OREGON State FACE Program
Fatality Assessment & Control Evaluation

Oregon Institute of Occupational Health Sciences • Oregon Health & Science University
3181 SW Sam Jackson Park Rd. L606 • Portland, OR 97239 • 503-494-3940

FATALITY INVESTIGATION REPORT

INCIDENT HIGHLIGHTS

DATE:
March 21, 2017

TIME:
8:00 a.m.

VICTIM:
46-year-old Hispanic farm mechanic

INDUSTRY/NAICS CODE:
Agriculture/11

EMPLOYER:
Multi-crop family farm

SAFETY & TRAINING:
Safety meetings & training facilitated by an outside organization

SCENE:
Farm mechanic shop building

LOCATION:
Oregon

EVENT TYPE:
Explosion

Farm mechanic died after torch cutting explosion – Oregon

REPORT#: 2017-07-1 **REPORT DATE:** March 2019

SUMMARY

On March 21, 2017, a 46-year-old Hispanic farm mechanic used a plasma torch to remove the lid from an old 55-gallon drum that formerly contained flammable brake wash fluid. The drum was empty but not cleaned. The first cut with the torch caused a flash and explosion that blew the bottom off of the drum and knocked the mechanic unconscious. He died in the hospital three months later. (Full report begins on p. 3)

CONTRIBUTING FACTORS

Key contributing factors identified in this investigation include:

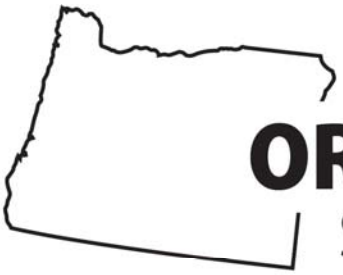
- Using a hot work method to remove the lid from a drum that formerly contained a flammable liquid
- Not cleaning or testing the used drum before hot work was performed
- Inadequate knowledge of, or access to, alternate, safer method(s) for removing the lid
- Inadequate training and communication regarding specific job hazards

(Contributing factors continued on p. 6)

RECOMMENDATIONS

Oregon Fatality Assessment and Control Evaluation (OR-FACE) investigators concluded that to help prevent similar occurrences, employers should:

- Never weld, cut, or perform other hot work on a drum or other metal container unless it has been cleaned and vented thoroughly.
- To further reduce the risk of ignition or explosion, use a non-sparking, manual tool when removing a lid from a metal drum or barrel.
- Routinely assess job hazards, provide regular, periodic training and communications on site-specific hazards and safe work practices, and take corrective action when needed.
- Check and monitor employees' knowledge of job hazards and implementation of safe practices to control those hazards.
- Provide appropriate, adequate personal protective equipment and ensure its appropriate use. (Recommendations section starts on p. 7)



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Oregon Fatality Assessment and Control Evaluation (FACE) Program

The Oregon Fatality Assessment and Control Evaluation (OR-FACE) Program is a project of the Oregon Institute of Occupational Health Sciences at Oregon Health & Science University (OHSU). OR-FACE is supported by a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH) (grant #U60OH008472) through the Occupational Public Health Program (OPHP) of the Public Health Division of the Oregon Health Authority. OR–FACE reports are for information, research, or occupational injury control only. Safety and health practices may have changed since the investigation was conducted and the report was completed. Persons needing regulatory compliance information should consult the appropriate regulatory agency.

OR-FACE supports the prioritization of safety interventions using a hierarchy of safety controls, where top priorities are hazard elimination or substitution, followed by engineering controls, administrative controls (including training and work practices), and personal protective equipment.

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INTRODUCTION

On March 21, 2017, a 46-year-old Hispanic farm shop mechanic was knocked unconscious by an explosion that occurred when he was using a plasma torch to remove the lid from a 55-gallon metal drum that formerly contained a flammable liquid. OR-FACE received notification of the incident from Oregon OSHA (OR-OSHA). This investigation report is based on review of OR-OSHA investigation documents and follow-up discussions with the OR-OSHA investigator; review of an incident investigation report written by an outside safety consultant and follow-up discussions with that consultant; and best practices research.

