Department of **Natural Resources and Mines**

Safety Bulletin

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Working safely with tyres: highway-style trailer haulage

The fatal injury of a driver of a bulk coal transport trailer while replacing a wheel has highlighted a risk for the mining industry that has long been recognised in the tyre manufacture and fitting industry: **the premature failure of radial construction tyres.**

Radial construction tyres—typically associated with tyres of up to 25” diameter on highway-style prime mover and mining-style trailers (double or triple)—have a single steel cord ply as the body ply (or casing ply). **Tyres with single steel cord body ply must be treated differently from earthmover tyres, yet most mining procedures treat them the same.**

This safety bulletin examines what actions to take to avoid similar incidents and possible fatalities.

What happened

The driver had followed set procedures: he took a tyre and wheel assembly from the rack, pressurised the tyre in a tyre-fitting safety cage, fitted it to the axle, and lowered the lifting jack. The steel body ply cord in the tyre then ruptured in a typical ‘zipper failure’ in which a radial cord breaks overloading the two adjacent cords, which then break and so on. The air blast shockwave caused the driver’s fatal injuries.

The investigation found it likely that the ‘almost new’ replacement tyre selected by the driver had previously operated at low pressure. It had a puncture repair indicating it had probably been run flat.

Current practice

Bulk haulage using ‘on highway’ style prime movers—towing two or three trailers and mostly conducted by contracting companies—is common practice at mines for transporting material. The trailers, designed for mines, have larger sized or heavier axle loads, which restrict their movement on highways.

The actual tyre loading can be at or above that stated on the tyre. The international standards used by manufacturers to determine a tyre’s maximum load also allow manufacturers to vary

Control the risk

These factors affect tyre failure:

- tyre design
- speed
- road conditions
- load weight and consistency
- tyre pressure
- running flat.

Every mine must address these questions:

- Are roads maintained and are the road-condition reports of drivers (who examine the road every trip) being considered?
- Is loading considered important and is it measured by the actual weight of the load rather than the size of heap in the trailer, the number of bucket loads, or whether the material is wet, and so on?
- Is speed monitored, particularly on the loaded leg?
- Have drivers, repairers and tyre fitters been given the correct tyre cold inflation pressure?
- Can all tyres be accessed, including the inner dual tyre?
- How often are tyre pressures checked by suitably trained and qualified personnel using the proper equipment?
- When a tyre is found at a low pressure, is it replaced as soon as it is safe to do so?

the tyre's load and cold inflation pressure providing that the manufacturer warrants that the tyre will perform correctly at those levels.

Although tonne kilometre per hour (TKPH) is used to determine what load is to be carried at what speed when using earthmover tyres, 'highway truck type tyres' need a different approach to calculate the load and inflation pressures.

The maximum load per tyre at a minimum cold inflation pressure is calculated with reference to the *Tyre and Rim Association Australia Standards Manual* and other international standards. The recommended variations are nominated for tyres used at reduced speeds, where additional maximum design load is permitted at an increased cold inflation pressure. If maximum speed is increased, the maximum load must be reduced and/or the cold inflation pressure increased. However, the increased cold inflation pressure nominated by the manufacturer may not be permitted because of government regulations (e.g. public road limits) or the wheel's maximum pressure.

Operating conditions for these tyres (maximum design load per tyre, minimum cold inflation pressure, maximum speeds when full and empty, site conditions and the haul layout) are reviewed in actual operation and documented by the tyre manufacturer in a written 'Manufacturer's Approved Service Condition Allowance', which applies to that specific operation and only covers nominated tyres.

Where is the risk?

Values calculated for the manufacturer's allowance show how an individual tyre's design operating conditions can vary. Overloading, over-speed when loaded, lower than prescribed tyre pressure and unfavourable road conditions can each cause premature tyre failure. Under these conditions the rubber, rubber to cord interface and steel cord structure in the tyre suffer fatigue long before tread wear makes the tyre unusable.

Tyres fitted to 'on road' haulage vehicles on mine roads operated above their safe design operating parameters can fail catastrophically.

It is likely the 'almost new' replacement tyre had previously operated at low pressure. It had a puncture repair indicating it had probably been 'run flat'. The zipper rupture will occur at the place where the steel cord body ply has been weakened and is independent of the puncture repair location.

Ruptured tyre

Tyres with single steel cord body ply (usually of 25" diameter or less) must be treated differently from earthmover tyres, yet most mining procedures treat earthmover and highway truck tyres the same. The Australian Standard *AS4457.1—Off the road wheels, rims and tyres: maintenance and repair* requires earthmover tyres to be removed and internally inspected if the pressure is found to be 70 per cent or less than cold inflation pressure. Highway truck tyres should be internally inspected if found below their manufacturer-nominated cold inflation pressure.

