Treading Around the Dangers of Off-the-Road Mobile Equipment Tires

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.

Author

Carl Daniel
safety manager, Edw. C. Levy Co.,
Columbus, Miss., USA
cdaniel@edwlevy.net

Comments are welcome. If you have questions about this topic or other safety issues, please contact safetyfirst@aist.org. Please include your full name, company name, mailing address and email in all correspondence.

Large off-the-road (OTR) mobile equipment is a common sight at many industrial job sites across the country. In the steel industry, heavy mobile equipment is a critical part of the operation as it allows tasks to be conducted efficiently and effectively. But along with these benefits come the risks associated with the operation of this type of machinery. One frequently overlooked hazard involves the very item that allows mobile equipment to operate the way it does: the tires. Due to the size of most off-road mobile equipment, it takes large tires to support the equipment and carry the loads that are required. Many people don't understand how dangerous tires can be when not handled properly. The purpose of this article is to share information about the dangers associated with working around these tires and how to effectively mitigate the risk associated with them.

Fatalities and injuries have occurred in the workplace due to unexpected releases of energy from tires and wheel components. According to the U.S. Bureau of Labor Statistics (BLS), there were 55 occupational fatalities associated with tire explosions in the United States from 2011 to 2016.[2] The U.S. Occupational Safety and Health Administration (OSHA) revealed the data and causes of the tire associated deaths from 2017. Last year, there were five reported fatalities caused by tire explosions. In summary, there was one fatality when a multi-rim tire exploded during inflation, two fatalities from a tire explosion on heavy farm machinery, and one fatality from a sidewall eruption during inflation and repair of a tire.

In its simplest form, a tire is considered a pressure vessel and any item that is under pressure can become an explosive device. As with any vessel, if the temperature is raised, the pressure increases inside the vessel. This principle is no different with tires. This is the reason behind excessive heat being one of the main contributors of tire failures and explosions. When rubber tires become overheated, a condition known as pyrolysis can occur. Pyrolysis is the decomposition of carbon-based material inside the tire. If the rubber of the inner liner is heated, it can give off gaseous volatile organic compounds that are released into the air chamber of the tire. Under the right conditions, this combination of air and fuel can become an explosive mixture and can auto-ignite.

Sources of heat that can lead to an explosion include:

- Welding, cutting or grinding on wheel components.
- Contact with electricity.
- Vehicle struck by lightning.
- An external fire (hydraulic lines, engine fire, grass fires).
- Underinflated tires.
- Overheating of the brakes.
- Overloading of the vehicle.

When a tire explodes, the pressure can exceed 1,000 psi. This release can propel materials great distances, endangering anyone in the immediate vicinity and even persons inside a vehicle. The injuries from these events can be life-altering and even deadly. Studies have shown that the primary injury associated with tire explosions is caused by the shock wave, which can cause barotrauma. Barotrauma occurs when one is subjected to extreme changes in air pressure, and this can lead to eye injuries and

Figure 1

Detailed photo of a zipper rupture.

damage to air containing organs such as the lungs, ear drums and even the nasal sinuses. Secondary injuries are caused by the flying debris striking the victim at a high speed and leading to complex injuries. There can also be tertiary injuries as the victim is thrown against objects as a result of the force of the blast. It is important to note that the head and face are most commonly injured, as victims are normally facing the tire when the explosion occurs. The force of a tire explosion can be summarized by this:

A 26.5 x 25 tire at 90 psi has 373,650 ft/lbs of stored energy. If released "instantly," it packs the power to move an average-sized person 1,868 feet in one direction.

Tires represent one of the most common and dangerous sources of stored energy at many worksites. While many employers work to identify and control hazardous stored energy, the pressure in a tire is often overlooked.