BACKGROUND

Hot work includes welding, brazing, cutting, soldering, grinding, and other processes that produce or use flames, sparks, or heat that could act as an ignition source, and can expose workers to a variety of safety and health hazards. The heat produced by such work can generate air contaminants and hazardous decomposition products. Workers performing hot work are exposed to the risk of fire and explosion from ignition of flammable or combustible materials in the area. Other hazardous exposures can include ultraviolet (UV) light, noise, or skin injury. Hot work is common in many industry sectors. While this incident occurred on a farm, hot work and its associated risks are found in construction, manufacturing, boat building, oil and gas, and renovation and maintenance work in almost any setting.

EMPLOYERS

The decedent worked at a family-owned, multi-crop farm that also provides agri-tourism events for visitors. The farm has been in business for 40 or more years. The farm employed a total of 14 employees at the time of the incident, including full-time and part-time employees, and four owners who manage farm operations. There were 13 employees working on site on the day of the incident.

WRITTEN SAFETY PROGRAMS and TRAINING

The employer, along with other area agricultural employers, belongs to a non-profit organization that provides educational resources and other services for members. These services include facilitation of monthly safety meetings and quarterly walk-throughs on members' sites. The organization also sub-contracts with outside safety consultants to help facilitate these safety-related services. Review of available safety meeting minutes recorded over a several-month period prior to the incident suggested that follow-up on action items, and day-to-day implementation of safety topics discussed at meetings, may have been limited or inconsistent.

Based on document review and discussions with the OR-OSHA compliance officer and the outside safety consultant, it appeared that training provided by the employer at the farm was informal. It was reported that the employer's written Hazard Communication (HazCom) Program was based on a template provided by their workers' compensation insurance carrier. Review of a copy of available portions of this document indicated that site-specific job hazards were not addressed in any detail.

WORKER INFORMATION

The decedent had 25 years of experience working for this employer. He had worked his way up from field laborer to mechanic. It was reported that he was knowledgeable, experienced, and proficient in using the plasma torch. It was also reported that one co-worker described him as a "…very skilled, safe, and responsible employee," and that he was considered a skilled fabricator who took initiative. During the growing season, he operated equipment such as tractors

and combines. During the non-growing season (when the incident occurred), he spent time repairing and maintaining various farm equipment. He spoke and read both English and Spanish fluently. His direct supervisor was also fluent in both languages.

INCIDENT SCENE

The incident occurred near the front of the farm's mechanical shop building (see photo 1) on an approximately 15-acre farm. The purpose of removing the drum lids was to repurpose the drums for use as trash containers. He had opened the shop's bay door part way, presumably for ventilation, because smoke was produced when he used the torch to remove the lid from a different drum earlier that morning.

Photo 1. Shop exterior; bay door reportedly had been partway open at time of incident, presumably for ventilation (*Photo courtesy of OR-OSHA*).

WEATHER

The weather was not considered to be a factor in the incident. According to Weather Underground – Historical Weather, the average temperature on the day of the incident was 54 degrees Fahrenheit (F); the temperature at the time of the incident was approximately 46 degrees F. Light rain was falling (≤ 0.1 inch). Wind speed was reported as calm just prior to the time of the incident and an easterly wind up to 13 miles per hour (mph) was reported shortly after the time of the incident.

INVESTIGATION

It was reported that the farm used empty 55-gallon steel drums as trash containers in the fields because they were heavy and didn't blow over. The task of removing drum lids to make them into trash cans was typically performed every couple of years, either by a supervisor or by the mechanic (decedent). Typically this task was performing using the plasma torch, and the work typically was done in the farm's mechanical shop. The torch was purchased new three to five years before the incident. It was reported there were no mechanical, non-sparking tools to remove drum lids available on site.

