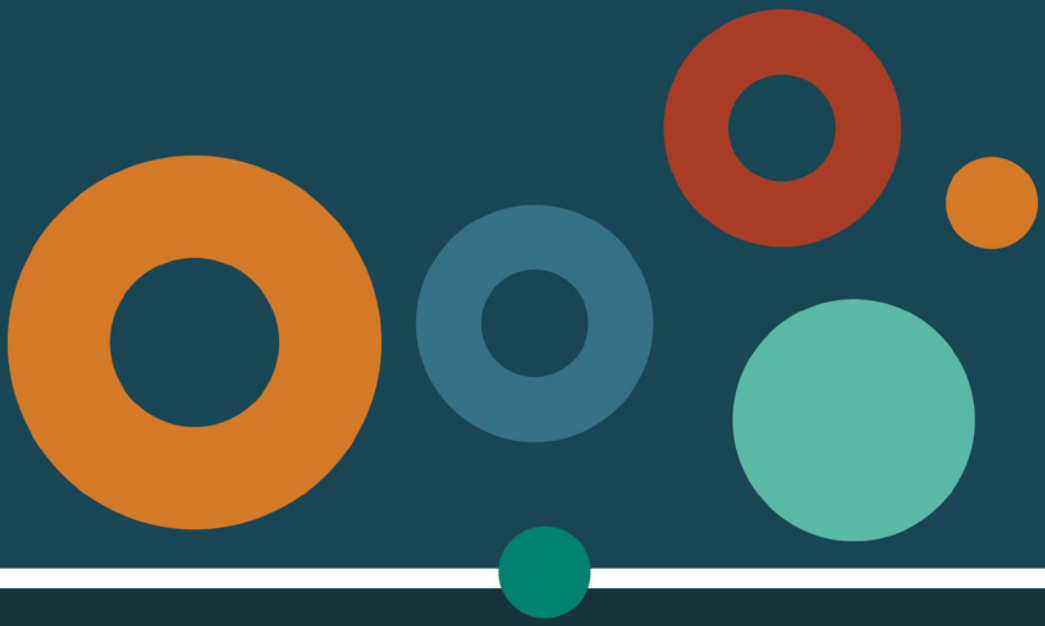
Department of Natural Resources, Mines and Energy

Guidance Note QGN 31
Tyre, wheel & rim management

Mining and Quarrying Safety and Health Act 1999

August 2018



Queensland Government

This publication has been compiled by the Mineral Mines and Quarries Inspectorate of Resources Safety & Health, Department of Natural Resources, Mines and Energy.

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1 Purpose and scope

This Guidance Note (GN) has been issued by the Mineral Mines and Quarries Inspectorate of the Department of Natural Resources, Mines and Energy.

It's designed to assist in identifying hazards associated with tyres, wheels, and rims and effective controls to minimise the risk of injury and death from uncontrolled movements and pressure release events. These controls should then be incorporated into the site's Safety and Health Management System (SHMS).

This GN applies to all tyres, wheels and rims on mobile, transportable and fixed plant used as part of operations at a mine.

It **does not** apply to tyres, wheels and rims that have a proven low risk—such as those fitted to gas trolleys, wheelbarrows, parts trolleys, ride on lawnmowers, and earthmover equipment jacks.

The Site Senior Executive (SSE) has obligations under the *Mining and Quarrying Safety and Health Act 1999* to ensure the risk to persons from operations is at an acceptable level, as well as to provide for regular monitoring and assessment of the working environment, work procedures, equipment, and installations at the mine.

A GN is not a Guideline as defined in the *Mining and Quarrying Safety and Health Act 1999.* In some circumstances, compliance with the GN may not be sufficient to ensure compliance with the requirements of the legislation. Depending on the specific site, some information contained in this GN may not be relevant or required.

GNs may be updated from time to time. To ensure you have the latest version, check the Department of Natural Resources, Mines and Energy website at www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/legislation-standards/recognised-standards or contact your local Inspector of Mines.

2 Common terms

Bead	The part of the tyre that secures the tyre to the rim
Carcass	The multi-cord layer structure and components of a bias or diagonal ply tyre
Carcass separation	The detachment of the carcass plies from each other or the internal detachment of the plies resulting in a loss of structural strength
Casing	Structure and components of a radial ply tyre
Bead seat band	A tapered component on which the tyre bead is mounted and held in place by the lock ring

Gutter – single	A profiled section at the front of the rim base that accommodates the “O” ring, the lock ring and the bead seat band
Gutter – double	A rim base that has two profiled sections, one at the front and one at back of the rim base
Lock ring	Part of a wheel or rim which retains the components when a tyre is mounted to the wheel/rim base
Mine	Reference *Mining and Quarrying Safety and Health Act 1999*, (s9).
Mismatching components	Components not designed to fit together.
Plant	Includes machinery, equipment, appliance, pressure vessel, implement and tool.
Pyrolysis	Chemical decomposition of the tyre’s inner layer producing gases that form an explosive atmosphere inside the tyre’s air chamber.
Repairable	A tyre that has suffered damage and is deemed safe for continued service once an appropriate repair is carried out.
Rim base	Part of the assembly on which the tyre is mounted and supported. Typically consists of a back section, centre section and gutter section that are welded together to form the rim base.
Rim assembly	An assembly of components, which together comprise the rim. A typical rim assembly comprises a rim base, flanges, bead seat band and lock ring, but without a tyre mounted. A rim assembly is mounted to earth-moving machinery by a system of wedges or cleats.
Rim failure	When the integrity of the rim components is compromised by incorrect assembly or disassembly, disassembly whilst in service, damage, or metal fatigue causing components to become projectiles.
Size	*Earthmover* is used for rims/wheels fitted to earthmoving machinery (where tyre handlers or forklifts are needed to handle them). *Large* is used for tyres, wheels and rims that cannot be handled safely by manual means and are fitted to trucks, cranes etc. *Light truck* is used for tyres, wheels and rims that can be manually handled and are fitted to passenger vehicles, light trucks and smaller machinery.

SHMS	The Safety and Health Management System at a site.
Tread	The portion of the tyre that comes into contact with the road.
Tyre assembly	A tyre when mounted to a wheel or rim assembly.
Tyre burst	The release of inflation pressure due to a structural failure of the casing.
Tyre explosion	Involves the automatic ignition of an explosive gas mixture within a tyre's air chamber that results in a large over pressure, leading to catastrophic tyre failure and rapid release of hazardous energy.
Wheel	A rotating load-carrying member between the tyre and axle. It usually consists of the rim base and the wheel disc/nave plate that is used to mount it to the vehicle by studs/nuts.
Wheel assembly	Comprises a rim base, flanges, bead seat band, lock ring and a wheel disc or nave plated welding to the rim base.
Wheel disc/nave plate	Part of the wheel which is the supporting member between the axle or hub and the rim base.

3 Tyre, wheel and rim risk management

The site's SHMS should document how tyres, wheels and rims will be safely managed throughout their life cycle (from procurement to disposal) at the mine.

Tyre, wheel and rim hazards and risks must be identified and assessed. The risk management approach used must consider all worker interactions with tyres, wheels and rims and include hazard controls necessary to ensure the risk is within acceptable limits and as low as reasonably achievable.

Examples of hazards that are associated with tyres, wheels and rims during operations include:

Hazards that can cause a tyre burst

- Over inflation
- Running over rocks/objects on haul road
- Sidewall of tyre contacting an object
- Excessive payload
- Tyre wear.

Hazards that can cause rim components to become projectiles

- Displacement of the rim components during operations
- Removal of rim whilst the tyre is pressurised
- Incorrectly assembling the rim components
- Recycling of damaged components

- Using mismatching components
- Cracked rim components.

Hazards that can cause a tyre explosion

- Heat from external sources such as brakes, welding/hot work on rim or oxy-cutting wheel nuts
- Vehicle striking overhead power lines
- Overheating due to under inflation
- Using flammable lubricant
- Objects left inside the tyre
- Lightning strike.

Hazards that can result in entrapment

- Working underneath suspended loads/plant
- Working with tyre handling machines
- Handling of heavy objects (large tyre assemblies, stands etc.).

During the conduct of the risk assessment, even if a tyre related event has never occurred at the mine, because of the high consequence nature of the hazard it should still be considered. Controls identified must be implemented and monitored for their effectiveness.

When undertaking the risk assessment the following should be considered:

- Selection and procurement
- Receipt, handling and storage
- The operating environment
- Maintenance facilities
- Tyre changing
- Maintenance and repairs
- Management of hazards
- Life cycle and disposal considerations
- Information, documentation and tracking
- Competency.

