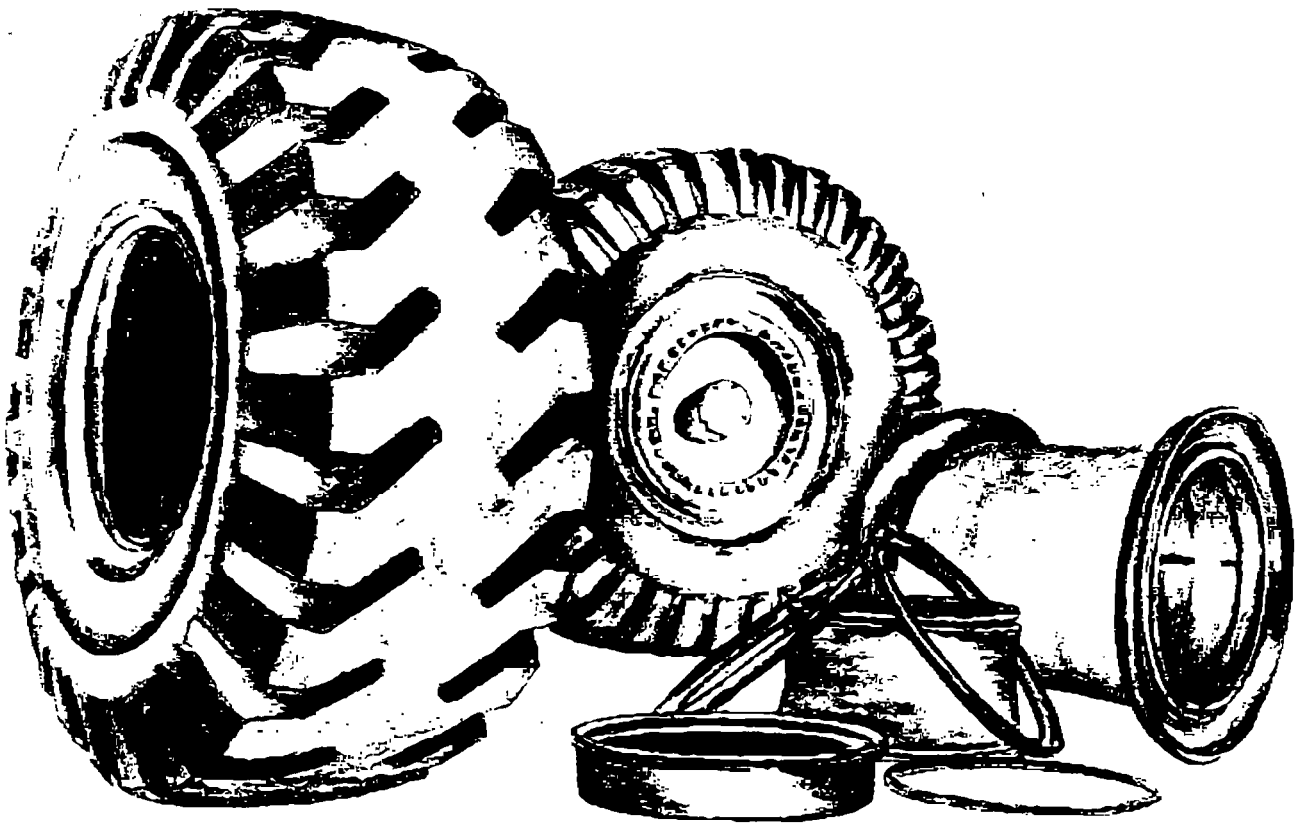
Tire and Rim Safety Awareness Program

U.S. Department of Labor
Mine Safety and Health Administration
National Mine Health and Safety Academy

Instruction Guide Series
MSHA IG 60

Revised 1996



Tire and Rim Safety Awareness Program

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INTRODUCTION

BACKGROUND

Tire and rim related accidents at surface mines are caused, in many instances, by the handling and servicing of multipiece and single piece rim wheels such as are used on large surface mining equipment. Certain accidents are caused by unsafe mounting, de-mounting, exploding tires, faulty tire and rim components, improperly trained personnel, etc. All mining personnel should be trained in safe tire and rim handling and servicing procedures.

OBJECTIVE OF THE PROGRAM

This program was developed to give mining industry personnel additional information to use with already existing training materials related to servicing multipiece and single piece rim wheels on large surface mining equipment. Special sections or all of this material can be used as a training aid to enhance the safety knowledge or awareness of the student.

WHAT THE PROGRAM CONTAINS

This program contains specific sections of the Code of Federal Regulations that relate to tire and rim safety at coal, metal, and nonmetal mines. It also contains sections on safe and unsafe practices while working on and around tires and rims; awareness of tire and rim problems; safety points related to servicing multipiece and single piece rim wheels; and safe operating procedures for multipiece and single piece rim wheels. Other sections cover safety awareness training on tires, rims, and restraining devices; safe preventive maintenance; general mine site maintenance; mining equipment operator training; mounting heavy-duty tires and rims for large surface mining equipment; major safety factors when working on tires and rims; and tire care and selection for surface mining operations. The last section contains illustrations and descriptions of tire and rim related fatalities.

USING THE PROGRAM

The material in this program should be modified and supplemented by industry trainers to develop training courses specific to their mines. All or selected portions of the material in this program may be reproduced and distributed as course handouts. Pages may be reproduced as overhead transparencies if so desired.

SECTION I

TIRE AND RIM RELATED REGULATIONS

This section contains regulations from Title 30, Code of Federal Regulations, pertaining to tire and rim safety.

30 CFR 56/57.14100	Safety defects; examination, correction and records.
30 CFR 56/57.14104	Tire repairs.
30 CFR 56/57.14105	Procedures during repairs or maintenance.
30 CFR 56/57.14211	Blocking equipment in a raised position.
30 CFR 56/57.16007	Taglines, hitches, and slings.
30 CFR 56/57.16009	Suspended loads.
30 CFR 77.210	Hoisting of materials.
30 CFR 77.404	Machinery and equipment; operation and maintenance.
30 CFR 77.405	Performing work from a raised position; safeguards.
30 CFR 77.1606 (a & c)	Loading and haulage equipment; inspection and maintenance.
30 CFR 77.1607(1)	Loading and haulage equipment; operation.

§ 56/57.14100 Safety defects; examination, correction and records.

(a) Self-propelled mobile equipment to be used during a shift shall be inspected by the equipment operator before being placed in operation on that shift.

(b) Defects on any equipment, machinery, and tools that affect safety shall be corrected in a timely manner to prevent the creation of a hazard to persons.

(c)When defects make continued operation hazardous to persons, the defective items including self-propelled mobile equipment shall be taken out of service and placed in a designated area posted for that purpose, or a tag or other effective method of marking the defective items shall be used to prohibit further use until the defects are corrected.

(d) Defects on self-propelled mobile equipment affecting safety, which are not corrected immediately, shall be reported to and recorded by the mine operator. The records shall be kept at the mine or nearest mine office from the date the defects are recorded, until the defects are corrected. Such records shall be made available for inspection by an authorized representative of the Secretary.

§ 56/57.14104 Tire repairs.