Another factor that can be a contributor to tire failure is underinflation and overloading. OSHA standard 1910.177 Servicing Multi-Piece and Single-Piece Rims defines a tire as being flat when the tire has been "driven underinflated at 80% or less of its recommended pressure"[1] which, for example, would be 80 psi for a 100 psi tire. Running mobile equipment with underinflated tires can lead to degradation of the tire, which can cause a zipper rupture (Fig. 1). A zipper rupture is a circumferential rupture in the mid-sidewall of a steel-belted tire. These ruptures are unpredictable and can occur without any warning.

If tires are underinflated and show potential signs of a zipper rupture, they must be handled with caution by a trained and qualified professional. A trained tire technician will remove the valve core and completely remove the tire from the equipment to safely inspect and service the tire. When working around tires that are mounted or unmounted, technicians and other employees need to be aware of the trajectory zone and know this is also a danger zone. OSHA defines the trajectory zone as "any potential path or route that a wheel component may travel during an explosive separation or sudden release of air pressure."[1] This danger zone, illustrated in Fig. 2, is 45° from the center of the tire/wheel in any direction. It

Figure 2

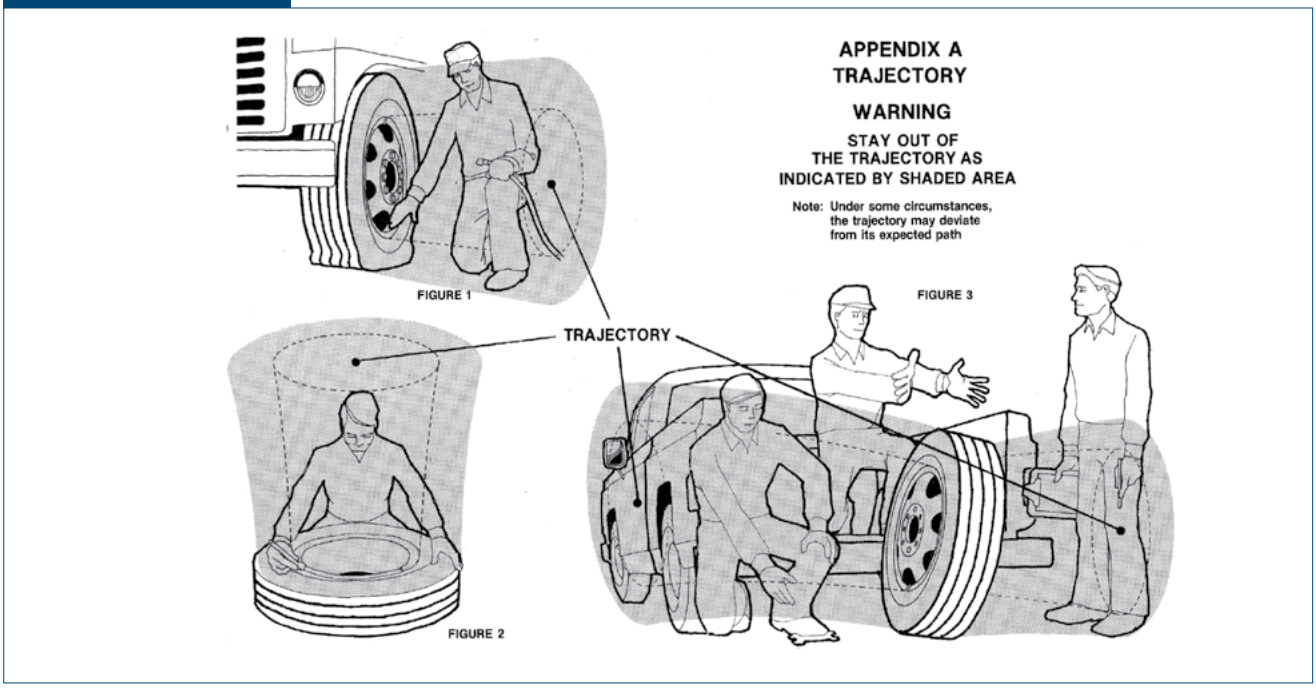
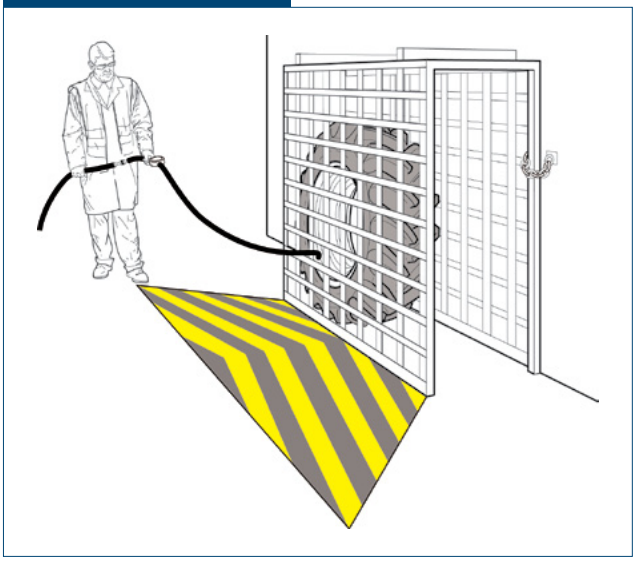