4 Selection and procurement

Ensure that appropriate people are involved in the selection and procurement of tyres, wheels and rims. For example, the tyre, wheel and rim manufacturers, mine operators, tyre, wheel and rim technicians and maintainers, and the plant Original Equipment Manufacturers (OEM) should be involved. Information required for selection and procurement should include:

- the types of tyres required, e.g. earthmoving, large tyres, light truck or fixed plant
- the application the tyre will be used for

- if the tyre is pneumatic or if there is a requirement for solid fill or solid tyres (solid fill or solid tyres are generally used for slow moving or occasionally moved equipment)
- whether the wheel or rim is a multi-piece, divided (two piece or split rim), or single piece
- if the mounting will be cleat mounted or disc mounted
- the duty cycle, expressed as tonne kilometre per hour (TKPH - measurement of the load speed rating of a tyre)
- the conditions of operation, e.g. surface or underground, type of plant, payload, speed, environmental conditions, equipment utilisation, road design and road surfaces.

Other considerations to assist procurement should include:

- the method of tracking and keeping record of tyres, wheels and rims, such as unique identifiers (tyre branding and wheel or rim markings), and operating hours on wheels and rims
- how the introduction of new tyres, wheels and rims will be managed on site, e.g. ensure training of on-site personnel, or if new mobile equipment comes to site)
- the choice of ‘safer’ designs, for instance:
    - bead seat band designs (for certainty of lock ring correct fit and retainment)
    - two-piece lock rings to eliminate stored energy, minimise manual handling and ‘line of fire’ hazards (these many also have lock ring retainers, bolted connectors)
- whether the tyres have been repaired or re-treaded. If this is the case, they should have repair marks on the sidewall and be tracked in the Tyre, wheel and rim management plan (refer AS 4457.2, AS 1973).

NOTE: reconditioned tyres may have speed or load restrictions and may only be fitted to certain positions on the vehicle. For example, they should not be used as steering tyres. Similarly, new or unknown brands should be positioned on rear axles until reliability is proven.

Other items to be supplied to the site include:

- the OEM or suppliers’ recommended tyre pressure, wheel or rim fastener torque and the OEM or suppliers’ ‘reasons for removal’ of a tyre, wheel or rim
- maintenance requirements during the life of the wheel or rim (refer AS 4457.1) with reference to the OEM recommendations and conditions of operation.

5 Receipt handling and storage

5.1 Receipt

Suppliers of tyres, wheels, rims and assemblies have an obligation to ensure they are delivered in a safe manner and are assembled in a way not to cause an unacceptable level of risk. This should include:

- the vehicle used to transport tyres, wheels, rims and assemblies is fit for purpose
- manufacturers' transport and handling instructions are followed (e.g. bead protectors are in place on new tyres)
- tyres are secured during transport using the correct slings or strapping, not chains, to avoid internal damage to the tyres
- ensure tyres are loaded and unloaded correctly with suitably rated mobile plant, preferably a tyre handler (if using a forklift, to avoid damage, do not insert tynes through the centre of the tyre)
- tyres assemblies are assembled and inflated to OEM requirements for transportation.

On receipt of assemblies, where tyres have been fitted to wheels or rims off site, conduct a verification check that all wheel and rim components are secure and that the tyres are at the OEM recommended pressure for transport, prior to handling.

A record of the details of tyres, wheels and rims that have come to site and are to be used as part of operations must be maintained. This should include inspection and repair information. This may be achieved by using the stamped or branded serial numbers for identification.

5.2 Handling

Handling damage to tyres can lead to tyre failure at any time. As a minimum, the tyre manufacturers' instructions should form the basis of correct handling technique. General guidance includes:

- use only fit-for-purpose tyre handling equipment
- using flat slings or straps for lifting—never use steel wire rope slings, chains or rope
- where possible leave the bead protector in place until the tyre is ready to be fitted
- consider keeping the bead protectors in case the tyre is removed in the future for repair or re-tread.

Large heavy equipment tyres and tyre assemblies can weigh a significant amount. Some vehicles use water ballast in the tyres which may weigh some 20-30% more than similar sized air-filled tyres. At this size there is no other option but to use mobile machinery to handle the items. If tyre assemblies move unexpectedly during transport, handling or fitting there is potential for crush injuries to tyre fitters or machine operators.

The following should be considered, when working with, or handling heavy objects during tyre, wheel and rim repairs (see section 8 of this document for further information):

- use jacking pads, jacking equipment and stands that are designed and rated according to the instructions of the OEM
- the weight of wheel assemblies should be clearly marked in a prominent location
- never work near or under a suspended load—this includes vehicles that are on jacks. A vehicle on a jack is considered a suspended load until it is supported on appropriate work stands
- apply sound communication and traffic management procedures when tyre fitters or spotters are interacting with heavy mobile equipment

Aside from purpose-built tyre handling machines, various tyre-handling equipment and attachments are commercially available for use with forklifts, telehandlers, loaders and hydraulic vehicle loading cranes.

5.2.1 Use of clamp-type tyre handlers

- Verify the operator's competency against a national standard such as *AURKTJ006 – 'Use of earthmoving and off-the-road tyre handlers'*
- Ensure the machine is assessed as fit-for-purpose and deemed safe to use by a suitably qualified person
- Operate the tyre handler in accordance with the OEM instructions and within its rated capacity
- Ensure the gripping pads make full contact with the tyre tread before lifting and travel at a safe speed with the tyre low to the ground in the horizontal position
- Only rotate the tyre to the vertical position when stationary
- Appropriate procedural and engineering controls are required to ensure workers are not crushed by the tyre handling equipment or a falling tyre. Ensure anti-fall-back arms are fitted and in serviceable condition and locked in place before allowing tyre fitters to enter the operating space of the gripper arms
- Do not inflate or deflate tyre assemblies with the tyre handler gripping the tyre. Overload of the machine or loss of grip of the tyre could result
- Ensure the tyre handling equipment is rated for the load and operated within its design.

Image 1: A front-end loader with clamp type tyre handler attached

5.2.2 Using a forklift

- Verify that the forklift operator is competent and has been trained and assessed to the required standard
- Operate the forklift in accordance with the OEM instructions and within its rated capacity
- Assess the ground conditions in the work area to ensure the forklift does not become unstable
- Never insert the fork tynes through the centre of the tyre as this can cause bead damage. Always lift a tyre from beneath, under the tread
- Secure the tyre to be lifted with appropriate capacity straps to prevent it from toppling during lifting and travelling. All persons should stay clear of the suspended load and the drop zone
- If the operator's view is obstructed during travelling, then operate the forklift in reverse and use a spotter for guidance. Ensure positive communication between the operator and the spotter at all times.

5.2.3 Using a crane

- Verify the operators' competency and the competency of the person slinging the load
- Operate the crane within its rated capacity with respect to the weight of the tyre/assembly being lifted
- Assess the ground conditions in the work area to ensure the crane, and its suspended load, does not become unstable when lifting or travelling

- Ensure an exclusion zone is in place to keep all persons out of the lift area with consideration for potential load swing
- Never work beneath a suspended tyre, or within the ‘drop zone’
- Never use chains to lift or suspend a tyre.

Image 2: Vehicle mounted crane with clamp type handler attachment

5.3 Storage

Tyres should be stored in accordance with OEM recommendations, with guidance from the site tyre, wheel and rim risk assessment.

When storing tyres, wheels and rims, consideration should be given to:

- ensuring they do not present a hazard which could include fire, toppling or falling off a stack, or rolling away
- a storage location away from general traffic to minimise machinery interaction when handling or damage from collision
- being stored on flat ground, with adequate drainage, and with no rough surfaces (rocks or debris) that could damage the tyres
- adequate working space with access for fire-fighting equipment
- lighting for working during hours of darkness
- ensuring relevant information is chalked or painted on the sidewall or other location where it will be clearly visible
- ensuring a stock rotation strategy exists to limit storage time of all components based on OEM requirements (e.g. rubber products should be efficiently rotated to ensure they meet the OEM recommended set ‘use by’ date).

Typically, tyre manufacturers recommend new, unmounted tyres are stored upright at a safe angle rather than being laid on top of one another. This prevents permanent distortion of the casing and consequent difficulties when attempting to mount the tyre.

Image 3: Earth mover tyre storage showing segregation and access

If storing large tyres and assemblies horizontally, the tyre at the base of the stack may suffer structural integrity damage to the tyre. They should preferably be stacked no more than three high to reduce the risk of damage or having a dislodged tyre toppling in an uncontrolled manner.

Tyres should be stored in a dry and clean environment where they are protected from water, sunlight, petroleum products, electrical equipment producing ozone and any heat sources. If stored outdoors they should be covered with a suitable waterproof tarpaulin for protection. All tyres should be checked internally for debris (i.e. water, wood, dust etc.) and be internally clean prior to assembly.

Tyres and wheel or rim assemblies should be stored appropriately to ensure that they cannot roll away, topple or be dislodged.

To overcome tyre bead issues, assemblies should be inflated to storage pressures, as determined by OEM recommendations, for the size and type of assembly to maintain the bead in the correct seating location on the rim base. It is recommended that the inflation pressure and date of inflation is written on the tyre sidewall with permanent crayon.

Valve caps should be fitted to all valve stems to prevent ingress of dirt into the valve stem and provide airtight seal against leakage. Consider using metal valve caps for this purpose.