(a) Before a tire is removed from a vehicle for tire repair, the valve core shall be partially removed to allow for gradual deflation and then removed. During deflation, to the extent possible, persons shall stand outside of the potential trajectory of the lock ring of a multi-piece wheel rim.

(b) To prevent injury from wheel rims during tire inflation, one of the following shall be used:

(1) A wheel cage or other restraining device that will constrain all wheel rim components during an explosive separation of a multi-piece wheel rim, or during the sudden release of contained air in a single piece rim wheel; or

(2) A stand-off inflation device which permits persons to stand outside of the potential trajectory of wheel components.

§ 56/57.14105 Procedures during repairs or maintenance.

Repairs or maintenance of machinery or equipment shall be performed only after the power is off, and the machinery or equipment blocked against hazardous motion. Machinery or equipment motion or activation is permitted to the extent that adjustments or testing cannot be performed without motion or activation, provided that persons are effectively protected from hazardous motion.

§ 56/57.14211 Blocking equipment in a raised position.

(a) Persons shall not work on top of, under, or work from mobile equipment in a raised position until the equipment has been blocked or mechanically secured to prevent it from rolling or falling accidentally.

(b) Persons shall not work on top of, under, or work from a raised component of mobile equipment until the component has been blocked or mechanically secured to prevent accidental lowering. The equipment must also be blocked or secured to prevent rolling.

(c)A raised component must be secured to prevent accidental lowering when persons are working on or around mobile equipment and are exposed to the hazard of accidental lowering of the component.

(d) Under this section, a raised component of mobile equipment is considered to be blocked or mechanically secured if provided with a functional load-locking device or a device which prevents free and uncontrolled descent.

(e) Blocking or mechanical securing of the raised component is required during repair or maintenance of elevated mobile work platforms.

§ 56/57.16007 Taglines, hitches, and slings.

(a) Taglines shall be attached to loads that may require steadying or guidance while suspended.

(b) Hitches and slings used to hoist materials shall be suitable for the particular material handled.

§ 56/57.16009 Suspended loads.

Persons shall stay clear of suspended loads.

.§ 77.210 Hoisting of materials

(a) Hitches and slings used to hoist materials shall be suitable for handling the type of materials being hoisted.

(b) Men shall stay clear of hoisted loads.

(c)Taglines shall be attached to hoisted materials that require steadying or guidance.

§ 77.404 Machinery and equipment; operation and maintenance.

(a) Mobile and stationary machinery and equipment shall be maintained in safe operating condition and machinery or equipment in unsafe condition shall be removed from service immediately.

(b) Machinery and equipment shall be operated only by persons trained in the use of and authorized to operate such machinery or equipment.

(c)Repairs or maintenance shall not be performed on machinery until the power is off and the machinery is blocked against motion, except where machinery motion is necessary to make adjustments.

(d) Machinery shall not be lubricated while in motion where a hazard exists, unless equipped with extended fittings or cups.

§ 77.405 Performing work from a raised position; safeguards.

(a) Men shall not work on or from a piece of mobile equipment in a raised position until it has been blocked in place securely. This does not preclude the use of equipment specifically designed as elevated mobile work platforms.

(b) No work shall be performed under machinery or equipment that has been raised until such machinery or equipment has been securely blocked in position.

§ 77.1606 Loading and haulage equipment; inspection and maintenance.

(a) Mobile loading and haulage equipment shall be inspected by a competent person before such equipment is placed in operation. Equipment defects affecting safety shall be recorded and reported to the mine operator.

(c)Equipment defects affecting safety shall be corrected before the equipment is used.

§ 77.1607 Loading and haulage equipment; operation.

(1) Tires shall be deflated before repairs on them are started and adequate means shall be provided to prevent wheel locking rims from creating a hazard during tire inflation.

SECTION II

MOST COMMON SAFETY DO'S AND DON'TS OF WORKING ON OR AROUND TIRES AND RIMS

A. **A miner should always:**

1. **Check** tires and rims--
   a. Prior to mounting for damage or defects.
   b. After mounting to see if they are properly seated.
   c. Inspect the flange and side ring to make sure they are correctly positioned.

2. **Inspect** all clamps and wheel nuts --
   a. For wheel vibration due to loose nuts.
   b. For loose clamps that can cause rim slippage or detachment of the rim and tire from the vehicle.

3. **Replace** all damaged or weak parts.
   a. Check for metal cracks, dents and signs of metal fatigue.

4. **Check** for --
   a. Excessive ring butting and side ring play.
   b. Mismatched rim parts.

5. **Replace** all severely rusted rims.
   a. Check all rims for excessive corrosion which could cause weakness.
   b. Check for proper fitting of all rings due to potential build up of rust.

6. **Inflate** all tires in a safety cage --
   a. To prevent injury from a flying ring.
   b. To prevent injury from a flying piece of metal due to a weak rim part.

7. **Deflate** tires prior to demounting.
   a. Check for damage to rim and rings.
   b. Check for an unseated ring.
   c. Remove the tire by deflating it first, if the ring appears to be unseated.
   d. Remove the valve core to ensure complete deflation

B. A miner should never:

1. **Work carelessly.**
   a. Always follow standard operating procedures for a given tire and rim task.

2. **Take unnecessary chances.**
   a. Always be sure of the proper procedure of mating rim and wheel parts.
   b. Always ask questions of a more knowledgeable miner or distributor if there is a question regarding a certain tire and rim procedure.

3. **Operate a vehicle on a single tire of a dual assembly.**
   a. Always inflate both tires to recommended balanced pressures before operating the vehicle.
   b. Always check the capacity of each tire to determine if it is being exceeded.

4. **Exceed the load rating of the tires.**
   a. Always make sure rims are not cracked or go out-of-round.
   b. Always increase the tire ply rating or size, or both, if the vehicle is to have excessively heavy loads.
   c. Always use correct size rims for certain tire sizes.
   d. Always stay within the specific tire pressure.

5. **Use undersized tires.**
   a. Always check for chafing, pinching and premature failure of rim due to undersizing.
   b. Always check for bead or sidewall failure of the tire.

6. **Take one manufacturer's rims and mix with another manufacturer's rims.**
   a. Always match component parts and rims by make, size, and type.

7. **Take a flat tire and reinflate it without first carefully inspecting the complete tire, wheel assembly, and rim for unsafe conditions.**
   a. Always inspect the lock ring for potential damage as well as making certain it is secure in the gutter before inflation.

SECTION III
BECOMING MORE AWARE OF POTENTIAL TIRE AND RIM PROBLEMS

Proper operation, maintenance, and tire selection can increase the life of a tire and rim.

A. General problems that may affect tire and rim safety:

1. Improper operator practice
2. Overloading
3. Excessive haul speed
4. Improper tire and rim maintenance
5. Overinflation of tires
6. Underinflation of tires
7. Improper tire repair
8. Cutting of tread by sharp/hard objects
9. Improper tire selection

B. Haul road problems that may affect tire and rim safety:

1. Tire ply separation could occur if reduced speed limits are not in effect on curved or rugged terrain.
2. Internal friction could occur at high speeds on rough terrain causing heat wear on tires.
3. Poorly drained roads can cause depressions in roadsÅcutting, bruising or bursting tires and denting or cracking rims.
4. Poorly maintained roads, especially in wet weather, can cause slippage or spinning which in turn cuts and rapidly wears a tire.
5. On excessively rocky roads, tires and rims can become damaged unless tire protection chains are used.

