

Gas cylinders manufactured from aluminium alloy 6351-T6 safety alert

This safety alert highlights the risks associated with filling gas cylinders manufactured from aluminium alloy 6351-T6 and updates a previous SafeWork NSW (formerly WorkCover NSW) 2009 safety alert.

Background

In August 2016 a worker suffered serious injuries including partial amputation of a leg when an aluminium scuba cylinder catastrophically failed, exploding while being filled.

□ Figure 1. Pieces of a failed aluminium cylinder.

The cylinder that failed was manufactured in 1987 from aluminium alloy 6351-T6. However, the investigation into this incident has not yet determined the cause of the failure.

Investigative work into similar failures worldwide has shown that failure is typically caused by sustained load cracking (SLC) in the neck and shoulder area of the cylinder. The problem of SLC only affects cylinders made from aluminium alloy 6351-T6 and is not limited to any one cylinder design or manufacturer. Failures have typically occurred when filling SCUBA/SCBA and oxygen cylinders. Catastrophic failures have occurred at or below the working (fill) pressure.

Additional control measures have been introduced for cylinders made from the above alloy, including the requirement for eddy current non-destructive testing (NDT).

Risks

Explosion hazards resulting in the possibility of serious traumatic injury or death and extensive damage to property.

At risk cylinders

Any cylinder manufactured from aluminium alloy 6351-T6 is susceptible to SLC and therefore considered to be at risk cylinders.

Cylinders can be identified by their cylinder markings by either locating the oldest hydrostatic pressure test date typically marked mm yy applied at time of manufacture or the following DOT special permit or exemption number markings.

At risk cylinders that SafeWork NSW is aware of include:

- Luxfer cylinders marked with a special permit or exemption number: 6498
- Luxfer cylinders originating in the UK marked with a special permit or exemption number: 8364
- Wallter Kidde cylinders marked with a special permit or exemption number: 7042
- other cylinder manufacturers marked with a special permit or exemption number: 6576 or 6688 or 8107 or 8422
- aluminium composite cylinders (hoop wrapped) marked with exemption number: 7235 or 8023 or 8115
- Luxfer cylinders marked as DOT 3AL with a hydrostatic test date before 1989
- Walter Kidde cylinders marked as DOT 3AL with a hydrostatic test date before 1990
- CIG (Australia) cylinders marked as AS 1777 with a hydrostatic test date before 1991
- Luxfer cylinders originating in the UK marked with a hydrostatic test date before 1996.

Work health and safety requirements

The [Work Health and Safety Act 2011](#) requires persons conducting a business or undertaking (PCBU) to provide plant and systems of work that are safe and without risks to health and safety so far as is reasonably practicable. The reasonably practicable provisions of the Act in part require PCBUs to implement controls based on what industry currently knows or ought reasonably know in managing risks. For at risk cylinders this would include the following actions:

Action for person who requalify at risk cylinders:

- For SCUBA and SCBA cylinders manufactured from aluminium alloy 6351-T6, eddy current testing needs to occur in accordance with manufacturer's instructions. In the absence of manufacturer's instructions requalification should include eddy current inspection testing combined with visual inspection of the internal shoulder and neck thread area.
- For cylinders that pass requalification include in the cylinder test report whether requalification has included eddy current testing.
- If changing the valve ensure the valve thread matches the cylinder thread, e.g. both tapered or both parallel threaded.
- Where cracks are evident during inspection the cylinder must be condemned

Action for fillers of at risk cylinders:

For SCUBA, SCBA and oxygen service cylinders:

- Prior to filling, ensure each cylinder has a current test station mark – SCUBA cylinder test station marks are only valid for 12 months. Do not fill a cylinder that does not have a current test station mark.

- Prior to filling, inspect the cylinder for damage, and do not fill a damaged cylinder e.g. if there is evidence of surface gouging , cuts , dents or damaged fittings.
- Do not fill any cylinder that has lost internal pressure for no apparent reason. Unexpected loss of cylinder pressure may be an indication of SLC defects.
- Cylinders should only be refilled in a manner that minimises risk to people and property in the event of a failure – e.g. filled in a suitable enclosure or behind a barrier that separates persons filling a cylinder and provides adequate protection from explosion hazards.
- Only allow persons essential to the filling process to be in the vicinity of the cylinder during the filling process.
- Use filling procedures in accordance with AS 3848.2-1999 including:
 - refrain from filling cylinders too rapidly to avoid cylinder temperatures exceeding 50oC. Typically the maximum charging/ filling rate should be approximately 20bar/min or as recommended by the cylinder manufacturer.
- Use filling equipment in accordance with AS 3848.2-1999 including restraining flexible connections (e.g. hoses) before filling, so they will not whip if the hose bursts or disconnects when pressurised.
- Prevent the cylinder from being filled to a pressure greater than the working pressure stamped on the cylinder, e.g. a regulated supply set to the working pressure and with a downstream safety valve.
- In addition there should be provision to quickly shut off supply to the cylinder at a safe position, e.g. outside the fill enclosure/or behind a suitable barrier from where cylinders are to be filled. The shut off could be a valve in the supply line or an off switch for the compressor if filling directly from a compressor. This allows the filler to quickly shut off supply air to the fill cylinder from the safe position if required.
- Do not approach the cylinder if you detect or hear a leak. Don't assume the leaking sound is due to a leaking connection. From the safe position shut off the air supply to the cylinder and evacuate the area, as it may be a sign the cylinder is about to catastrophically fail. Allow the cylinder to discharge significantly before returning and investigating the cause of the leak.

Further information

- [AS 2030.5 -2009 Gas cylinders Part 5: Filling, inspection and testing of refillable cylinders](#)
- [AS 2337.1-2004 Gas cylinder test stations Part 1: General requirements inspections and tests](#)
- [AS 3848.2-1999 Filling of portable cylinders for self-contained underwater breathing apparatus \(SCUBA\) and non-underwater self-contained breathing apparatus \(SCBA\)-Safe procedures](#)
- [AS 4544-2005 Non-destructive testing for the detection of surface flaws- Ferromagnetic and non-ferromagnetic metallic products](#)
- [Managing risks of plant in the workplace](#)
- [How to manage work health and safety risks](#)

<https://www.safework.nsw.gov.au/safety-alerts/safety-alerts/gas-cylinders-manufactured-from-aluminium-alloy-6351-t6>

06-07-20

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