Assemblies and tyre, wheel and rim components should be stored in a segregated manner to avoid mismatch and reintroduction of previously quarantined or damaged items. Storage of these items should ensure:

- they are stored off the ground on a compacted, well drained area that allows all-weather access for forklifts and other load shifting equipment, such as tyre handlers
- rim components such as bead seat, flange rings and lock rings should be stored in a manner that retains their serviceability and segregates compatible and incompatible components
- components waiting for testing or repair should be clearly marked and stored in a designated and clearly identified ‘quarantine area’ to prevent accidental return to service
- damaged, worn-out or unserviceable components should be rendered inoperable (e.g. by cutting up) and discarded.

In general, tyres should not be stored on vehicles for long periods. The vehicle should be operated periodically to prevent permanent distortion of the tyres. If a vehicle is to be stored it is not to be left in the loaded condition. This should not include water trucks that are parked with a full tank to enable a fast response to an emergency situation. Generally, these types of vehicles are driven on a regular basis during the course of their normal duty.

If long term storage is required, use guidance from the OEM. The vehicle should be parked on a flat stable surface and supported on adequate stands, so the wheels are clear of the ground. The tyre pressures can then be reduced to the storage pressure set by the OEM. The date and pressure reduction should be clearly marked and recorded to warn of the pressure reduction in the tyres. Where possible, it may be beneficial to remove the outer of dual wheels and store them under cover. All tyres are to be inspected by competent persons before allowing repressurising and loading.

6 The operating environment

Tyre assemblies are exposed to a variety of operating conditions including overloading, rock damage and heat build-up within the tyre from combinations of flexing, impact, load and speed. These conditions create different loads that the tyre assembly has to withstand. Therefore, a major part of the tyre, wheel and rim selection process will include an assessment of the operating conditions which the tyre assembly will face.

Inspections of the operating environment include looking for tyre damaging conditions in the pit or quarry load area, haul roads, dumps and stockpiles. The individuals conducting inspections should include supervisors and operators of the vehicles working in those areas. If necessary to repair or replace a tyre in the mine area, consideration should be given to the operating environment inclusive of the areas where the tyre handler, crane, or service vehicle will be working.

Correct road maintenance involves all aspects of maintaining the haul roads to a standard where tyre wear or damage is not accelerated. This includes the removal of rocks and spillage laying on the road, removal of rocks imbedded in the road surface, resheeting and grading of road surfaces to reprofile them, upkeep of drainage channels and the grooming of windrows and emergency stopping buffers. These situations are

just as relevant in an underground mine as it is for surface operations. Tyre life will usually reflect the level of haul road maintenance. If haul roads are maintained well then the tyre life is usually high.

Care should be taken when watering haul roads to ensure that the road surface is not overwatered. Overwatering can lower the surface friction and cause scouring, erosion and grooving of the road base, which can lead to impact loading of individual tyres, reduced traction and loss of control. The combination of wet tyres and wheel slip through loss of traction dramatically increases the tyre wear rate.

In the interests of safety, all roadways should be constructed to provide safe, efficient travel at normal operating speeds. Correct road design is one of the most critical aspects of achieving high tyre life and is a function of the equipment being used. Consideration should be given to the braking and haulage capabilities of the equipment, both currently in use and proposed, to allow for adequate vision and to provide safe stopping distances. Road design should take into consideration, among other things:

- horizontal and vertical alignment
- cross-fall and camber
- drainage
- superelevation rates
- curve radii
- road construction material
- road widths.

7 Maintenance facilities

7.1 Work area

The tyre maintenance area-specific needs should be considered in the risk assessment process. Typically, the tyre maintenance area should be located away from other work areas, traffic, pedestrians, offices and other populated areas.

The number of workers involved in the repairs or working in the vicinity should be reduced to the minimum number required for the work. All other personnel should be excluded from the area. There should be sufficient supervision, signage and barricading in place to prevent inadvertent access by unauthorised personnel. A *no-go* zone of sufficient size needs to be marked out in front of the work area to indicate the potential blast direction in the event of rapid tyre deflation or uncontrolled release of the wheel or rim components during inflation or deflation.

The type, location and design features of the facility should take into account the specific site and the equipment requirements. If repairs become necessary at a location away from the site workshop, then competent personnel will need to assess the job risks prior to commencing the job (e.g. such as location, ground conditions, and prevailing weather conditions). Ideally, repairs would be carried out in a permanent maintenance facility.

For a permanent maintenance facility there are a number of design principles that would support the ongoing safe fitting and removal of tyres. These considerations should include the following:

- a level, well drained stable surface (either rated and fit-for-purpose concrete or compacted aggregate surface) assessed by a competent person to have sufficient integrity to support the point loads imposed from jacks and stands
- if operating at night there should be provision of good local area lighting in the work area where assembly of components is being conducted, and adequate general area lighting to all other work areas
- shade and weather protection to provide comfort, fatigue management and general protection from the elements for tyre fitting personnel.

7.2 Tools and equipment

- Suitably rated jacking pads, fit-for-purpose jacks and equipment stands (timber cribbing and blocks should not be used as load bearing members)
- Plant rated fit-for-purpose for handling tyres, wheels and rims
- Certified and rated fit-for-purpose tyre and rim maintenance stands
- Work platforms of suitable height to access the largest vehicle to be serviced
- Tyre pressure gauges should be periodically checked against a calibrated master gauge for accuracy. The gauge should return to zero when not in use
- Certified safety inflation cage to suit the assembly size, located in an appropriate area with clearly identified restricted area signage
- Storage facility for all essential items within close proximity to the work area.

7.3 Compressed air

Compressed air hazards are those from inflation or deflation of tyres. Consideration should be given to the following points:

- When releasing air from the valve stem, stand in a safe location as foreign matter or frozen particles inside the tyre may be discharged at high velocity.
- Do not allow high pressure air to contact the skin.
- Compressors and air receivers should provide sufficient pressure and volume for the tyres in use, and cater for the largest volume and highest-pressure tyre on the site.
- The compressor and receiver should be located away from personnel, suitably protected from mobile equipment, and serviced regularly as per OEM recommendations.
- If a motor driven compressor is used there should be adequate ventilation so that there no chance of exhaust recirculation.
- Air receivers and safety valves should be tested regularly as per Australian Standard AS3788. All other air fittings and lines should be rated to withstand the highest air pressure the supplying air compressor can produce. Air lines/hoses should be kink resistant, clean and clearly identifiable.
- Airline couplings should have a feature that ensures they don’t uncouple accidently when under pressure.

- There should be remote inflation/deflation and pressure monitoring ability to ensure persons are not positioned in the high-risk zone of a potential air blast during inflation/deflation. Air-control valves should be fail-safe type (e.g. incorporating a pressure limiting device).
- Deflation devices should be fitted with noise suppression.
- Air used to inflate tyres should be oil free, dry and free of foreign matter (e.g. corrosion scale, water condensate, oil). Consider the inclusion of an air dryer to minimise the amount of moisture entering the wheel or rim assembly.
- Compressed air should not be directed at a person or used to remove dirt and dust from clothing while being worn.

7.4 Nitrogen

The use of nitrogen for inflating tyres may help to prevent pyrolysis. However, to be effective, the oxygen concentration in the tyre has to be less than 5.5% by volume, which can be difficult to achieve if air is used to seat the bead. Several purges may be required to decrease the oxygen content below this level. Although nitrogen gas is virtually chemically inert, the use of it introduces other hazards to the site such as:

- nitrogen gas stored in pressurised containers is a form of stored energy that should be handled appropriately
- nitrogen is an asphyxiant so venting tyres in an enclosed or poorly ventilated area can create an oxygen deficient atmosphere.

NOTE: Cold nitrogen gas can be denser than ambient air and can therefore settle in low areas such as sumps and workshop pits.

7.5 Water ballast

Some low speed vehicles (e.g. tyre dozers, tractors, front-end loaders) use a non-toxic/non-corrosive anti-freeze and water solution as ballast to increase traction. Water-ballasted tyres may weigh significantly more than an air-filled tyre and presents the hazard of handling a heavy object. It is therefore important that reliable information on the mass of tyre assemblies, and their fill medium, is available to competent persons to select suitably rated tyre-handling machinery. The weight of tyre assemblies should be clearly marked on the assembly.

Consultation with the OEM and the product supplier is essential to ensure the correct quantity of fill and procedure is followed.

8 Tyre changing

The steps involved in fitting the wheel and rim assemblies vary depending on the type and size of the tyres, wheels and rims. OEM requirements should be available and referred to, prior to the task being carried out. This section outlines the controls and points to consider to ensure removal and demounting, inspection and mounting, and installing are performed correctly and safely. If there are any doubts about procedures

or work safety, then stop work immediately and seek the expert advice of competent and experienced personnel.

Tyres can be demounted and/or mounted when:

- the wheel or rim has already been removed from the vehicle
- the wheel or rim is still on the vehicle.

Whatever method is adopted, the procedure should be supported by sound risk assessment principles and developed by a representative group of workers. The safety critical steps and their controls should be identified and highlighted in the procedure.