C. Vehicle operator problems that may affect tire and rim safety:

1. Driving at excessive speeds on poor road conditions
2. Spins and slippage
3. Fast stops, fast starts, fast turns and excessive loads
4. Tires allowed to rub against the banks of haul roads or guide rails
5. Excessive braking which could cause deterioration of tire beads and inner liner

D. Repair and maintenance problems that may affect tire and rim safety:

1. Tires allowed to rub against part of the vehicle
2. Underinflation of tires
3. Overinflating tires beyond recommended inflation chart
4. Stones allowed to remain caught or wedged between dual tires
5. New tires being mounted beside worn tires
6. Mismatching of tires
7. Promoting wear of tires by parking in gasoline or oil puddles
8. Uneven brakes, poorly aligned wheels, wheels that are wobbly or bent, or bent axles

SECTION IV
SAFETY POINTS

A tire and rim safety training program should be provided to all personnel working on or around tires and rims.

No employee should service any rim wheel unless he or she has been trained and instructed in the correct procedures of servicing the type of wheel being worked on.

Personnel working on a tire and/or rim should be competent in the tasks of demounting tires, inspecting and identifying rim wheel components, mounting of tires, using restraining devices, handling rim wheels, inflating a tire when a single piece rim wheel is mounted on a vehicle, and installing and removing rim wheels.

Assembled tires should not be welded or cut.

Even a tire that has been deflated can explode under certain conditions. Heat may cause decomposition of a section of the tire carcass or rubber liner and generate explosive mixtures of gases within the tire. Heat sources include welding, fire, dragging brakes or excessive brake use, and electrical arcing. Ignition of the gases may then occur resulting in a violent explosion and injury to miners. Tire assemblies should therefore never be welded, brazed, or cut. Purging the air from the tire and then inflating the tire with an inert gas or with nitrogen or carbon dioxide in an attempt to remove all the oxygen does not ensure that a chemical explosion will not occur. Because of the complexity of the chemical compositions making up the tire, it is never certain which gases would be evolved and form an explosive mixture. **The safest procedure is to never apply heat to any rim or rim/hub assembly that has an inflated or deflated tire mounted on it.**

If a tire has been on fire, or been exposed to another source of heat, deflating the tire does not immediately eliminate the potential danger of a tire explosion. Chemical reactions, and thus the danger of explosion, can continue for some time after a fire has been extinguished or the heat source removed.

Personnel should always stand outside the area of trajectory both during inflation of the tire and during the inspection of the rim wheel following inflation.

Restraining devices should be used while inflating tires on multipiece wheels. A miner should also use a restraining device or barrier while inflating tires on single piece wheels unless the rim wheel is bolted onto the vehicle during inflation.

Restraining devices and barriers should be capable of preventing rim wheel components from being thrown outside or beyond the device or barrier.

Restraining devices and barriers should be visually inspected prior to use and after any separation of the rim wheel components or sudden release of contained air.

Any restraining device or barrier exhibiting damage, such as cracks at welds; cracked or broken components; bent or sprung components caused by mishandling, abuse, tire explosion, or rim wheel separation; and pitting of components due to corrosion, should be removed from service.

An air line assembly consisting of the following components should be used to inflate tires: clip-on chuck; in-line valve with a pressure gauge or a regulator that can be preset; and a sufficient length of hose between the clip-on chuck and the in-line valve to allow the miner to stand outside the trajectory.

Only tools recommended in the rim manual for the type of wheel being serviced should be used.

All multipiece wheel components and single piece wheels should be inspected prior to assembly. Any component that is bent, pitted from corrosion, broken, or cracked should not be used and should be marked or tagged unserviceable.

Rim flanges, rim gutters, rings, bead seating surfaces, and the bead areas of tires should be free of any dirt, surface rust, or loose or flaked rubber build-up prior to mounting and inflation.

The size and type of both the tire and the wheel should be checked for compatibility prior to assembly of the rim wheel.

SECTION V
SAFE OPERATING PROCEDURES

A. Safe operating procedures for multipiece rim wheels:

1. A tire must be completely deflated by removing the valve core before a rim wheel is removed from the axle.
2. Tires should be deflated and removed from the rims before repairs are made.
3. Assembled tires should not be welded or cut.
4. Rubber lubricant must be applied to the bead and rim mating surfaces when assembling the wheel and inflating the tire unless the tire or wheel manufacturer recommends against its use.

5. If a tire is underinflated but has more than 80 percent of the recommended pressure, the tire may be inflated while the rim wheel is on the vehicle, provided remote control inflation equipment is used, and no miner remains in the area of trajectory during inflation.

6. A tire shall be inflated outside a restraining device only to a pressure sufficient to force the tire bead onto the rim ledge and create an airtight seal with the tire and bead.

7. Whenever a rim wheel is in a restraining device, no equipment or any part of a miner's body may rest or lean against the restraining device.

8. After tire inflation, the tire and wheel must be inspected while still within the restraining device to make sure that they are properly seated and locked. If further adjustment is necessary, the tire must be deflated by removing the valve core before the adjustment is made.

9. Do not attempt to correct the seating of side and lock rings by hammering, striking, or forcing the components while the tire is pressurized.

10. Cracked, broken, bent, or otherwise damaged rim components must not be reworked, welded, brazed, or otherwise heated. Heat must not be applied to a multipiece wheel.

11. Whenever multipiece rim wheels are being handled, miners should stay out of the area of trajectory unless the mine operator can show that performance of the servicing makes the miners presence in the trajectory area necessary.

12. Never add air until each side of lock ring is fully seated. An available end rim would keep the tire from holding any air since the bead seat would have to contact the O-ring.

B. Safe operating procedures for single piece rim wheels:

1. A tire must be completely deflated by removing the valve core before demounting.
2. Tires should be deflated and removed from the rims before repairs are made.
3. Assembled tires should not be welded or cut.
4. Mounting and demounting of the tire must be done only from the narrow ledge side of the wheel. Care must be taken to avoid damaging the tire beads, and the tire must be mounted only on a compatible wheel of mating bead diameter and width.

5. Nonflammable rubber lubricant must be applied to bead and wheel mating surfaces before assembling the rim wheels, unless the tire or wheel manufacturer recommends against the use of any rubber lubricant.

6. If a tire changing machine is used, the tire may be inflated only to the minimum pressure necessary to force the tire bead onto the rim ledge and create an airtight seal before removal from the tire changing machine.

7. If a bead expander is used, it must be removed before the valve core is installed and as soon as the rim wheel becomes airtight (when the tire bead slips onto the bead seat).

8. A tire may be inflated only when contained within a restraining device, positioned behind a barrier, or bolted on the vehicle with the lug nuts fully tightened.

9. A tire must not be inflated to more than the inflation pressure stamped in the sidewall unless a higher pressure is recommended by the manufacturer.