On the day before the incident, the mechanic used the plasma torch to remove lids from three other drums. Just prior to the incident the next morning, the mechanic removed the lid from a first drum. OR-OSHA reported observing a small amount of residual product in the first drum; OR-OSHA also reported observing a label indicating the first drum's original content to be antifreeze, and also a pictogram indicating not to apply heat. Review of interview remarks indicated that the mechanic reported to his supervisor that the cutting performed on the first drum that morning produced smoke. Evidence indicated that the mechanic partially opened the shop bay door prior to removing the lid of a second drum (the drum that exploded), presumably for ventilation. Security camera footage from the shop indicated that just prior to working on the second drum, the mechanic tilted the drum on an angle and then rolled it toward the front of the shop near the partially opened door. He was working alone at the time of the incident.

A review of available safety training records and the farm's written HazCom program suggested that internal training at the farm was informal and did not address site-specific job hazards in any detail. There were no procedures for safe removal of drum lids in the farm's written safety program records. The supervisor indicated he had advised the mechanic to clean the drums prior to cutting them. It is not known what specific cleaning technique was expected, or whether any cleaning practice was followed either on the day of the incident or during prior, similar work. It was reported that supervisory personnel provided "informal trainings," such as advising the mechanic not to cut near flammable materials and to "check to ensure it was safe to cut." It was also reported that on the day before the incident, the supervisor provided a general reminder to check drum contents prior to performing hot work, but no specific instructions were given. Evidence did not indicate the level of knowledge the mechanic had regarding flammable hazards, but he was considered to be generally familiar with the hazards and with flammable labels. Records indicated that approximately a month prior to the incident, the mechanic attended a safety training where a farm shop safety video was shown. The video provides an overview of common safety concerns in a typical farm shop. It is not known whether the safety video addressed flammable hazards. On the whole, evidence suggests that typical safety supervision and safety program processes at the farm did not regularly address specific safe practices for working around flammable materials.

It was reported that empty drums were periodically obtained in bulk from an outside vendor that delivered the drums to the farm. Evidence suggests that the drum that exploded may have been on site for at least 15 years prior to the incident. Product-specific safety data sheets (SDS) were not available, and it is not known if they accompanied the drums when originally obtained. Labels on the drum that exploded indicated its former content was a flammable "brake wash blend" (see photos 2, 3, and 4 on the next page). The OR-OSHA investigator obtained a SDS for a similar brake wash blend product, which stated, "Classified as flammable material. Avoid heat, sparks, or flames."

Evidence indicated that the mechanic's first cut with the torch on the drum lid caused a flash and an explosion that blew the bottom off the drum and knocked the mechanic to the ground. His supervisor was approximately 100 yards away when the explosion occurred. Two other workers and a neighbor reported hearing a loud explosion. Co-workers ran to the shop where they found the mechanic lying on the concrete floor of the shop, unconscious but breathing, with the operating plasma torch still in his hand. It was reported he had been wearing shaded safety glasses, welding gloves, and work coveralls. Co-workers called 911; emergency responders arrived shortly thereafter and life-flighted the mechanic to a hospital burn center. He never regained consciousness and died at the hospital three months later.

The cause of death was reported as traumatic head injury. Evidence suggested that the explosion blew the bottom off the drum and propelled the drum against his face and head, knocking him to the ground. Discussion with the OR-OSHA investigator indicated that his injuries appeared to involve a combination of being struck by the top of the drum as it

propelled into his head, then being thrown backwards and landing on the concrete floor of the shop. Most of the flames from the ignition event were contained in the drum, but it is possible the worker suffered minor flash burns in addition to his traumatic head injuries.

Photo 2. Label on one side of damaged drum, stating "Caution - Flammable" (*Photo courtesy of OR-OSHA*)

Photo 3. Flammable label on another side of damaged drum (*Photo courtesy of OR-OSHA*)

Photo 4. View of damaged drum following explosion; bottom of drum was blown off. (*Photo courtesy of OR-OSHA*)

CAUSE OF DEATH

According to Oregon Vital Records data, the cause of death was traumatic head injury.