8.1 Removal and demounting

When demounting a tyre assembly, the following should be considered:

- the vehicle should be prepared correctly prior to entering the maintenance work area (e.g. clean, no load or hang-up material in tray, no rocks between dual wheels). Consideration should be given to providing access to vehicle wash-down facilities
- ensure the vehicle is isolated and stabilised (e.g. wheels wedged with suitably sized and strength chocks)
- where required, the turn restraining link (articulation locking struts) or steering locks, should be installed
- jacks and stands should be able to be positioned under the vehicle without a worker having to place his body under the vehicle, or to be within close proximity to the vehicle's tyres whilst jacking occurs
- jacking should be staged, depending on the size and type of vehicle being worked on. Staged jacking can sometimes be necessary for larger earthmoving equipment due to the rearward movement of the jacking point as the vehicle lifts(e.g. chock machine, lift part way, support vehicle on stands, reset wheel chocks, reset jack ground position, recommence lifting).

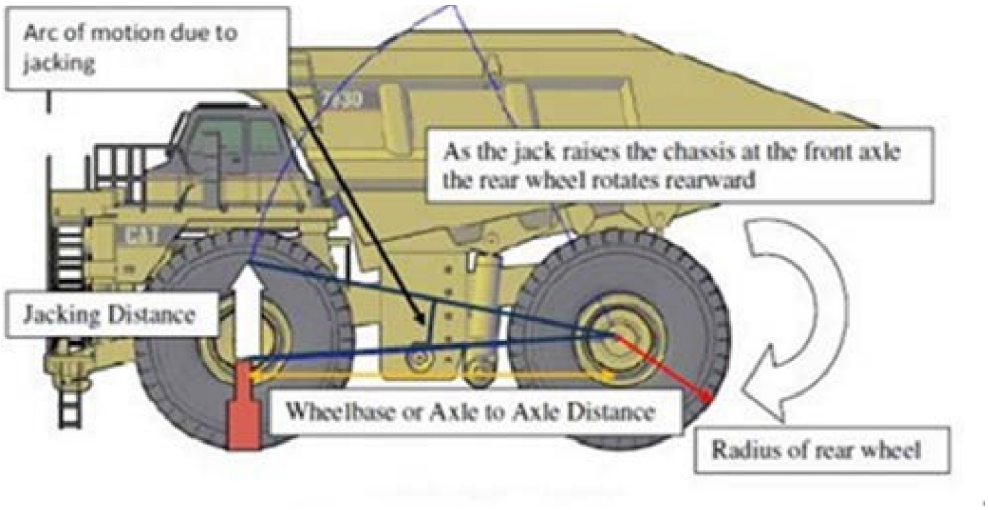

Image 4: Typical movement when jacking large vehicles

- Consider the movement of vehicles with oscillating axles when jacking
- Completely deflate the tyre and remove the valve core before attempting to disassemble the tyre assembly. There should be confirmation that no foreign material is blocking the valve stem and that all pressure can be exhausted. Release of air from valve removal can present a noise hazard to personnel
- Tyres should be deflated while standing outside the range of the 'hazardous trajectory'. Do not allow high pressure air to contact the skin
- Deflate BOTH tyres on a dual assembly wheelset to zero, or to a safe handling pressure (as predetermined by the site risk assessment) prior to removing any clamp components and demounting the outer wheel
- Ensure that the lock ring and o-ring can be removed safely. On some assemblies the use of a lock ring catcher may be beneficial to minimise the risk of injury
- Exercise caution when removing the lock ring as it may fly off once released. Do not spread the ends of the lock ring excessively as it may be permanently distorted and will have to be discarded
- Controlling the hazards involved with breaking the tyre bead (e.g. using barricades or guards to prevent injury from unexpected ejection of bead-breaking tools)
- What mechanism/method will be used to remove the tyre from the assembly and transport for reuse, reconditioning or scrap
- How to safely remove the tyre bead seat-band and flange from the tyre.

If tyres were fitted offsite, then an inspection and sign-off by an authorised and competent person should be conducted prior to them being used or stored onsite.

8.2 Inspection and mounting

8.2.1 Wheels and rims

Considerations for assembly should include:

- Ensure crack testing schedule for wheels and rims is aligned with the OEM recommendations, with consideration given to work-site conditions and vehicle usage
- Examine the cause of any cracked or damaged paint, and any other defects or signs of abnormal wear
- Thoroughly clean rim components for inspection and remove scale, rust, dirt and other foreign materials from all surfaces. Gutter of rim base should be cleared of rust and other materials that could obstruct seating of lock rings. Bead seat areas of rim should be free of rust and rubber deposits
- Examine all components for serviceability (e.g. wheel disc, fastener holes, seating taper, bead seat band, flange, and locking ring). Discard lock rings with open ends (ends that aren't touching or overlapping) as they will not sit correctly

and could result in serious injury or death. Used o-rings should be cut to prevent reuse.

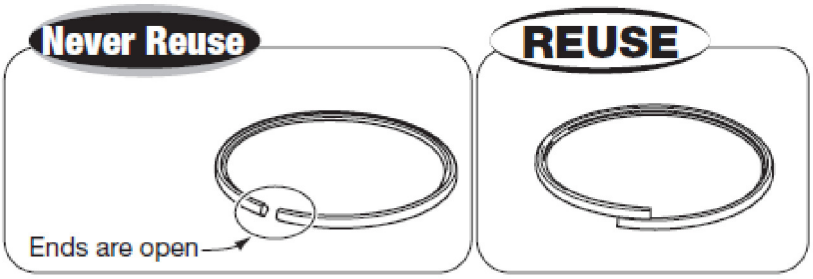

***Image 5: Lock ring suitability** (Source: Topy 2008.08)*

- Confirm the correct seating of components prior to partial inflation, again after partial inflation and then prior to increasing the pressure to full inflation (consider a 'hold-point' and second person verification). All personnel are to be kept clear of the *'hazardous trajectory'* range during inflation
- During inflation, do not allow the air pressure to exceed the pressure recommended by the tyre manufacturer. Never leave a tyre unattended during inflation
- Never attempt to seat or position the rim components by inflating the tyre
- If there are any issues identified or mistakes made during the assembly, immediately stop inflation, release the air and reassemble the tyre and rim components.

WARNING: Do not hammer, weld or heat to position the rim components. Doing so can lead to the deformation as well as the deterioration of the strength and structural integrity of the rim components.

Using tyre inflation cages

Large tyres and light vehicle tyres are commonly inflated within a tyre inflation cage. The use of a cage for inflation can mislead personnel that the hazard is controlled. The tyre inflation cage may not completely restrain projectiles if a tyre fails catastrophically. Before a tyre inflation cage is used, a risk assessment should be conducted to determine, among other things, a suitable location away from general traffic and personnel, signage, barricading, tyre size limits, procedures for use and training. Other considerations include:

- Use only fit-for-purpose tyre inflation cages certified by competent persons
- Ensure competent persons install, use, inspect and maintain tyre inflation cages in accordance with the designers' or OEM instructions
- Consult the designer or OEM prior to fixing the tyre inflation cage to concrete floors, footings or other structure. In the event of a tyre burst the design may rely on the tyre cage to deform and absorb the energy and excessive restraint may impede the intention of the design.

8.2.2 Tyres

When preparing tyres for mounting, the following should be considered:

- Establish that any components to be reused meet the OEM's component reusability criteria
- Establish that any of the components to be reassembled are compatible components, referenced to OEM requirements. Incompatible combinations could cause violent separation of the assembly resulting in serious injury or death.
- Check and/or replace valve components
- Ensure no deformities or anomalies are identified on the tyre
- Check that the tyre internals are free from foreign materials and dirt
- Ensure current data of recommended cold inflation pressure for the plant being worked on is available
- Clean and correctly lubricate tyre beads, rim components and o-rings with OEM recommended lubricant
- Ensure reconditioned tyres are being fitted to correct positions on the vehicle (i.e. they should not be used as steering tyres). Typically, only new tyres are fitted to steer wheels wherever possible.

WARNING: As a control of the hazard of rapid tyre deflation or uncontrolled release of the wheel or rim components during inflation and deflation, an exclusion zone should be setup around the work area. The size and shape of the exclusion zone should be suitable for the size of the tyre assembly, and the pressure it contains.

Other mounting considerations *could* include:

- The fitting of remote tyre pressure monitoring systems (TPMS). Correct pressure in a tyre is critical to its safe performance, load carrying capacity and fatigue life. TPMS are beneficial in keeping the tyre pressure within its stated pressure envelope. Some pressure monitoring systems also include temperature monitoring of the tyre air chamber. The capability to inform the vehicle operator (by remote monitoring in the operators' cab) of a tyre pressure outside of the envelope can ensure swift action to correct the situation or prevent tyre damage.
- The fitting of temperature sensitive pressure relief valves, which can be installed in the bare wheel/rim prior to assembly of the tyre. These devices are typically fitted to heavy equipment wheels and rims. They are basically a rupture disc that will release at a given temperature and pressure to mitigate a potentially violent tyre explosion. Rupture discs are precision safety devices and should be installed by trained, knowledgeable installers and only within environments suitable and appropriate for a rupture disc.