10. Employees must stay out of the area of trajectory when a tire is being inflated.

11. Heat must not be applied to a single piece wheel.

12. Cracked, broken, bent, or otherwise damaged wheels must not be reworked, welded, brazed, or otherwise heated.

SECTION VI

SAFETY AWARENESS TRAINING

Personnel who work with tires and rims should be trained in how to safely maintain and service any tires and rims they may work on. This training should include:

inspecting and identifying rim wheel components

mounting tires

demounting tires

installing and removing rim wheels

inflating tires

A training demonstration should be developed for the use of different restraining devices -- rack, cage, assemblage of bars, etc. These methods of restraint should relate to all rim wheel components that may be involved during an explosive separation of a multipiece rim wheel or during the sudden release of contained air of a single piece rim wheel. Each barrier or restraining device should be able to withstand the maximum force of an explosive rim wheel separation or release of pressurized air occurring at 150 percent of the maximum tire specification pressure for the rim wheel being serviced. A visual inspection should take place before and after use of a restraining device. These inspection procedures can be incorporated in the training of each miner that uses a restraining device.

The trainer should pinpoint specific defects that relate to restraining devices, such as cracks at welds, cracked or broken components, bent or sprung components, corroded components, etc. Certain examples should be given where unsafe conditions could result if these devices are not removed from service and repaired.

SECTION VII

SAFE PREVENTIVE MAINTENANCE OF TIRES

Once the proper tire selection has been made, steps must be taken to ensure that the tires operate under the best possible service conditions. The following suggestions should help in setting up a tire preventive maintenance program or adding to or evaluating an existing program.

A. Inflation Preventive Maintenance Program

The most fundamental and important procedure is maintenance of the specified air pressure for tires under established load and service conditions.

For a tire to successfully perform the function for which it was designed, care must be taken to ensure that neither underinflation nor overinflation occur, as both will seriously detract from tire performance. The operation of tires with too much or too little air is similar to the operation of an engine with too much or too little oil. Such an operation brings about predictable disastrous results.

1. **Underinflation** -- When inflation pressure is less than specified for a given tire load, the desired percentage of deflation is surpassed and any of the following conditions are likely to occur:
   Ply, tread or bead separation
   Tire fatigue/stress
   Radial sidewall cracks
   Liner failures (tubeless tires)
   Irregular or rapid wear
   Poor handling

2. **Overinflation** -- Excessively high pressures for a given tire load and ply rating create excessive stress such as:
   Punctures
   Cuts
   Rock penetration
   Impact breaks
   Bruise damage
   Cut separations
   Cut growth
   Irregular and rapid tread wear
   Spin cuts

Additional disadvantages can result from overinflation causing decreased mobility or damage to mining equipment:
Loss of traction
"Hard Ride" and excessive vibration
Excessive shock loads
Poor handling
Payload spillage
Operator fatigue

Specified inflation pressures must be set **"cold,"** that is, after allowing at least 24 hours of idle time. Most mining equipment manufacturers include recommendations for inflation pressures, but whenever possible, actual tire loads should be used to determine the required inflation pressure.

3. **Cold Inflation Check** -- Cold inflation pressure is determined by the actual tire load. Inflation pressures should be periodically checked. Cold inflation pressure should be adjusted to the correct pressure as often as possible -- in all cases at least once a week.

4. **Hot Inflation Check** -- During the time between cold pressure checks, it is advisable to check and record hot inflation pressures. This program has great value as it detects under-inflation or leaking tires, which if found in time can be properly corrected to avert needless damage. For the most effective results, hot inflation pressures should be taken at about the same time every day and the readings recorded for each tire on the vehicle. Once this data has been accumulated, a comparison can be made with the previous day's pressure for the same tire and a judgment made as to the air retention.

   If a steady drop is noted for one tire, but pressures of the other tires are relatively stable from one day to the next, it is reasonable to assume that a leak exists. For the hot inflation program to be effective, it must be frequent, regular, and factual. A tire or tires with what appears to be abnormally high pressure should never be "bled," that is, air released from the tire. The high pressure can often be attributed to some service irregularity which should be investigated to determine the cause rather than attempting to eliminate the effect by bleeding air.

B. Pressure Loss in Tubeless Tires

A tubeless tire does not normally leak any more than a tube-type tire. The slight loss of air from diffusion through the liner and vents of a tubeless tire is insignificant in the daily operation of the tires.

1. **Reasons for Air Loss in Properly Mounted Tires** -- The most probable cause of leaks in properly mounted tubeless tire assemblies are:
   a. Loose or damaged valve components
   b. Cut or impact punctures
   c. Cracked rim
   d. Broken or burned beads

   Detection of a leak requires some knowledge of air pressure behavior. The temperature of the air in the tire affects the pressure; therefore, it is necessary to make pressure measurements at relatively the same contained air temperature to determine if air has been lost. This is the purpose of the "hot inflation check."

2. **Finding Leaks** Once the influence of tire operating conditions has been eliminated as a possible reason for a drop in air pressure, the tire assembly should be checked with a soap and water solution or soap spray.

   a. The first step is to inspect the valve. Possible leakage areas in this part are the O-ring seals, spud washers, valve core, extensions, and adapters.

   b. Next, the outside face of the tire should be checked for penetrations which can be caused by small metal objects or from large cuts and punctures.

   c. The rim assembly is a third possible leakage source. The welded portions of the rim base, including the gutter section and that portion of the bead base band which can be seen, should be soaped.

   d. A hardened or burned bead base, caused by hot brakes, can also cause leakage, either by cracks or erosion of the material under the wire beads. Separation may be caused around the bead wire, allowing the wire to unwind and pierce the liner, or may cause beadouts and broken beads. Beads may also break due to excessive strain. If beads are suspect, deflate the tire immediately. Leaks under the bead can be detected by soaping the bead base band and flange junction and the pry bar pockets. Also, soap the opposite side of the rim assembly at the pry bar pockets.

3. **Leaks from Improper Mounting** -- An improperly mounted tire may leak due to the use of a faulty O-ring. It may be the wrong size, damaged, or applied improperly. The O-ring groove may also be pitted or chipped. Leaks in this area can be detected by the use of soap solution at the junction of the lock ring and the bead base band, and in the space at the ends of the split lock ring.

   Leaks in a tubeless assembly are usually easy to trace and to explain by a systematic inspection of the various parts. It is not necessary to demount the tires in most cases. Soap solution will indicate where the leak is. If this is not the case, then a more detailed inspection of the inside of the tire and the disassembled rim

parts is required.

C. Airing Equipment

1. **Gauges** -- Should be of high quality, accuracy and durability. A master gauge should be available for checking and calibrating (if the gauge is so equipped). If gauges are not adjustable, an allowance should be checked with the master gauge at least on a weekly basis.

2. **Compressors**

   a. Stationary compressors (minimum 150 psi capacity) should have a drying system and water traps in lines to prevent moisture build-up. Moisture can rust rim parts and valve cores, reduce gauge life, and complicate demounting (rim component breakdown) procedures.

   b. Mobile units (minimum of 150 psi capacity) should also be equipped with a water trap assembly.

3. **Miscellaneous Equipment**

   Air-water gauge for ballasted tires
   Valve core removers and reamers
   Supply of valve caps
   Valve cap wrenches

   NOTE: Always replace valve caps securely. Release a small amount of air from the stem before applying the gauge to keep debris from clogging the gauge.

D. Rim Maintenance

Proper preventive maintenance of rims and necessary hardware is of absolute importance to good tire service. Earthmover rims are submitted to extremely high stresses due to high inflation pressures, torque loads, steering and braking force, shock loads, and the applied load of the vehicle. Therefore, rims must be strong and durable, but like any other components, they have service life limits. Most rim assembly failures occur in the form of fatigue cracks in the rim base or flanges.