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. OR-FACE investigators identified the following factors that may have contributed to this incident:

- Using a hot work method to remove the lid from a drum that formerly contained a flammable liquid
- Not cleaning or testing the used drum before hot work was performed
- Inadequate knowledge of, or access to, alternate, safer method(s) for removing the lid
- Inadequate training and communication regarding specific job hazard knowledge and associated safe work practices

RECOMMENDATIONS/DISCUSSION

- ***Recommendation #1: Never weld, cut, or perform other hot work on a drum or other metal container unless it has been cleaned and vented thoroughly***.
  Discussion: Avoid hot work on drums or any metal containers that contain or previously contained flammable *or* toxic substances, or if you do not know the nature of its contents. This includes containers that appear to be empty because residues inside the container may present explosion or fire hazards, or toxic exposures.
  However, if no alternatives are available and it is necessary to perform hot work on metal drums, there are several important steps that should be taken to help prevent similar occurrences:

    - Identify what was inside the drum and whether the substance is flammable or toxic; otherwise, treat every container to be torch cut as if it contained a flammable substance.
    - Follow all manufacturer precautions on warning labels, pictograms, and/or SDSs;
    - Follow product and equipment manufacturers' instructions;
    - Establish safe work procedures in advance of hot work tasks, including how to clean a drum and test for residues.
    - Employers should train workers on how to identify hazards and ensure that they follow safe hot work procedures above.

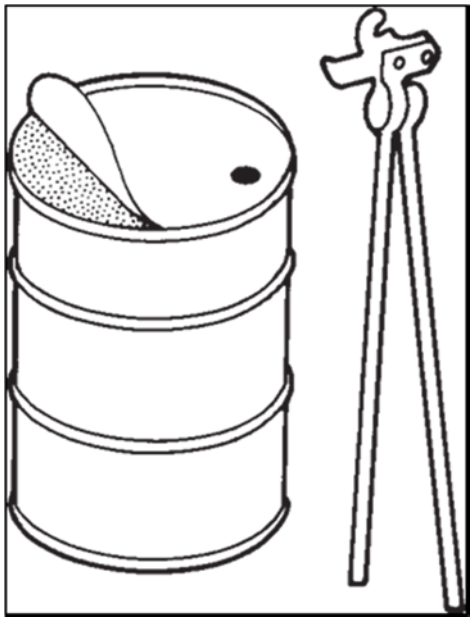
  Oregon OSHA regulations require that containers be cleaned before any hot work is performed, such that "…there are no flammable materials present or any substances that when subjected to heat, might produce flammable or toxic vapors." [OAR 437-004-2310(5)(a)]. Note that while this rule applies to welding at agricultural workplaces, similar requirements are in place for general industry, construction, and other industry sectors as well. These rules also discuss testing, venting, and purging such containers to ensure that they are free and remain free of flammable or toxic vapors. In the current incident, the procedures used did not include any of these steps. In addition, all possible ignition sources should be removed from the area such as flames, sparks, and/or spark-producing equipment, and all caps and stoppers should be removed from the drum.

  OR-OSHA includes additional, specific requirements in the general industry standard regarding cleaning and testing containers before performing hot work. For example, OAR 437-002-0297 does not allow hot work to be performed on "…drums, barrels, tanks, or other containers until they have been cleaned so thoroughly as to make absolutely certain that there are no flammable materials present or any substances…or other materials which, when subjected to heat, might produce flammable or toxic vapors." To meet the "absolutely certain" test, the rule further states that "…appropriate testing equipment is to be used prior to and frequently during the welding, torch or abrasive cutting or other hot work operations" to verify the conditions remain safe throughout the process.