NOTE: The instantaneous release of pressure from the rupture disc can create excessive noise due to the discharge of air/gas at sonic velocity.

- For those vehicles requiring polyurethane filled tyres, the OEM's process should be followed. An incomplete fill will allow the fill material to move during operation of the vehicle and subsequently cause frictional heating inside the tyre.
- Some sites choose to fit tyre protection chains to protect against the sharp, edged rock, or for muddy and slippery surfaces, which are potential hazards to tyres, even when new. The benefits of tyre protection chains are reduced equipment downtime and loss of productivity. The tyre protection chains also assist with containment in the event of a sudden tyre failure. Fitting and maintenance of chains requires specialised training and equipment. Assemblies, when fitted with tyre protection chains, can weigh a substantial amount more, and any machine used to handle these assemblies should be rated appropriately.
- For protection and traction chains, readjustment and tightening presents a unique risk profile, the controls for this task should be assessed using the expertise of the chain manufacturer or supplier.

9 Maintenance and repair

Maintenance work should only be carried out by persons who have received appropriate formal training and assessment by a competent person. This formal training should include relevant on-the-job instruction on the safe handling of tyres and rims. The technician should have a proper understanding of how the tools are used and how to carry out the work in accordance with the correct procedure.

Mobile equipment operators are most likely to identify issues during the pre-start or in-shift inspection. Operations personnel should therefore be given training to assist them in recognising potential problems with tyres, wheels and rims. Pre-start check sheets should be developed that include tyre, wheel and rim, and fastener inspection. The operator should also be given guidance on how to report any defect noted.

Information on tyre and wheel assembly maintenance and repair is provided in Australian Standards AS 4457.1 and AS 4457.2. Persons involved with work on tyres wheels and rims should consult these standards.

9.1 Tyres

The safe operation and serviceability of a tyre is primarily determined through periodic visual inspections, and inflation pressure monitoring undertaken according to the OEM recommendations and site-specific requirements. The inspection should include, but not be limited to, the following items:

- verify tyre identification number and relative location or position on the vehicle, if fitted
- inflation pressure—both over-pressure and under-pressure
- wear/tread depth—important to assist with the matching of similarly worn tyre in dual arrangements

- damage/condition (e.g. cuts, tears, sidewall bubbles and deformations)
- rock ejectors are in place and effective
- fatigue/heat induced damage (separation, delamination, bubbles)
- valve assembly integrity.

The tyre supplier, manufacturer or tyre repair facility should provide guidance to the site for the determination of continued use, recondition or discard of the tyre.

The correct pressure in a tyre is critical to its load carrying capacity, service life and for reduction of risk of premature failure. Operating with tyres that are excessively over or under inflated may not only cause damage to the tyre, but also expose workers to unnecessary risks. A process and schedule for taking pressure readings specific to earthmover and large vehicle tyres should be in place at sites.

Any tyre found to be either deflated or running at an inflation pressure of less than 70 per cent of the tyre's recommended cold inflation pressure, will require the tyre to be removed and inspected internally. Tyres which have been run flat or under-inflated may have suffered damage to the casing or carcass, and reinflation may result in a serious or dangerous occurrence. Low pressure operation can also cause uneven wear of tread, ply separation, heat separation and damage to the bead.

Tyres that have been run overloaded, under-inflated or flat for extended periods of time can also suffer from "zipper failure". This is where the sidewall of the tyre tears open violently during the reinflation process. The failure gains its name from the appearance of the sidewall after the incident. Any adjacent dual tyre to the one that has run flat or underinflated should also be removed and inspected as this tyre may have been overloaded and also damaged.

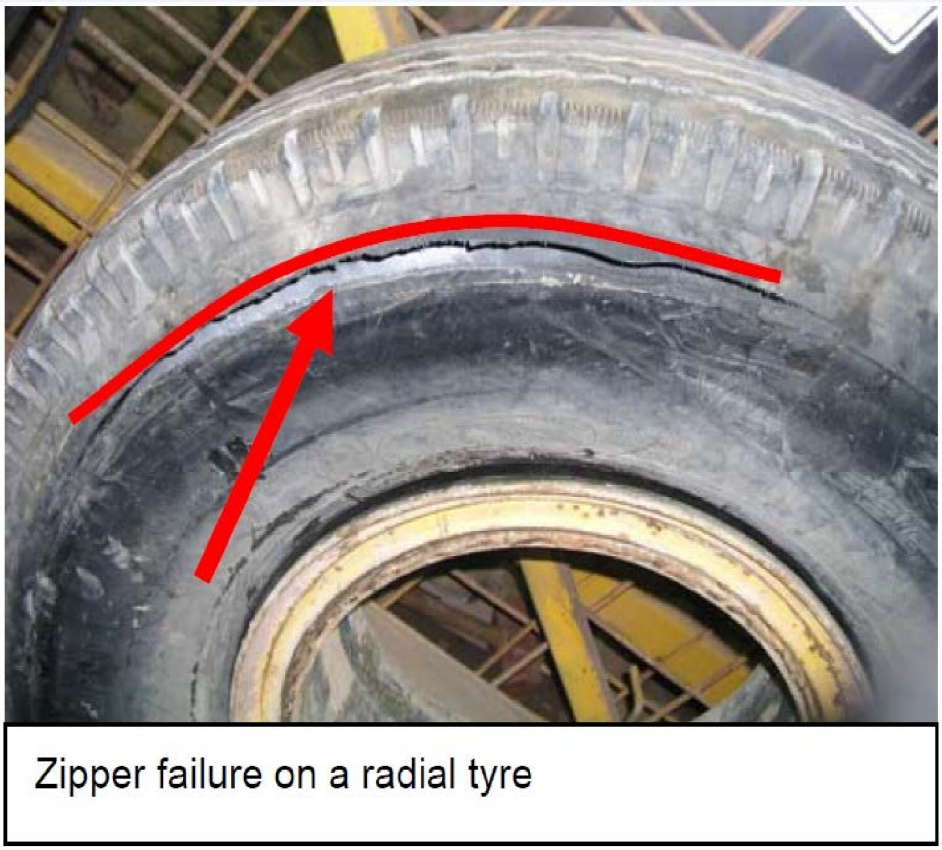

Image 6: Zipper failure on a radial tyre

High pressure operation can cause the tyre to be more rigid and less likely to absorb impacts making the tyre more susceptible to cuts and impact breaks. The centre of the footprint will carry more of the load which can cause heat build-up in the tread centre. Over-pressure also magnifies the stress on the tyre structure causing reduced life, reduced traction and flotation, and compromise handling.

Discard tyres that may have unseen damage, such as those with:

- a history of under-inflation (i.e. run flat)
- signs of heat.

Reference should be made to AS 4457.2 Appendix B for further examples of conditions for periodic inspection.

9.2 Wheels and rims

Regular visual inspection by vehicle operators (generally at the same time as tyre inspections are carried out) can provide an early indication of problems developing. A thorough visual inspection of cleaned wheels and rims at each tyre change can provide early indication of developing integrity issues. Results of the latter inspections should be recorded in the maintenance history and may require the wheel or rim to undergo further inspection, possibly non-destructive testing.

Wheels and rims should be checked to ensure fitting and wear tolerances in multi-piece wheels or rims are not exceeded. Profile templates may be available from the OEM to ensure the wheel or rim is suitable for reuse. Wheels should be examined for damage to the wheel stud holes, cracking of rims, welds, and centre discs, signs of rust and fretting between mating surfaces, general corrosion and damage. All identification markings should be clearly visible on all components. Discard criteria should be established in consultation with the OEM for any wheel and rim components that are deformed, bent, cracked, corroded, worn, or damaged, or are suspected of being so.

