and their employees to ensure safe work.

Discussion: On the day of the incident, there were workers other than the employer's engaged in various tasks on the boat. At some point during the day, the boat's crane was used to move the pressure washer from the dock onto the boat by some of these other workers. This was done because supplies needed to be moved onto the boat, the pressure washer was considered to be in the way. The crane and the decision to use it was under the control of the boat's chief engineer who is in charge of the boat and is responsible to the owner. It is unknown who made the decision to move the pressure washer or whether there was communication about this with the employer's supervisor, the victim. It is also unknown why the pressure washer was moved into the plastic tarp enclosed space of the boat's companion way deck. The employer believes that the victim moved it there.

A Certified Marine Chemist inspected and tested the atmosphere of areas of the boat where work was planned and issued a certificate which was posted on the boat. Worker CO exposure relating to pressure washing work on the starboard companion way deck was not noted on the Marine Chemist's certificate.

If the pressure washer had remained on the dock, this fatality would not have occurred. It is essential that coordination of work activities at job sites be planned and communicated to all affected contractors and their employees to ensure work is conducted in a safe manner.

Recommendation 5: Employers should ensure that CO safety warning labels are attached to pressure washers and that they are replaced when no longer readable.

Discussion: Incident scene photos of the pressure washer do not show any safety labels affixed to the machine warning of CO exposure. It is unknown whether the pressure washer previously had these labels, and if so whether they were worn off or obscured by grime and dust. The manufacturer of the incident pressure washer's engine provides a safety warning label that reads, in part, "engine emits toxic carbon monoxide – do not run in enclosed area."

Recommendation 6: Consider using alternatives to fuel-powered equipment and tools.

Discussion: Employers should consider the use of technologies that do not rely on equipment or tools powered by fuel, thereby removing the hazard of CO exposure to workers. For example, electric-powered pressure washers or laser technology can be used to clean and remove paint from many types of steel structures, including ships.

REFERENCES

1. U.S. Bureau of Labor Statistics. Job Fatalities Due to Unintentional Carbon Monoxide Poisoning, 1992-96. Compensation and Working Conditions, Fall 1998.
www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwil0ISoxY3bAhU4IMKHbOwB5gQFggnMAA&url=https%3A%2F%2Fwww.bls.gov%2Fopub%2Fmlr%2Fcwc%2Fjob-fatalities-due-to-unintentional-carbon-dioxide-poisoning-1992-96.pdf&usg=AOvVaw1E0S1Rk2rquQl170DqKcxe
2. Centers for Disease Control and Prevention (CDC). Carbon Monoxide Exposures – United States, 2000—2009. Morbidity and Mortality Weekly Report 2011; 60(30); 1014-1017.
www.cdc.gov/mmwr/preview/mmwrhtml/mm6030a2.htm

3. Centers for Disease Control and Prevention (CDC). Quick Stats: Average Annual Number of Deaths and Death Rates from Unintentional, Non-Fire-Related Carbon Monoxide Poisoning, by Sex and Age Group, United States, 1999-2010. Morbidity and Mortality Weekly Report 2014; 63:65. www.cdc.gov/mmwr/preview/mmwrhtml/mm6303a6.htm
4. Henn SA, Bell JL, Sussell AL, Konda S. Occupational carbon monoxide fatalities in the US from unintentional non-fire related exposures, 1992-2008. American Journal of Industrial Medicine 2013 November; 56 (11): 1280-1289. <https://onlinelibrary.wiley.com/doi/full/10.1002/ajim.22226>
5. Carolyn K. Reeb-Whitaker, David K. Bonauto, Stephen G. Whittaker & Darrin Adams. Occupational Carbon Monoxide Poisoning in Washington State, 2000–2005. Journal of Occupational and Environmental Hygiene 2010, 7:10, 547-556. www.tandfonline.com/doi/abs/10.1080/15459624.2010.488210
6. Washington Administrative Code. WAC 296-304-01021. Competent Person, Safety standards for ship repairing, shipbuilding and shipbreaking. <http://apps.leg.wa.gov/wac/default.aspx?cite=296-304-01021>
7. Occupational Safety and Health Administration (OSHA). 29 CFR, Part 1915, Occupational Safety and Health Standards for Shipyard Employment, Subpart A, General Provision 1915.7, Competent Person. [www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10215#1915.7\(d\)](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10215#1915.7(d))
8. Honda. <https://engines.honda.com/models/model-detail/gx690>
9. Centers for Disease Control and Prevention (CDC), Agency for Toxic Substances and Disease Registry (ATSDR). ToxGuide for Carbon Monoxide. www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwijn9TFjM_cAhVsljQIHfyKDGyQfjAAegQlCRAC&url=https%3A%2F%2Fwww.atsdr.cdc.gov%2Ftoxguides%2Ftoxguide-201.pdf&usg=AOvVaw1Jr_ZJMPwh3PyBpdoNm7O-
10. National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention. Carbon Monoxide – Immediately Dangerous to Life or Health Concentrations. www.cdc.gov/niosh/idlh/630080.html
11. Weather Underground. www.wunderground.com/history/airport/KBFI/2012/5/17/DailyHistory.html
12. National Institute for Occupational Safety and Health (NIOSH). Preventing carbon monoxide poisoning from small gasoline-powered engines and tools. www.cdc.gov/niosh/docs/96-118/