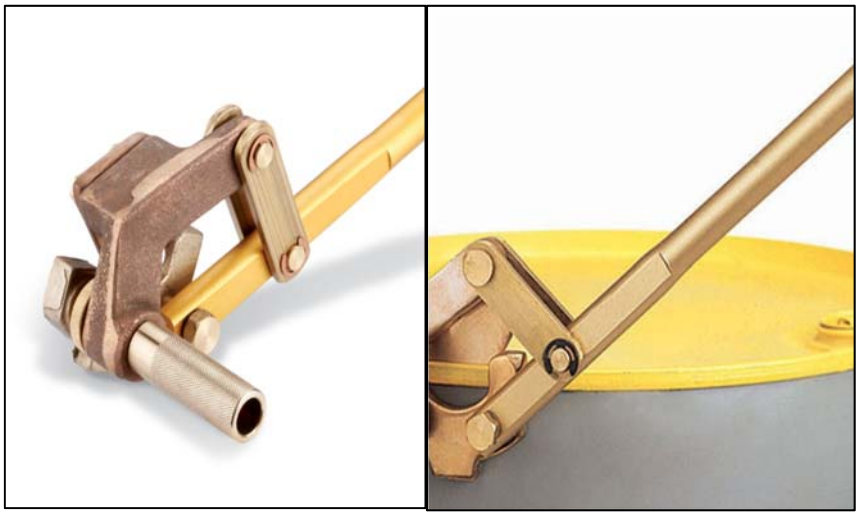
Some resources suggest purging the drum with water as an effective way to reduce hazards associated with hot work. One example is to fill the drum completely with water (or to overflowing) prior to applying heat. However, be aware that filling the container with water may not remove all residues and solids; it is possible that vapor pockets could remain and could be ignited. In addition, simply rinsing out the empty container and drying it does not remove all residual product and vapors. Further, disposal of the water used for cleaning or purging may introduce environmental concerns that would need to be addressed. In addition, many manufacturers recommend that drums should not be reused, nor should heat be applied to them, and that they should be disposed of properly. It was learned from follow-up discussion with the outside safety specialist involved in the incident investigation, that after the incident occurred, the farm implemented changes in its safety procedures to reduce the risk of explosions, including filling drums to the brim with water prior to torch cutting. While these implemented changes reduce the risk of another incident occurring, they do not eliminate the risk.

- ***Recommendation #2: To further reduce the risk of ignition or explosion, use a non-sparking, manual tool when removing a lid from a metal drum or barrel.***
  Discussion: As stated in Recommendation #1, avoid hot work on drums or any metal containers that contain, may contain, or previously contained flammable or toxic substances, or if you do not know the nature of the contents. Instead, use methods that do not involve heat or sparks. Mechanical drum opening tools are available that can accomplish the task quickly and efficiently. One resource suggested that even when using a non-sparking tool to open a drum that contains or may have contained a flammable liquid, the drum should be filled with water first as an added precaution. The same need to address secondary environmental issues with the water used for this purpose would still apply.

  Several examples of non-sparking manual drum opening tools are shown on the following page. Please note that these examples are provided for informational purposes only. Mention of any product or manufacturer in this report does not constitute or imply an endorsement by NIOSH or OR-FACE.



Example 1. Mechanical drum opening tool eliminates the need for hot work https://worksafe.govt.nz/dmsdocument/353-hot-work-on-drums-and-tanks



Example 2. Non-sparking drum deheader with aluminum blade, bronze alloy https://www.newpig.com/non-sparking-drum-deheader/p/DRM563

Example 3. Manual drum deheader with non-spark blade https://www.homedepot.com/b/Building-Materials-Material-Handling-Equipment/Vestil/N-5yc1vZca3dZe3g

- ***Recommendation #3: Employers should routinely assess job hazards, provide regular, periodic training and communications on site-specific hazards and safe work practices, and take corrective action when needed.***
  Discussion: Routine hazard assessments of the worksite should be performed to identify new, potential, and ongoing hazards. Workplace hazard communication and other safety and health programs and training should be based on these site-specific job hazard assessments, to develop appropriate procedures and provide adequate direction on how to safely address the identified hazards. For example, results of a hazard assessment might have prompted the farm to develop a hot work management program to control or eliminate hot work hazards.

  In this case, an applicable template was used for the farm's written HazCom program, but the program did not adequately incorporate site-specific job hazards and conditions or include specific procedures and practices to address and control them. The outsourced, group-based training and safety meetings provided basic information on relevant farm safety topics. However, it appeared that adequate job hazard assessments or follow-up were not provided on site to reinforce workers' knowledge of specific hazards and how to implement safe work practices. While the mechanic was considered knowledgeable and experienced in operating the plasma torch and in other job tasks he performed, he received only informal and non-specific guidance regarding safe work practices for cutting drums. As mentioned earlier, after the mechanic reported smoke being produced while working on the first drum on the day of the incident, a supervisor did not provide specific instructions about using different, safer equipment or work practices before removing the lid from the drum that exploded. It is not known whether job hazard assessments conducted at the farm following this fatal injury included consideration for discontinuing the practice of converting used drums into trash cans.