1. Cleaning and Inspecting -- Rim bases and rim parts should be thoroughly cleaned -- especially the O-ring and gutter lock ring grooves Ä and cracks carefully inspected before they are placed in service. Two methods of cleaning rims are:

   Brushing -- hand wire brush or wire wheel on a flexible shaft grinder
   Sandblasting -- commercially available sandblasting unit

Both methods achieve the desired results with an advantage to the sandblasting operation in that all rust scale and foreign matter are removed down to bare metal.

Once rim parts have been cleaned, they can be inspected for stress cracks, broken welds or other damage. If the rim appears sound, it should be painted with rust preventive paint or coated with a rust inhibitor and prepared for service.

2. **Storage** -- Rims should be stored in a dry area to prevent rust or corrosion. Lock rings and flanges should be separated to allow easy identification and matching of correct parts in the final assembly. Rim parts and wheels should always be properly identified by size, type, and manufacturer.

   Always use a new O-ring, correctly matched to the rim assembly, when mounting a tire. Used 0-rings should be immediately cut and discarded.

E. Valves and Their Maintenance

1. **Large Bore and Super Large Bore Valves** -- The difference in size of mining tires requires different amounts of air volume to provide proper inflation. The Large Bore Valve is standard for most tires, but increased inflation and deflation time of the giant tires requires a faster, more efficient system. This has brought about development of the Super Large Bore Valve inflating system. Comparative tests reveal that deflation time is decreased by 75 percent and inflation time reduced by more than 50 percent. The system uses adapters that allow pressures to be checked with standard large bore gauges.

2. **Valve Maintenance** -- All valve hardware should be inspected during routine preventive maintenance checks. Some basic suggestions:

   a. Always check stems and extensions to be sure they are tight and properly secured.
   b. Check valve cores and remove if plugged or leaking.
   c. Always replace valve caps to keep dirt or water from damaging the core.
   d. Release of a small quantity of air will clean stem and core assembly and keep foreign matter from fouling the gauges.

F. Mounting and Demounting Procedures

A vital part of a sound tire maintenance program is correct mounting and demounting procedures. Special tools and handling devices have become necessary due to increased tire size.

G. **Cut Repair**

Systematic and conscientious preventive maintenance of a tire's work environment provides a solid foundation for economical tire service. It is, however, understood that damage to tires will occur and cannot be totally eliminated. Once damage occurs, steps should be taken to repair the damage. Situations to consider are:

1. Punctures and Rock Penetration Å These situations require immediate tire removal.

   The tires should be inspected to determine the extent of the damage and the possibility of repair. If the tire is determined to be repairable, it should be sent to a qualified repair installation for further inspection and the necessary repairs.

2. **Cuts** -- The extent of the damage determines what course of action should be followed.

   It is important to remember that although a cut may not require immediate removal, if left unattended it can lead to eventual failure of the tire. Cuts are classified as follows:

   a. Tread surface cuts not extending into the carcass.
   b. Cuts through tread penetrating into or through the carcass.
   c. Sidewall cuts.

3. **Cut Through Tread** -- If the damage is severe enough, it could lead to premature tire failure. When it is determined that the tire has been damaged, the tire should be immediately removed from service and sent to a qualified repair facility. The three general repair classifications are:

   a. **Spot Repairs** -- are for penetrations normally no deeper than 1/4 or less of the total carcass. After removal of damaged material, the skived opening is filled with repair rubber and cured to make the repair.

   b. **Reinforcement Repairs** -- are for cuts that penetrate more than 1/4 but less than 3/4 of the tire plies. In such cases, strength must be reinforced. Fabric repair material is used to reinforce the tire and then repair processes similar to those used in spot repairing are followed to complete the repair.

   c. **Section Repairs** -- are for cuts that penetrate more than 3/4 of the plies and completely rupture the casing. This often requires a reinforcing patch on the inside of the tire and additional repair materials placed in the cut from the outside. Repair rubber is again used to replace what has been removed.

4. **Sidewall Cuts** -- Sidewall cuts are repairable, depending on the location and extent of the damage. Mining personnel at the repair facility will determine after inspection if a successful repair can be made.

5. **Loose Rubber** -- Loose rubber from a snag or cut should be removed from a tire to prevent further damage.

H. Tire Performance Record System

Performance records provide knowledge of a job's service requirements and can be used as a training tool for service personnel. Thorough and accurate recordkeeping shows problem areas which cause failures. This will help eliminate the problem and improve tire service. Tire record data should include a continuous accounting of each tire's service life. The following data should be recorded:

1. Brand and/or serial number Ä for positive identification.
2. New tire nonskid depth.
3. Original and subsequent installations and removals by unit number and position. With each item the following should be included:

   Date of mounting and removal
   Unit number and position
   Reason for removal
   Accumulated mining service hours or miles

4. Final disposition (scrap, repair, retread, etc.) -- total hours or miles of mining service remaining and date of removal.

   The key to using the record system is the method used to analyze the data. This data should take into account seasonal variations which can greatly affect tire performance.

SECTION VIII

GENERAL MINE SITE MAINTENANCE

Mining conditions are great contributors to short tire life. One way to solve the problem is to remove the source of trouble. This is particularly true in the operation of heavy mining equipment. Any effort that can be made to remove hazards from the area of operation will not be wasted.

A. Loading Areas

1. **Mines, Quarries or Pits** -- In these areas, shovels, loaders, and draglines load material into mine haulage equipment. Good site maintenance practices for these mining areas are:

    a. The areas should be smooth, as dry as possible, and should provide adequate room for maneuvering.
    b. The loading pad should always be clean and free of hazards.
    c. Fine material should be used, if practical, to construct the loading pad and secondary haul roads. This is the best and quickest way to avoid undue exposure to cuts, impacts, and similar damage.
    d. Loader and shovel operators should:
        (1) Avoid bucket spillage
        (2) Center load correctly
        (3) Avoid overloading
        (4) Request support equipment for cleanup

2. **Mine Construction Sites** -- Generally, these are the areas where scrapers, dozers, and related equipment operate. Although the loading area is not fixed, it is still important to keep it as smooth as possible and free of hazards. If the material is ripped or blasted, dozers should be used to smooth the approach and departure areas over which the haul trucks must travel. Personnel should remove chuckholes and spillage from any temporary haul roads.

B. **Crushers And Tipples**

These areas are generally quite confined, offering little maneuverability and usually have heavy traffic. Extra care must be taken to make sure they remain clean. If barriers are erected to facilitate unloading, drivers should be cautioned that slamming into the barriers could possibly cause damage to tires and equipment. Since it is difficult for equipment operators to see, spotters should be used to guide drivers into these areas, thereby avoiding hazards and reducing the time required for the dumping cycle.

C. **Dumping and Fill Areas**

In mining and quarry operations, dumping areas are usually established for long periods of time. It is vitally important that they receive constant maintenance and cleanup. Mine haulage vehicles should never be driven over previously dumped material. Fine material should be provided to prepare a smooth, rock-free dump area for the trucks.