Illustration of the trajectory zone. Source: OSHA Standard 1910.177 Appendix A.

Figure 3



Tire inflation practices.

is important to remember that being in the trajectory zone can be determined if the sidewall can be read.

Tire inflation also poses many risks for employees working with tires. Tires that are underinflated should be removed from the equipment to be safely serviced. The tire should be placed into an OSHA-approved tire safety cage, when possible, and a remote airing device used. A clip-on chuck should be used and there should be a sufficient length of hose between the clip-on chuck and the in-line valve (if one is used) to allow the employee to stand outside the trajectory (see Fig. 3).

Road conditions also can affect the life of tires and play an important part in maintaining good tires. Material such as scrap metal, molten material, large pieces of aggregate and even water can be possible sources of damage for tires. A wet tire can be cut 8–10 times easier than a dry one and standing water can also hide roadway hazards. Therefore, an effective plan to inspect and maintain roads should be an integral part of an operation's tire maintenance program and safety process.

To effectively manage the safety associated with tires, a safety inspection process should be established. Tire inspections should be a critical part of all equipment pre-shift and post-trip inspections. Some items to look for on an inspection include:

- Low air pressure.
- Missing valve caps.
- Missing/loose lug nuts.
- Cracks in the rim or wheelbase.
- Cracks in the side rings.
- Worn tread.
- Cuts in the sidewall or tread area.
- Exposed or rusty steel cable on the sidewall or tread.
- Bulges/bubbles or separations on the tire.
- Bent rock knockers.
- Leaking struts or bent struts.

In addition to routine inspections of tires, there are other steps that can be taken to ensure the safety of those working around tire maintenance operations:

1. Ensure that work involving the servicing of tires is conducted by trained and certified personnel.
2. Always use approved personal protective equipment (PPE):
   a. Safety glasses.
   b. Hearing protection.
   c. Safety footwear.
3. Never sit or stand in front of a tire and rim that is being inflated.
4. Make sure all workers are out of the trajectory zone.
5. Always deflate the tire prior to removing from the vehicle. If it is a dual assemble, deflate both tires.
6. Always stand clear during deflation.
7. Do not re-inflate a tire that has been run flat or underinflated until it has been properly inspected.
8. If a tire has less than 80% of its recommended air pressure, it should be considered flat and removed for inspection.
9. Never weld on a tire and rim assembly (inflated or deflated).
10. Tires should never be stored laying down flat, or, if left standing, tire must be blocked and safely secured.

To summarize, the stored energy in a tire can cause significant injury and even property damage if not properly recognized and controlled. To reduce the exposures that arise from tire maintenance, employers should educate and train their employees about the hazards associated with large mobile equipment tires. Preventive actions such as identifying the risks associated with tire operations, effective equipment inspection processes, and ensuring that tire and wheel maintenance is conducted by trained and certified personnel can go a long way in reducing the exposure to injury that a tire poses.

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