ADDITIONAL RESOURCES

- Centers for Disease Control and Prevention (CDC). Average annual number of deaths and deaths from unintentional, non-fire-related carbon monoxide poisoning, by sex and age group. www.cdc.gov/mmwr/preview/mmwrhtml/mm6303a6.htm
- Centers for Disease Control and Prevention (CDC). Carbon monoxide-related deaths, United States, 1999-2004. www.cdc.gov/mmwr/preview/mmwrhtml/mm5650a1.htm
- Centers for Disease Control and Prevention (CDC). Nonfatal, unintentional, non-fire-related carbon monoxide exposures, United States, 2004-2006. www.cdc.gov/mmwr/preview/mmwrhtml/mm5733a2.htm
- Centers for Disease Control and Prevention (CDC). Agency for Toxic Substances and Disease Registry (ATSDR). Carbon Monoxide – Fact Sheet. www.atsdr.cdc.gov/toxfaqs/TF.asp?id=1163&tid=253
- Center to Protect Workers' Rights (CPWR). Carbon monoxide, toolbox talk (English and Spanish). www.cpwr.com/publications/carbon-monoxide-poisoning



Center to Protect Workers' Rights (CPWR). Carbon monoxide poisoning – gas-powered generators tools and other equipment, hazard alert (English and Spanish). www.cpwr.com/publications/carbon-monoxide-poisoning-0

National Institute for Occupational Safety and Health (NIOSH). Carbon monoxide, publications and resources. www.cdc.gov/niosh/topics/co-comp/

Occupational Safety and Health Administration (OSHA). 29 CFR 1915, Occupational Safety and Health Standards for Shipyard Employment, Subpart Z, Air contaminants, Toxic and Substances. www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10286&p_text_version=FALSE

Occupational Safety and Health Administration (OSHA). Ship repair. www.osha.gov/SLTC/etools/shipyard/shiprepair/sr_index.html

Washington State Department of Labor and Industries. Carbon Monoxide. www.lni.wa.gov/Safety/Topics/AtoZ/CarbonMonoxide/

Washington State Department of Labor and Industries, Washington Administrative Code (WAC). WAC 296-304-02005, Cleaning and other cold work, Safety standards for ship repairing, shipbuilding and shipbreaking. <http://app.leg.wa.gov/WAC/default.aspx?cite=296-304&full=true#296-304-02005>

INVESTIGATOR INFORMATION

Todd Schoonover has a PhD in Industrial Hygiene from the University of Illinois at Chicago. He is a Certified Industrial Hygienist (CIH) and Certified Safety Professional (CSP). Todd is currently the Principle Investigator for the WA FACE Program.

Christina Rappin has a BA/BS from The Evergreen State College. She is a Research Investigator with the WA FACE program.

Randy Clark has a BA from the Evergreen State College. He is a Safety and Health Specialist with the WA FACE Program.

ACKNOWLEDGEMENTS

This report was reviewed by stakeholders from labor and business communities and various Washington State and Federal worker safety agencies. Though we are unable to acknowledge specific individuals for their contributions to this report, we would like to recognize the following for their help and support of the FACE mission and objectives:

- The employer involved in the incident
- Occupational Safety and Health Administration (OSHA)
- Federal FACE Program management (NIOSH)
- Safety & Health Assessment & Research for Prevention (SHARP)

DISCLAIMER

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH). In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.