Fill areas on road construction sites are generally well-maintained since roadbed preparation requires a certain amount of compaction. Graders and compactors provide a generally good working area over which the haul vehicles may travel. Care should be taken to avoid spillage which may present a hazard.

SECTION IX

MINING EQUIPMENT OPERATOR TRAINING

The personnel most able to contribute to the elimination of premature tire failures are the equipment operators. Alert and conscientious drivers are an asset to the economical operation of heavy equipment. Any operator training program should include the following items, some of which will appear to be general knowledge but can never be overemphasized in a classroom setting or at the mine site.

A. **Equipment Inspection**

1. Each operator should inspect the equipment (including the tires) before putting it in operation.
   a. **Tires** -- cut damage, obvious air loss, rock ejectors secure, rocks lodged between duals or in cuts, equipment-tire interference.
   b. **Equipment** -- headlights, mirrors, and windshields are clean; brakes checked to see if they lock or drag; oil leaks which would cause damage to tires; hot planetaries or wheel motor assemblies; obvious wheel misalignment and uneven suspensions.

   Any irregularities should be reported at once so that corrective measures can be taken. The inspections require little time to complete, and if done two or three times per shift, can often prevent tire damage or destruction.

B. **Equipment Operators Should**:
1. Be alert.
2. Avoid hazards in loading areas, on haul roads, at dumps, and within an underground mine.
3. Report spillage and hazardous conditions as quickly as possible.
4. Avoid fast stops and starts.
5. Slow down on sharp curves and rough roads.
6. Avoid driving on road shoulders or berms.
7. Report tire damage immediately.

C. **Equipment Operators Should Not:**
1. Back into banks at loading or dumping areas.
2. Spin tires when getting underway or, in the case of self-propelled scrapers, when loading.
3. Turn dozers sharply when push-loading scrapers. (This situation could cause damage to rear scraper tires.)
4. Turn front wheels unless vehicle is in motion as the resulting stress can shear the tread from the tire.

SECTION X

MOUNTING HEAVY-DUTY TIRES AND RIMS

Increasing size and use of rubber-tired mining equipment, plus the constant need for replacing tires in rugged, mining terrain, all combine to increase tire handling hazards and the number of miners exposed to hazards.

A. General Safety Awareness

1. All persons who work with tires and rims must fully understand the potential hazards. Also, they must be taught:
   a. which rims, flags, and tires to mount together, and
   b. how to spot defects, and what the safe procedure is for each part of the job.

2. Tires, rims, and lock flags should be inspected frequently while in service. Any suspect part should be checked.

3. Tires should be completely depressurized before any attempt is made to remove the wheel from the vehicle.

4. Before work of any type is attempted on large tires, every precaution should be taken to see that the area is free of water, grease, mud, pebbles, or any other material that would prevent a secure footing.

5. No work should be performed on a tire unless there is sufficient space to permit a miner to jump clear if the tire should accidentally fall over.

6. No attempt should ever be made to roll or guide a tire while standing beside the tire. The repair person should stand directly behind the tire and roll it. This position minimizes the hazard of the tire falling on the person.

B. **Inflating and Deflating Tires**

1. Eye protection is essential during tire inflation. Also, a person's face should be turned away from the tire while it is being filled with air.

2. Restraining devices and limit gauges must be considered as additional safeguards. An effort must be made to prevent blowoffs, not only to contain them.

3. Even though a tire appears to be flat, it may still contain enough air to be dangerous. Therefore, before a heavy-duty tire is removed from a rim, the valve core should be removed from the valve stem. Persons doing this work must wear eye or face protection, or both, and be positioned out of the direct line of escaping air.

C. **Changing Tires**

1. If tires must be changed on the roadway, all trucks should be supplied with wheel chocks, jacks, tools, and gauges as well as flags, flares, and warning devices. The drivers should park the truck on level ground where there is solid footing for jacking up the truck and ample clearance for moving traffic.

2. The driver should park the vehicle, turn off the engine, and set the parking brake. If the vehicle is equipped with a blade or bucket, it should be lowered to the ground.

3. Wheels, tires, and rims should not be thrown, dropped, or otherwise roughly handled. The vehicle's wheels should be chocked with blocks. Flares or flasher barricades should be set out at night. Red fluorescent flags should be set out in the daytime.

4. In cases where large mining vehicles are inoperative and cannot be removed from steep inclines, another large truck or heavy vehicle may have to be positioned against the inoperative vehicle to assist in keeping it from rolling. After the assist vehicle is positioned, the driver should park the vehicle, turn off the engine, and set the parking brake. If the assist vehicle is equipped with a blade or bucket, it should be lowered to the ground.

5. Lug nuts or bolts should be loosened before the vehicle is raised.

6. Jacks used to raise the vehicle must be perpendicular to the ground. All jacks operated by compressed air should have hoses and attachments tested and serviced at least once a week.

7. Some wheels are secured to the hubs with heavy steel wedges held in place by lug bolts. Foot and leg injuries result from the accidental falling of these wedges. Sometimes it is necessary to loosen these with a hammer. The person using the hammer should take a position to the side of the tire and away from the direct line of failing wedges. Safety shoes must be worn.

8. When the wheel is picked up to be placed on the wheel hub, all mine employees must stay out from between the oncoming wheel and the hub. It is recommended that a cable hook or probe be used to help position the dangling tire.

9. Dual wheels should be installed so that the valve on the inside wheel can be easily reached for inflation and checking. Also, the nuts on the inside wheels should be checked to see that they are securely tightened before outside wheels are mounted.

10. Finally, the lug bolts should be tightened and the jack removed from under the vehicle; the vehicle should be driven about 500 feet after the lug bolts are

tightened; the wheel should be examined for proper alignment of rims, rings, and flanges; and if the wheel is in good order, the lug bolts should be retightened. If alignment is improper, the tire should be deflated and the wheel reassembled correctly.

SECTION XI

MAJOR SAFETY FACTORS WHEN WORKING ON TIRES AND RIMS

Remember:

An inflated tire can be very dangerous; under pressure it packs the explosive force of dynamite.

Check to make sure the valve stem is not plugged by running a piece of wire through the stem.

A broken rim part under pressure could blow apart and kill the miner the moment the lugs on dual assemblies are removed.

Regardless of how hard or firm the ground appears, put hardwood blocks under the jack.

Use a clip-on chuck and extension hose that is long enough to allow you to stand to one side and not in front of the assembly during inflation.

Carefully clean all dirt and rust from the lock ring gutter so the lock ring can be secured in its proper position. Inspect the rim and base and lock ring gutter for cracks. Cracked, damaged, or sprung rim bases or lock rings should be replaced.

Block the tire and wheel on the other side of the vehicle before you place the jack in position; always crib up with blocks just in case the jack may slip.

Remove the bead seat band slowly to prevent it from dropping off and crushing your toes. Support the band on your thigh and roll it slowly to the ground. This will protect both your back and toes.

Bead breakers and rims apply pressure to bead flanges. Keep your fingers clear. Slant bead breaker approximately 10 degrees to keep it firmly in place. If it slips it can fly off with enough force to injure or kill a person. Always stand to one side when applying hydraulic pressure.

When using a cable or chain sling, stand clear; it might snap and lash out.

When lock rings are tapped with a hammer during the first part of inflation, stand to one side when swinging the hammer. If the lock ring should blow off, it and other parts could fly off with enough force to injure or kill a person.