Important: 'Tap and listen' tests are unlikely to discriminate adequately between full inflation and tyres at nominated cold inflation pressure. They should only ever be performed by qualified tyre fitters using the appropriate safety equipment when checking for abnormal tyre conditions, not pressure checks.

Zipper rupture

Controlling the risk

Tyre design

- **Decide early on what tyre type to use.** Make a decision based on these factors: mine road conditions, the load to be carried, the total trip for each load, gradients, and tight curves. Calculating the Manufacturer's Approved Service Conditions Allowance helps set tyre maximum load rating (trailer load), recommended cold inflation tyre pressures and operating speed. The manufacturer can provide a tyre loading in excess of the standard design recommended load, but this is at the expense of speed and cold inflation pressure increase.
- **Develop tyre maintenance procedures that include condition monitoring and inflation pressure**. Proper maintenance from new can extend tyre life.
- **Measure the life of the tyre**. Although tyre fatigue and zipper failures are not necessarily linked, tyre usage (tonnes carried) may predict tyre life (useful when tyres are taken from one truck or trailer to another). Barcoding and chip insertion can assist tyre maintenance procedures.

Speed

- **Give maximum loaded and unloaded speeds to drivers.** Speed is the least controlled aspect of the manufacturer's allowance at a mine site. Drivers decide the speed so they should be given the maximum loaded and unloaded speeds.
- **Supervise and monitor compliance.** Roadside monitors (e.g. speed cameras) visually indicate speed to the driver and relay that to the base. Consider spot speed checks with hand-held speed cameras or a supervisor driving behind a truck who can radio a speeding driver.

Road conditions

- **Maintain roads.** Road maintenance can reduce tyre damage and road sheeting can reduce cuts and punctures from sharp rocks.
- **Clear spillage from the road by grading**. This prevents excessive tyre deflection caused by driving over large objects. A wheel in a soft spot takes a lesser load which overloads adjacent wheels: grading removes soft spots in the road.
- **Reduce tight turning circles** to limit overloading.

Load weight and consistency

- **Maintain consistent and correct loads.** The weight in the trailer is critical to tyre fatigue. Consistently correct loads increase tyre life, reduce down-time from unplanned replacements, and increase tonnes carried when lightly loaded trailers are eliminated. Load cells and sensors help achieve consistency because they measure weight rather than heap size, and take into account wet or dry material. Load sensors show how much has been put into the trailer. Load cells on the trailer can show the driver when the trailer is at maximum load.

Tyre pressure

- **Maintain optimum tyre pressure.** The greater the trailer weight and load, the greater the tyre pressure needed. Under-pressure tyres flex excessively, damaging their cords.
- **Re-inflate or test under-pressure tyres.** Drivers, repairers and tyre fitters must know the manufacturer's stipulated minimum cold inflation pressure for that mine. Any tyres found below this level must be re-inflated to that level immediately or sent for testing by the manufacturer or a tyre fitter with the appropriate training, qualifications and equipment.

Run flat

- **Check pressure as a routine,** not with ad hoc or unreliable 'tap and listen' tests. A calibrated pressure gauge is the correct tool to measure inflation pressure. Frequency of pressure checks should fit in with the maintenance window and history of tyre pressure loss at that mine. All tyres should be checked, including the inner dual tyre. A puncture, particularly a slow leak, can cause a tyre to be run for some time at a damaging pressure; vigilance in pressure testing is the best control.
- **Replace a flat tyre properly as soon as possible.** Make the change promptly somewhere out of traffic flow with sufficient tools for the job. The longer a tyre has operated at a low pressure, the more

excessive flexing and fatigue stress in the radial cords. Low tyre pressure has two effects: a small reduction in pressure reduces the tyre service lift and accelerates the formation of tyre separations and tyre overheating; a large reduction in pressure concentrates the sidewall flex bulge into a small area resulting in the flex fatigue breaking of some of the individual steel filaments that make the steel wire cord, weakening the cord.

- **Check removed tyres**. After removal, have the tyre inspected by trained maintenance personnel.

Discolouration of the inner lining and soft spots in the tyre wall are indications of advanced damage, but most often there are no visible signs to indicate fatigue in the embedded wires. Suspect tyres with no visible damage on internal examination are better left for the manufacturer or repairer to decide on continued life.

A mine without trained tyre maintenance personnel should not use a suspect tyre until the manufacturer or a repairer has certified it fit for further use.

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