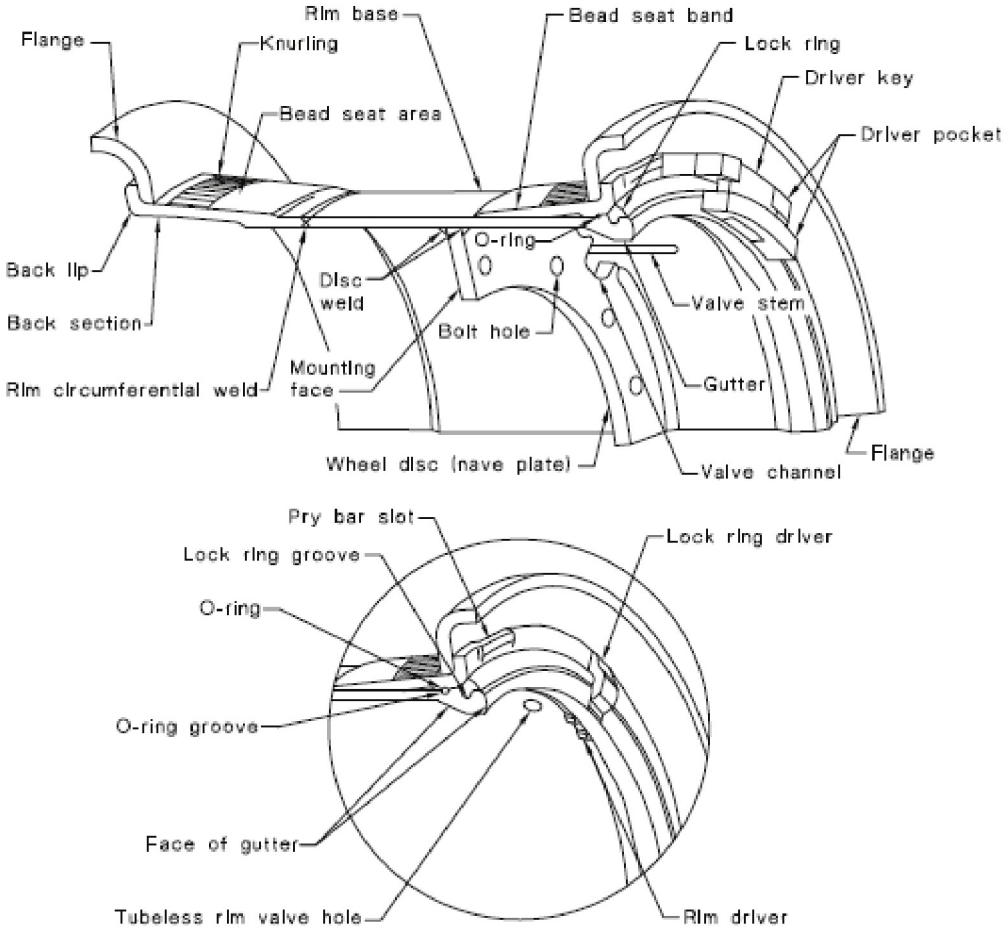

Image 7: Typical Heavy Equipment Wheel/Rim Nomenclature ***(Source: AS 4457.1)***

9.3 Repairs

Before any tyre repair is attempted, the tyre should be assessed by a competent person to determine serviceability and whether a repair is feasible. Feasibility of repair should take into account:

- potential remaining life of tyre based on tread depth, age etc.
- location of damage on the tyre
- extent and severity of damage to the tyre

- integrity of the casing liner and bead.

Earthmover wheels and rims that have been involved in an incident, sustained damage or had fatigue identified by the inspection may require non-destructive testing (NDT) to establish the competence of the wheel or rim. The frequency of NDT may require adjusting depending on operating conditions, results of previous testing and component deterioration. Passenger and light truck vehicle wheels and rims are usually considered consumable items and discarded if found in an unserviceable condition.

Any hot work (e.g. heating, grinding, welding or cutting) on wheels and rims, or heat application to fasteners and fittings, is prohibited with tyres mounted (including deflated tyres).

Unless authorised by the OEM no repairs to any lock ring, side ring or bead seat band should be undertaken. These should be rendered inoperable and discarded.

10 Managing hazardous conditions and hazards

Many hazardous conditions (unwanted events) may be encountered during operation. It's essential to develop a documented plan for dealing with these conditions before they arise. Workers who will encounter, or will manage, the hazardous conditions should be trained in the recognition of tyre, wheel and rim hazards and their associated controls.

If a defect is identified or suspected by an operator during an inspection, the area of concern should be clearly noted, and the vehicle parked in a safe location. The vehicle should not be taken into the tyre bay or workshop area until the defect has been inspected by a competent person. This reduces the exposure of mine workers to a potentially hazardous condition.

Typical hazardous conditions and hazards, as outlined in section 3, that should be considered when working with tyres include, but not limited to, the items noted below:

- Stored pressure energy
- Fire and heat
- Electrification
- Noise
- Fuels and chemicals.

10.1 Stored pressure energy

The stored potential energy contained within an inflated tyre depends on the volume and pressure within the tyre and may be substantial. Regardless of their size and mass, tyre, wheel and rim assembly components can be propelled long distances at great speed when tyres burst or explode. Multi-piece rims have potential for sudden catastrophic disassembly, which may expel the wheel or rim components violently. Various conditions can attribute to release of stored pressure energy including:

- poor maintenance (i.e. incorrectly adjusted or neglected operating pressures, ignored or non-existent inspection schedule)
- incorrect assembly (i.e. incompatible, poorly fitted or missing parts, use of non-approved replacement parts, incorrect seating of tyre beads)

- re-use of damaged or worn parts (i.e. damaged or deformed lock rings, worn or corroded components, wheels or rims)
- incorrect or ignored work procedures (i.e. disassembly of multi-piece rim before tyre is fully deflated, loosening fasteners before tyre is fully deflated, removing outer tyre without also deflating accompanying dual tyre, adjustment of poorly or incorrectly fitted components without tyre fully deflated)
- use of cracked wheel or rim (i.e. fatigue, impact damage)
- overpressure (i.e. caused by incorrect inflation, overload).

10.1.1 Unable to deflate

For tyres that are unable to be deflated, the hazards can be due to the stored pressure energy being blocked. This issue mainly affects large and earthmover tyres.

Connect the deflation tool to a remote inflation line and set the valving to 'open for inflation'. Confirm that the tyre is not deflating. The following escalating steps should be followed:

- pressurise the inflation line to a nominated pressure (less or equal to OEM cold inflation pressure)
- stop inflation, bleed and disconnect inflation line
- check pressure in the tyre is equal to the nominated inflation pressure
- continue to deflate, check pressure intermittently and verify it is decreasing.

If the pressure is not decreasing, the blockage has not been dislodged. Attempt to clear the blockage again by using the above approach if possible.

If the pressure is still not decreasing (blockage may be rubber nodules in the valve stem or the tyre inner liner creating a flap over the valve hole):

- a competent person needs to insert a probe (or a similar tool) into the valve stem to achieve full deflation, after carrying out a risk assessment
- attempt deflation by removing valve from rim/wheel base, or fusible link/burst disc if fitted.

As a last resort, consider tyre spiking:

- after risk assessment is carried out on the proposed method
- set up exclusion zone > 300m (for persons other than the operator) jack up vehicle and remotely lower tyre onto a hollow spike or reverse vehicle onto a plate that has a hollow spike welded at an angle.

10.2 Fire and heat

Tyre fires and heat can also be caused by another issue on the vehicle. External heat sources such as engine bay fires, hydraulic fires, wheel motor fires, and overheated brakes can spread to the tyres. Over-heated tyres can produce visible smoke or bubbles and give off a smell of hot/burning rubber. Overheated tyres can also be caused by operating outside the TKPH/OEM limits, poor road conditions, and incorrect inflation.

Internal tyre fires are very difficult to identify and may not necessarily produce any warning signs. A tyre can explode at any time after the application of heat or electrification. Tyre

pressure and temperature monitoring technology may not respond to a rapid temperature rise in time to alert of a potential explosion.

10.2.1 Pyrolysis

Poor maintenance practices, such as heating of seized wheel fasteners, and cutting, grinding or welding on wheels or rims with tyres fitted can also cause fires, heat or pyrolysis to occur.

Sources of heat that could result in a pyrolysis explosion include:

- poor maintenance practices (heating of seized wheel fasteners, cutting, grinding or welding on wheels or rims with tyres fitted – either inflated or deflated)
- not thoroughly cleaning the tyre cavity before assembly (i.e. debris left inside)
- external heat source (as noted above)
- under-inflated tyres
- poor operation (i.e. operating outside the TPKH rating)
- heat separation
- contact with high voltage conductors (e.g. powerlines)
- lightning strike.

10.2.2 Diffusion

Diffusion related explosions are not as common as other heat related incidents. Tyres mounted with foreign materials left inside (e.g. wood) can sustain internal damage to the casing liner and bead. When heated, any wood left inside the tyre can release methanol vapour and create an explosive mixture in the tyre's air chamber. Under the right conditions, temperature, and pressure this volatile mixture can auto-ignite at a temperature much lower than that of a pyrolysis-related explosion. Foreign material within a tyre can also block the valve stem during deflation, giving the impression that the tyre is deflated when it may not be.

WARNING: Any vehicle that has a tyre that shows evidence of, or is suspected of, overheating, should immediately park the vehicle in a safe location away from other machinery and workers. An exclusion zone of at least 300 metres should be setup and the tyre/s allowed to cool for a minimum of 24 hours before an inspection is allowed. Inspection risk may be mitigated with the use of camera mounted drone technology, or thermal imaging, if available. The requirement for safe parking area(s) should be identified in emergency response plans and traffic management plans. All operators should be trained in their location and use.

NOTE: Taking a laser assisted temperature reading of the tyre surface will not necessarily give an indication of internal heating.

10.3 Electrification

Electrification of mobile equipment is caused by contact with an electrical power source, typically overhead powerlines, and lightning strike. Electrification may trigger one or several tyres on the effected vehicle to explode, and can happen either instantaneously or be delayed.

An electrification scenario should be considered as a reasonably foreseeable emergency on a mine site. The SSE must ensure there is an emergency procedure developed for managing the event. Training should be provided so that all persons can respond appropriately to the emergency.