Do not mix rim parts of different brands. Never try to use the wrong size rim flange. Never use bent, chipped or broken rim parts. They are dangerous and can injure or kill.

Do not, under any circumstances, attempt to rework, weld, heat, or braze wheel parts. Always replace with new parts of the same size, type, and make.

Spare tires mounted on demountable rims should only have enough air pressure to keep the rim parts in place. Never transport a fully inflated tire. Inflate tires to correct operating pressure after the tire and rim assembly have been fastened in place with all lug nuts properly torqued.

SECTION XII

TIRE CARE AND SELECTION FOR SURFACE MINING OPERATIONS

Tire life can be increased substantially through effective operating, maintenance, and tire selection procedures. Surface mining operators who operate from a permanent, fixed base of operations can develop programs and facilities that increase tire life more than 50 percent.

Some of the factors affecting tire life, in order of most prevalence and frequency, are as follows:

1. Improper road and dump maintenance
2. Bad driver practices
3. Excessive haul speed
4. Overloading
5. Improper tire maintenance procedures
   a. Overinflation
   b. Underinflation
   c. Tire repair
6. Cutting
7. Wrong tire selection

A. Haul Road Maintenance

Proper haul road construction and maintenance are important for adequate tire life. Equipment operators should operate vehicles within haul road design limitations. Curves should be posted with proper speed limits, and be of such radius as to allow for specified speed limits. Flat curves are generally used in quarries, and should carry the following speed limits, to avoid tire ply separation:

50 ft. radius	5 mph max.
190 ft. radius	10 mph max.
750 ft. radius	20 mph max.
1170 ft. radius	25 mph max.

Proper curve elevation can permit the following speed limits:

50 ft. radius	8 mph
190 ft. radius	20 mph
750 ft. radius	30 mph
1170 ft. radius	35 mph

Poorly drained roads allow water to fill chuckholes and depressions, hiding rocks and other obstructions which can bruise or burst the tire from impact shock. Good drainage reduces haul road maintenance and reduces formation of chuckholes.

Loose, sharp rock fragments are usually encountered in the loading and dump areas, and are the result of spillage from a loader or truck. Overloading a truck results in loose, sharp rock fragments dropping on the haul road. Periodic dump and haul road maintenance with motor graders is the best method of reducing the potential hazard.

Loose surface or spilled material causes wheel slippage or spinning on long haul grades, which, in turn, cuts and rapidly wears the tires.

Road surfacing is also an important tire wear factor. Abrasive and sharp road surface materials cut and wear tires rapidly. Proper grade surfacing material should be used. Predominantly coarse material compacts slowly, and initially causes bruising and tire slippage. Once the material is compacted, rough, sharp, large fragments can cause tire damage. Various types of sands, gravels and crushed rocks are naturally abrasive due to geologic makeup.

B. Operator Driving

Bad driver practices are responsible for many tire failures. The driver should operate the vehicle in accordance with haul road conditions. Posted speed limits should be maintained, and the speed that road conditions dictate should be used. Road conditions do change and sometimes alertness is required. Obstacles such as sharp rocks, boulders, rock fragments, and chuckholes should be avoided. Tire slippage and spins should be held to a minimum. Fast starts, fast stops, fast turns, and loads that are too heavy can cause excessive wear to tires.

Tires should not be allowed to rub against banks of haul roads or barriers and guardrails that are erected to facilitate spotting and dumping. Excessive braking transfers heat from the brake to tire beads and the inner liner, thus causing potential tire failure from cracking. Proper use of retarders on long grades increases brake life and minimizes heating of brakes.

C. Tire Maintenance and Repair

Tires should be checked for rubbing against any part of the vehicle. Stones frequently become wedged between dual tires and should be removed immediately. Many quarries operate trucks with broken rock ejectors, which are designed to remove stones. Dual tires should be properly matched. New tires should not be mounted alongside worn tires. The size difference causes the larger tire to be overloaded.

Tires should be repaired as cuts and snags are detected. Water, dirt, stones, etc., enter exposed cuts and snags, extending into the cord body, causing tread and ply separation. Rubber becomes soft and spongy when exposed to gasoline, grease, and oil. Washing tires with gasoline or parking in puddles of oil should be avoided. Uneven brakes, poorly aligned, wobbly or bent wheels, or bent axles also cause abnormal wear.

Proper inflation is necessary. Underinflated tires flex excessively and build up tire heat, causing flex breaks, radial cracks, tread and ply separation, and tread shoulders to contact the ground.

Constant underinflation causes early wear out, and reduces tire life as follows:

90% inflated	95% tire life
86% inflated	75% tire life
70% inflated	48% tire life
60% inflated	35% tire life

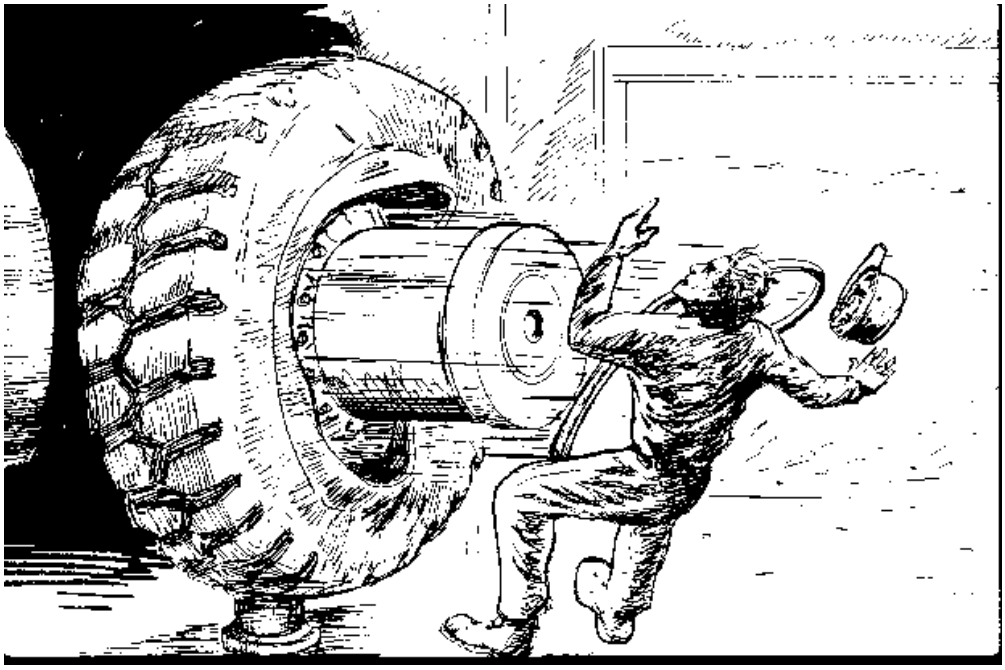
Overinflation reduces tread contact with the ground. This causes the center to wear down faster than the tread shoulder. There are less flotation and traction as the tire digs into soft ground. Overinflated tires tend to skid and spin easily. The tire is hard; thus, it cuts, snags, and breaks from impact easily. The driver experiences a harder ride, fatigues easily, and has more load spillage occurring.