- ***Recommendation #4: Supervisors should check and monitor employees' knowledge of job hazards and implementation of safe practices to control those hazards.***
  Discussion: Supervisors should regularly assess the effectiveness of safety training by asking workers questions about their work plans, observing work practices, and providing feedback. The purpose of this type of assessment is for the employer to ensure that employees are adequately knowledgeable of hazards (including potential hazards), and that they understand appropriate, safe work practices and how to implement them. Supervisors should monitor and provide feedback about employees' safe work practices, including how to recognize and control hazards.

- ***Recommendation #5: Employers should provide appropriate, adequate personal protective equipment and ensure their appropriate use.***
  Discussion: While it may not have prevented this fatal incident, welding helmets should be worn when arc welding or cutting. In this case, the mechanic was wearing shaded safety glasses, welding gloves, and work coveralls. The OR-OSHA report indicated a welding helmet was observed in the shop near where the incident occurred. It was reported that the mechanic wore the helmet when performing welding for fabrication work, although he did not wear the helmet when using the plasma torch to remove the lid on the drum that exploded.

DISCLAIMER

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REFERENCES

The incident described in this report is not unique to agriculture; fires and explosions have occurred in multiple industry sectors. Nor are these hazards limited to workplace settings; fatal and near-fatal injuries involving hot work performed on used industrial drums have happened to consumers as well. Used drums like the one involved in this incident are readily available on the consumer market, for example, for recycling or repurposing into consumer products such as rain barrels, barbeque grills, and other household or recreational uses. Resources addressing hot work hazards were incorporated into this report and are provided below.

Hazards of cutting empty drums –V1.1 – 17 September 2018 – NT WorkSafe bulletin - division of the Department of Attorney-General and Justice – Northern Territory, Australia.
http://www.worksafe.nt.gov.au/PDF%20Conversion/hazards-of-cutting-empty-drums.pdf

"Hot work on drums and tanks" – Dept of Labour, Occupational Safety & Health Service, Published: March 1988 - ISBN 0-477-03420-9 https://worksafe.govt.nz/dmsdocument/353-hot-work-on-drums-and-tanks

Oregon OSHA, Division 2, Subdivision Q, General Occupational Safety and Health Rules, OAR 437-002-0297 Welding or Cutting Containers.
https://osha.oregon.gov/OSHARules/div2/div2Q.pdf

Oregon OSHA, Division 3, Subdivision J (29 CFR 1926; adopted by reference), Construction, 1926.352(h)(i).
https://osha.oregon.gov/OSHARules/div3/div3J.pdf

Oregon OSHA, Division 4, Subdivision Q, Agriculture, OAR 004-2310(5) Welding or Cutting Containers.
https://osha.oregon.gov/OSHARules/div4/div4Q.pdf

Weather Underground. https://www.wunderground.com/history/

"Welding – Hot work" Fact Sheet – Canadian Centre for Occupational Health and Safety.
https://www.ccohs.ca/oshanswers/safety_haz/welding/hotwork.html

Additional resources:

"Drum explodes during welding, killing worker" – WorkSafeBC, published June 2012
https://www.youtube.com/watch?v=9DP5l9yYt-g

"Laborer burned cutting 55-gallon drum when leftover fuel exploded" – Washington FACE program, report # 71-177-2019, published January 2019 http://www.lni.wa.gov/Safety/Research/Face/Files/LaborerBurnedCuttingDrum.pdf

"Two Vietnamese floor sanders die when wood floor finish product ignites" – Massachusetts FACE program, Massachusetts case report# 04-MA-021, published January 2006.
https://www.cdc.gov/niosh/face/stateface/ma/04ma032.html

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INVESTIGATOR INFORMATION

This investigation was conducted by Barbara L. Epstien, Fatality Investigator/Outreach Specialist, OR-FACE Program. The report was reviewed and received input from Ryan Olson, PhD, Director, OR-FACE Program, and the OR-FACE Publications Review Panel.

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