The driver of the vehicle should act as quickly as possible after the initiating incident. The main points to consider relating to vehicle electrification or tyre fire include:

- advise of the emergency immediately
- where possible de-energise the power source
- direct the vehicle to a designated isolation area. If travel time does not permit then park the vehicle quickly, possibly in an area where it has the least exposure to personnel or passing traffic, and has clear access to the front of the vehicle for driver evacuation
- care should be exercised in removing the driver from the vehicle because of the danger of electrocution, and injury from a potential explosion coincident with the evacuation
- if the vehicle is on fire, shutdown the engine and activate fire suppression (if fitted) and exit the cab furthest from the point of fire, exit the front of the vehicle and quickly move away in the direction the vehicle is facing
- an exclusion zone of at least 300 metres should be setup and the vehicle quarantined for a minimum of 24 hours before an inspection is allowed.

10.4 Noise

Noise induced hearing loss can occur after prolonged exposure to high noise levels. High noise levels are typically from the use of pneumatic tools (i.e. impact wrenches), deflation of tyres and working in close proximity to mobile equipment.

Rapid release of compressed air/gas from valve removal can present a noise hazard to personnel. Deflation devices should therefore be fitted with a noise suppression device. Sound barriers should be used where possible. Tyre fitting and removal activities should be carried out where there are minimal other personnel exposed to the hazards. Personnel that can potentially be affected by high noise levels should be provided with adequate PPE and personnel trained in its correct use.

10.5 Fuels and chemicals

Certain fuels and chemicals may react with rubber which can have a detrimental effect on the integrity of the tyre. Allowing fuels or other hydrocarbons on the tyre will also enhance the ability for it to catch fire if there is any heat source or hot work nearby.

Other chemicals can inadvertently present a hazard to the integrity of the tyre such as using the incorrect lubricant when assembling the tyre on the wheel or rim. Ensure the lubricant has been approved for use by the OEM prior to it being used.

11 Lifecycle and disposal considerations

11.1 Lifecycle

Many factors can affect the life of a tyre, including:

- tyre selection
- operating conditions
- tyre incidents
- maintenance (i.e. monitoring tread wear, damage, pressure checks)
- design, construction and maintenance of roadways
- competency and work practices of operators.

Controls that can maximise tyre life include:

- matching of tyres by circumference and tread depth in dual assemblies
- rotation of tyres to maximise wear rates and use of run-out tyres
- correct set-up, operation and adjustment of wheel alignments, steering and suspension struts.

There are many reasons for the removal of a tyre, wheel or rim, such as:

- worn tyre, beyond further use or for tyre matching
- puncture
- tyre repair, tread or lug separation, cuts and delamination
- scheduled testing of wheel or rim
- damage to wheel or rim
- suspected crack in wheel or rim
- hot tyre or suspected electric arc
- replacement tyre to suit changed operating conditions.

The site should document the activities involved in the removal of a tyre, particularly when the reason is a confirmed or suspected hazardous condition. The manufacturer or supplier should be consulted to assist in preparation of the document. Wear and damage limits should be determined with the tyre manufacturers or suppliers.

Documented criteria for repair or discard should be prepared and communicated. A chart that includes photographs of tyre damage or wear tolerances can be made available to the tyre technician as guidance for refit, recondition or discard. These criteria may be different for each tyre type and manufacturer.

Alternatively, the site may choose to use an external services provider/contractor for examination and repair.

11.2 Disposal

A defined area should be chosen where all damaged, worn or suspect tyres, wheels and rims can be located prior to inspection. This will remove confusion as to their condition and prevent them being put into service before they have been examined.

Scrap tyre disposal on site will depend on the mines environmental policy and applicable legislative requirements.

Alternatively, they may be taken off site for disposal but in this case, they should be rendered unserviceable to prevent further use (i.e. cut through of the bead area will render the tyre unserviceable and stop inadvertent use of a faulty tyre). If they are to be on-sold for further use, they should be accompanied by a documented service history or condition report.

Unsafe, damaged and non-repairable wheels or rims and components (i.e. lock rings, nuts, studs, cleats and chains etc.) are to be rendered unusable by cutting up, so they cannot accidentally be reused.

12 Information, documentation and tracking

The SHMS should contain provision for storage of information and records, facilitate the tracking of tyres, wheels and rims and provide readily available relevant information to the end user. Information may be stored electronically or in hard copy but should be in a format that ensures ease of data entry, retrieval and reporting.

Wheel and rim assemblies should be permanently marked with a unique, and clearly visible identification for tracking and record keeping purposes. Such identification should be visible after the tyre has been fitted and inflated. (Refer AS 4457.1 – Sect 2.3).

All receipted tyres, wheels and rims, and all repair details, are to be entered in the site *Tyre, wheel and rim register* using their stamped or branded serial numbers for identification.

Off-site tyre, wheel or rim repairs and replacements introduces a third party latent risk. Effective controls should be in place for the mine to manage this risk, for example, by:

- contractor selection and system auditing
- workshop inspections
- checks of training and competency
- random check/inspection of assemblies delivered to site
- tyre fitting accreditation and verification of processes
- checks of quality assurance documentation.

The type of tyre and rim information the SHMS should contain, includes:

- the status, identity and history (from purchase to disposal) of tyres, wheels and rims
- contains OEM tyre, wheel and rim data to ensure they are fit for purpose and satisfy the operating envelope

- information provided by the OEM or supplier regarding tyre pressures, for example increase or decrease in air pressure due to operating environment
- risk assessments used to determine the controls contained in the written procedures
- written procedures
- critical task/control checklist (hold points/signoff)
- provide for an effective mechanism for handover of information between successive maintenance crews (i.e. shift work)
- records of all tests, inspections and audits, including:
    - pressure checks
    - tyre tread wear
    - tyre condition
    - rim test methods, NDT tests and results
    - details, inspection, certification and/or calibration information for specialised tooling such as jacks, torque tools, stands, master gauges, and support equipment (tyre handler, forklifts, HIABs, compressor(s), tyre bay work platforms, airlines, tyre service truck, etc.)
    - TKPH reports
- records of all repairs and work performed, including:
    - tyre repairs e.g. ‘patches’, re-lugs, re-treads and re-grooves etc. (AS 4457.2 and AS 1973)
    - component repairs/replacements for wheels, rims and structural load handling equipment (tyre handlers, forklifts, cranes, cages)
    - repair inspection and authorisation information.

13 Competency

Persons undertaking tyre maintenance tasks at the mine should be trained and competent to ensure they possess adequate knowledge and understanding of the processes to be carried out. The current Resource & Infrastructure Industry (RII) Competency Standards and Automotive Retail, Service and Repair (AUR) training packages are recognised Australian benchmarks for the training and assessment of competencies within the Queensland mining industry.

Training and assessment should cover the specific requirements for the tyres and rims used on site. Where tyre maintenance is done offsite, the SSE should ensure it is carried out by competent workers and that tyres, wheels and rims provided to site are safe for use.

To ensure workers are competent to undertake tyre maintenance tasks at the mine the SSE should:

- ensure tyre, wheel and rim training and assessment is part of the mines training and assessment system and include:
    - reference to OEM requirements, site procedures and site risk assessment
    - the use of or mapping against specific tyre, wheel and rim competencies including:
        - remove and fit wheel assemblies - RIISAM210, AURKT J002

        - remove, repair and refit tyres and tubes - RIISAM211, AURKT J001.
- ensure the training and assessment is undertaken by a suitably competent person
- identify equipment used for tyre fitting and ensure workers are trained and assessed prior to them using the equipment, e.g. tyre handler, truck mounted handler, forklift, tyre press etc.
- ensure workers are trained and assessed on any new equipment introduced to site prior to its use.

The site SSE must ensure a worker is competent to perform tyre maintenance tasks. A record of the training and assessment to verify competency should be kept. The SSE must also ensure periodic assessment of worker competencies is undertaken.

Personnel who work on or around mobile equipment and do not possess the required competencies (e.g. operators, supervisors of tyre bay and maintenance personnel), should receive awareness training in basic tyre, wheel and rim hazards, as their work is often in the direct vicinity of equipment-mounted tyres. Training and education for this group of people should focus on identifying tyre, wheel and rim hazards and taking effective precautions (focus on critical controls). Site training and assessment requirements should be determined by risk assessment.

Content should include such topics as, but not limited to:

- tyre, wheel and rim safety
- tyre hazardous conditions and response (e.g. tyre fires, hot tyre, sidewall bubbles, operator evacuation, park-up, lightning strike, potential tyre explosion)
- tyre, wheel and rim care and maintenance
- plan and prepare for tyre fitting operations
- hand tools and equipment
- non-earthmover tyre fitting (e.g. light vehicles, truck, cranes)
- Discard criteria should be established in consultation with the OEM for any wheel and rim components (worn out and damage).

Due to the complex nature of wheels and rims, it is strongly recommended that training and assessment should be provided on wheels and rims by the OEM, their agents, or recognised tyre management contractors.

The SSE must ensure a record is kept of the training given to, and assessment of, each worker with respect to tyres, wheels and rims.