Tire cutting can result from spillage, loose surfacing material, overinflation, and careless operating techniques.Tire manufacturers advise that 50 percent of all off-highway tires wear or fail because of rock cuts and tread separation. Most of these failures occur in rock quarries and gravel pits.

SECTION XIII

TIRE AND RIM RELATED FATALITIES

The following illustrations and descriptions are examples of various tire and rim related accidents. They can be used by the trainer to point out specific safety factors contributing to the accident.



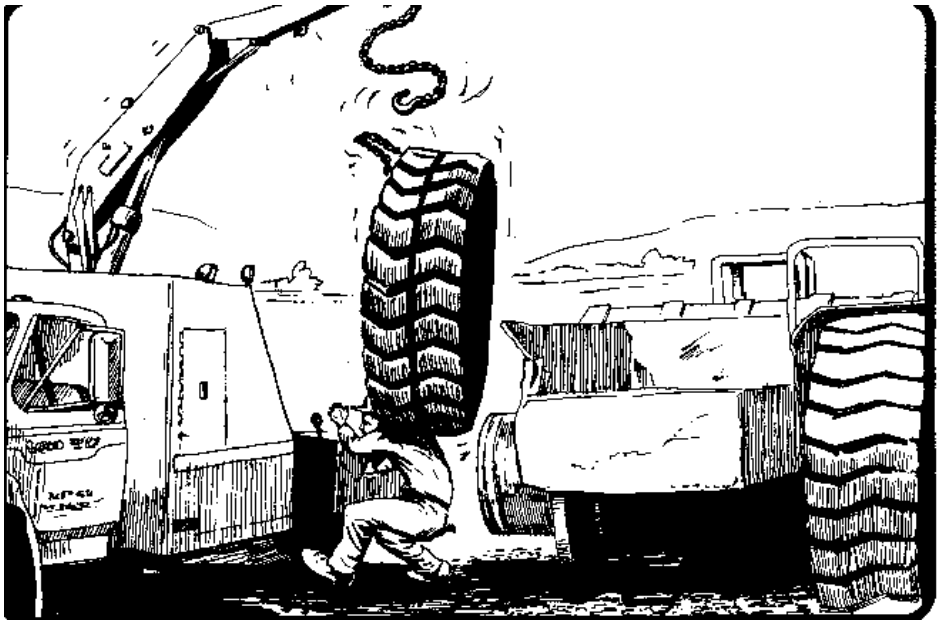
The victim was injured while he and another automotive mechanic were replacing the driver side outside dual tire on a haulage truck. The tire was usually inflated to 95 psi. They were getting ready to install the replacement tire when they heard air leaking from the inside dual. One of the mechanics went into the shop to get material to seal the leak. The victim was standing in front of the hub when the lip on the rim base holding the lock ring separated and the tire exploded. Parts of the multipiece wheel rim struck the victim. The force of the explosion threw him approximately 30 feet where he landed on the concrete surface in front of the shop area. He died thirteen days later as a result of his injuries.

MEANS OF PREVENTION

1. Deflate both tires of a dual tire assembly before removing the wheel mounting hardware.

2. Always stand outside the potential trajectory of a multipiece wheel rim lock ring.

3. Safety policies on tire repair/removal should be reviewed with employees frequently.



A tire service technician was mounting two new tires on the rear of a scraper and had the old tire hoisted on the boom hook. Although the service truck was provided with controls on both sides, he used the controls on the side nearest to the tire being changed. This placed the technician under a suspended load while operating the hoist controls. The 900 pound tire fell from the “J” style bead hook hitch, causing fatal crushing injuries to the service technician. The bead hook and hitch assembly were not designed to ensure that the tire could not slip off while being hoisted.

MEANS OF PREVENTION

1. Persons shall stay clear of suspended loads.

2. Hitches and slings used to hoist materials shall be suitable for the particular material being handled.

The victim (welder) was welding on a tire/rim assembly to modify the single wheel unit to a dual wheel assembly for a 25 cubic yard pull-type panscraper. The victim was sitting inside the rim and was welding the last of 36 gussets when one of the two tires exploded. The victim received fatal crushing injuries when he was thrown 15 feet against a parts trailer and pinned by the rim and tire assembly which was also thrown by the explosion. Another worker was thrown about 45 feet out of the shop by the force of the explosion but received no injuries.

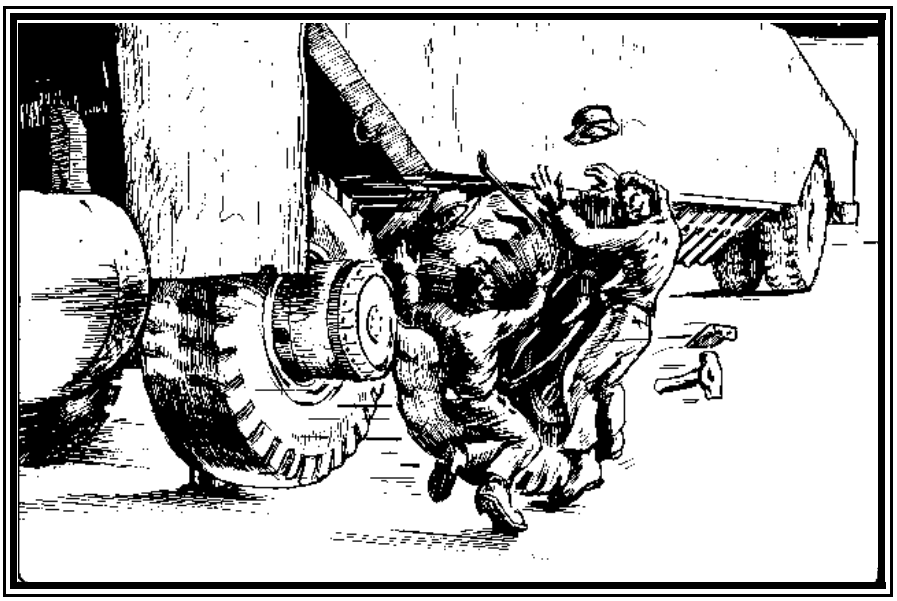
The explosion blew the other tire's rim components apart, causing them to strike an oxygen cylinder that had been secured in a cart 15 feet away. The cylinder and components continued airborne another 165 feet before severing a six inch diameter tree about 10 feet above ground level and striking an embankment. The outer rim flange flew an additional 60 feet before coming to rest.

MEANS OF PREVENTION

1. Tires should be completely deflated and removed from rims before repairs are started.

2. Never weld or cut assembled tires.

3. Always stay outside the potential area of trajectory of a tire/rim assembly.



An accident occurred in the shop area of a mine as three mechanics were attempting to remove a wheel from a 100-ton haulage truck. After five of the eight wheel retaining wedges were removed, a portion of the inner rim broke due to air pressure (80 - 100 psi) in the tire. A violent air pressure release occurred throwing the remaining wedges, a piece of broken hub, and the tire outward off the hub. Two of the mechanics, standing in front of the hub at the time of the explosion, were struck by flying material as they were thrown approximately 30 feet from the truck. The victim sustained fatal chest injuries and the other worker received serious head injuries.

MEANS OF PREVENTION

1. Tires should be deflated before any work is performed on them.

2. Always stand outside the potential area of trajectory of a tire/rim assembly.