Appendix 1 Incident description and Coroner's recommendations

Peter Marshall

Description

While removing the outer, right, rear, dual wheel from a giant dump truck, without warning, the highly compressed air in the inner wheel was released, throwing the 3.5 ton outer wheel some 13 metres. Mr Marshall had been standing in the path of the wheel's flight and he was driven by it across the tyre bay concrete apron. When the wheel came to rest, Mr Marshall was pinned under it.

Coroner's recommendations

Zinifex Century Zinc Mine – Peter Whitoria Marshall 9th February 2004

Recommendation 1 - An analysis of the safety culture at the mine

I recommend that Zinifex Century and REJV engage a competent consultant with an industrial or organisational psychology background to review the safety culture of the operation with a view to better informing management of how safe work practices can be internalised by staff of the mine.

Recommendation 2 - Supervision of autonomous skilled workers

I recommend that the Mines Inspectorate investigate how meaningful supervision can be delivered to a heterogeneous workforce of skilled autonomous workers engaged on a disparate site and that they publish their findings and practical examples applicable to various mining activities

Recommendation 3 – Continued development of AS 4457

I recommend that the Mines Inspectorate, SIMTARS and industry participants continue with the revision of AS 4457 and that special attention be given to tyre handling, lock ring retention and rim maintenance.

Shane Davis

Description

While changing a tyre and rim on a road train, the drive wheel rim assembly he was handling gave way under pressure due to a wear crack in the rim. Mr Davis had not deflated the tyres on the wheel assembly. The tyre on the outer rim was forced from the assembly and it and parts of the rim struck Mr Davis.

Coroner's recommendations

Foxleigh Mine – Shane William Davis 7th August 2005

I recommend that:

1. The coal mine operators critically review the effectiveness and implementation of their mine safety and health management system as they are obligated to do under section 41(f) of the Coal Mine Safety and Health Act 1999. It is recommended that particular attention be paid to how the mine system controls the activities of contractors and ensures they are carrying out their task in a safe manner.

2. 2.1 That senior site executives of coal mines be required to have a competency such as MNCG1107(a) establish and maintain the mine occupational health and safety management system.

2.2 The safety and health advisory counsel consider the range of competencies required for supervisors and persons charged with the development of safety and health management systems.

2.3 All SSEs of coal mines develop a system to ensure that all supervisors are able to and are effectively applying risk management competencies in the performance of their duties. That consideration be given to amending section 44(6) of the Coal Mining Safety and Health Act 1999 to require that manufacturers and suppliers inform the regulator, as well as their customers, in the event they become aware of the hazardous aspect of, or defect in the equipment that the supplier has supplied to a coal mine.

3. That consideration be given to amending section 44(6) of the Coal Mining Safety and Health Act1999 to require that manufacturers and suppliers inform the regulator, as well as their customers, in the event they become aware of the hazardous aspect of, or defect in the equipment that the supplier has supplied to a coal mine.

4. That a body such as the Resources and Infrastructure Skills Counsel develop a suite of competencies for persons providing advice on safety and health management systems in the coal mining industry.

5. 5.1 The earthmoving committee of Standards Australia review the suitability of retaining rim sizes as a limiting factor in determining the applicability of Australian Standard 4457.

5.2 Standards Australia should review all associated tyre and rim standards and, if necessary, introduce a standard in similar terms to AS4457 which applies to all multi-piece rims irrespective of size and industry application.

6. 6.1 That all coal mines employing contractors create a senior position for the control of contractors. Duties should include monitoring contractors, implementation of the mine safety and health management system including familiarisation and training of the contractor's workers and compliance with the mine safety and health management system.

6.2 This position should be included in accordance with section 55 of the Coal Mining Safety and Health Act 1999 in the management structure of the mine as a senior position and the role and responsibilities of the position should be specified.

7. 7.1 That a system be established by all coal mines to ensure the next of kin of any person involved in a serious or fatal accident can be expeditiously contacted and kept informed of the developing situation. The system should address the name and contact details of the next of kin and be kept current, how the next of kin should be informed and by who, guide on how and under what circumstances the next of kin should be kept informed of developments.

7.2 That the protocol between the Inspectorate and the Queensland Police Service be reviewed to ensure effective and timely communications between the organisations during the investigation.

8. That the Inspectorate liaises with other departments, industry, and professional bodies to ensure that the safety message relating to the hazard of uncontrolled release of stored energy from tyres, particularly when affixed to multi-piece rims and the need for training of those exposed to the hazard is disseminated across all industries and applications of the equipment.

Wayne MacDonald

Description

Mr MacDonald had completed changing a tyre on a road train trailer and was lowering the trailer to the ground using the jack which required him to place himself between two pairs of wheels on the four axle (double bogie) trailer. As the replacement tyre came into contact with the ground it catastrophically failed, suffering what was later described as a ‘zipper failure’. Mr MacDonald, who was then positioned, lying on the ground, between the trailer’s tyres, was hit by a percussive shockwave of air causing him fatal injuries.

Coroner’s recommendations

Foxleigh Mine – Wayne MacDonald 18th December 2010

In consideration of the evidence of this case, and for the reasons I have set out above, I recommend the following:-.

1. That management of mine sites, and their engaged contractors, review all tyre management practices to ensure that tyres on their mine sites are being operated within their specific design parameters applicable for their use. This review needs to occur within three months, and then annually the mine site needs to ensure that compliance is being maintained.

2. That any jack used by an operator has a handle of sufficient length to allow the operator to safely use the jack without the operator being in, or under, the truck or trailer, or within close proximity of the vehicle’s tyres whilst jacking occurs.

3. That the industry investigate, and implement within two years, remote, or wireless, tyre pressure sensing equipment to allow operators to monitor tyre pressures from within the cabin of the truck;

4. That until remote or wireless tyre pressure sensing equipment is introduced for these mine site tyres that the practice of tyre tapping should not be continued, and that accurate, calibrated, pressure gauge should be used to check correct tyre inflation whenever operational requirements dictate that pressures are to be checked;

5. That an Australian Standard for up to 24 inch diameter truck tyres be investigated, created, and, if considered appropriate, implemented into law by regulation within a period of two years, and if no Australian Standard is created within two years then a Recognised Standard under Part 5 of the Coal Mining Safety and Health Act 1999 be implemented within one year;

6. That whenever a tyre supplier grants a dispensation from the designed operating parameters of a tyre, that the tyre supplier provide, and receive written acknowledgement of from the customer, an appropriate and formal information package which clearly specifies the approved conditions of operation of that dispensation;

7. That whenever a tyre supplier grants a dispensation which a mine site operator uses, that the equipment's owners and operators incorporate into their written training and operating procedures the specific details of those dispensations;

8. That whenever a tyre manufacturer grants a dispensation from the designed operating parameters of a tyre, that the variations be permanently embossed (alternatively termed 'tyre stamping') on the sidewall of the tyre, and that the embossing be completed in a method which is not readily removable, and remains legible, throughout the tyre's serviceable life;

9. That every tyre, whether new or repaired, undergo integrity testing by its inflation in a suitable tyre inflation cage, to a pressure of 120% of the tyre's recommended minimum cold operational inflation pressure, and then left for 20 minutes to test its integrity, before its pressure is then reduced to its recommended minimum operating pressure before the tyre is then fitted for use.

References

- AS 1973-1993 Pneumatic tyres – Passenger car, light truck and truck/bus – Retreading and repair processes
- AS 1627.4-2005 Metal finishing – Preparation and pretreatment of surfaces, Part 4: Abrasive blast cleaning of steel
- AS/NZS 3788 Pressure equipment – In-service inspection
- AS 4457.1-2007 Earth-moving machinery – Off-the-road wheels, rims and tyres - Maintenance and repair - Part 1 Wheel assemblies and rim assemblies
- AS 4457.2-2008 Earth-moving machinery – Off-the-road wheels, rims and tyres - Maintenance and repair - Part 2 Tyres
- “How to Avoid Tyre Pyrolysis Explosions” http://ohspolicy.com.au/how-to-avoid-tyre-pyrolysis-explosions/, QLD Government
- WA Department of Mines and Petroleum Mines Safety Bulletin No 122. Use of tyre inflation cages
- WA Department of Mines and Petroleum – Guideline, Tyre safety for earth-moving machinery on Western Australian mining operations
- ACARP report 51036 ‘Fit for purpose’ tyre maintenance equipment and management practises for non-earthmover vehicles; Dr Tilman Rasche
- ACARP report C13049 ‘Tyre Fires and Explosions of Earthmover Tyres’; Dr Tilman Rasche
- ACARP report C15046 ‘Tyre Related Accidents and Incidents - A Study with Recommendations to improve Tyre & Rim Maintenance and Operational Safety of Rubber Tyred Earthmover Equipment’; Dr Tilman Rasche
- TOPY Industries Limited – ‘Rim Instruction Manual – Multi-piece Rims for Industrial and Construction Vehicles’, Version 1, 2008.08
- Tyre and Rim Association of Australia – Standards Manual 2017
- Commissioner safety alert No.1 – Earthmover tyre and rim safety
- Safety bulletin No.118, Working safely with tyres: Highway style haulage trailer