

Carbon Monoxide Poisoning

This article (updated in mid-2019) discusses the very real risks if LP gas is misused in a caravan or motor home, or any type of RV, tent or annexe. In particular it emphasises the major risk of brain damage at very low levels of carbon monoxide produced. It also advises that the previous AS 5601 Gas Standard has been replaced by the joint AS/NZS two-part Standard AS 5601.2013 with an Amendment for LP Gas Installations in caravans and boats for non-propulsive purposes being published by Standards Australia on 11 May 2016.



That relevant for caravan and motor homes is Part 2 (Gas Installations in caravans and boats for non-propulsive purposes. Note that, legally, 'caravans' includes *all* RVs.

The most significant amendments to Part 2 are:

- New diagram for the mounting of an LP gas cylinder in a caravan including clearances from openings into the living space
- New requirement for the installation of gas BBQs and radiant gas heaters designed for outdoor use.
- New pipe-work strength and gas tightness test

In the Beginning...

Around 1850, when the first domestically available gas was produced by burning coal (usually as carbon) in the virtual absence of air, (about 10% carbon monoxide content), few people knew why it was so lethal. But the only too real danger became quickly known and respected. Following the general acceptance of propane in the 1930s and the later usage of LP gas in RVs, and natural gas in homes, much of that respect appeared to become lost.

The reality is not that that LP gas is safe, but that because its carbon monoxide concentration is lower, it takes longer to kill than it did before. Nevertheless approximately 30% of people with severe carbon monoxide poisoning are likely to result in death. ^[1]

It is still, in some countries, that most used for deliberate poisoning. During 2001-2002, carbon monoxide poisoning was responsible for 43.9% of deaths by poisoning in New Zealand. ^[2] That same NZ report also noted that imported LP gas portable appliances, certified only for outdoor use, were nevertheless being claimed by their manufacturers and distributors as suitable for indoor use.

It warned that the misuse of such appliances in an indoor environment, including caravans and tents, could be unsafe and potentially fatal. In 2010 an independent report (for NZ Energy Safety) found that there was not a sufficient safety problem to ban their use, but because of fire risk and concerns about ongoing chronic health hazards, additional health and safety warnings were placed on these units at their point of sale.

The Cause of Risk

The major risk with LP gas (and fossil fuels generally) is that they require a lot of air to burn safely. Burning LP gas in an enclosed space decreases the oxygen content and increases the carbon dioxide concentration. Further, the amount of air required varies with the nature of that gas. Most RV equipment is designed to run from propane, but if used as some do (illegally as well as dangerously) with Autogas, that gas might well contain a fair amount of butane and thus produces a lot of carbon monoxide through incomplete combustion. A total giveaway is any yellow content in the flame. As 100% total burning cannot be guaranteed, space heating in Australia, and many other countries, requires the burning process to be external to the space heated.

Australian Standards

The above is made totally clear in AS/NZS AS5601. As with its earlier version, and its predecessor, (AG 601-1995), the appropriate wording states:

'The following appliances shall not be installed in a caravan *:

(c) a space heater, other than a room-sealed type.

* (A caravan is defined in AS 5601 as being – 'a structure that is or was designed or intended to move from one place to another, whether towed or transported, which is intended for human habitation... and includes a self-propelled recreational vehicle.')

Item 6.9.4 of the new Code calls for a permanently legible label with a minimum character height of 4.0 mm to be affixed 'in a conspicuous position on or adjacent to, the '[gas cooking]' appliance and shall provide at least the following information:

WARNING

Ensure ventilation when the cooker is in use.

Do not use for space heating.

Brain Damage

Inhaling even relatively small amounts of the gas can lead to hypoxic injury, neurological damage and even death' [3]

Carbon monoxide exposure might lead to a significantly shorter life span due to heart damage, [4]. Exposures at 100 ppm (parts per million) can be dangerous to human health. [5] Carbon monoxide poisoning is the most common cause of injury and death due to poisoning, worldwide. [6]

(Toxic gasses are measured in parts per million (ppm) 1% volume = 10,000 ppm)

Ongoing denial

This matter came to a head in early 2012, when three men died in a matter related to carbon monoxide poisoning, in a caravan in Tasmania. Despite the Coroner's report not yet having been published and ongoing media reports based almost totally on speculation, this was initially met on some Internet forums by a wall of denial from people with no possible knowledge of what had occurred.

Government Response

Consequent to those deaths, a formal government-related initiative, the 'Gas Appliances (Carbon Monoxide) Safety Strategy' was established with the intent of making people (particularly RV users) aware of the risks. I was asked to assist in preparing the formal submission for the 60,000-plus membership of the Caravan and Motorhome Club of Australia (CMCA). That submission included:

'Our view is not so much that the existing regulations relating to gas installation in RVs necessarily need changing, but that RV owners do not take the known risks sufficiently seriously. This is shown often, not only on our own (now shut down) website forum, but on other similar RV forums.'

It then noted that: 'The major risk identified (in our opinion) is that of gas appliances being used in an inappropriate manner, e.g. LP gas ovens left on with the door open to provide heat, steel plates and ceramic pots placed over LP gas rings for the same purpose. It also alluded to the ongoing illegal use of LP gas catalytic heaters 'in poorly ventilated annexes and within the RV itself.'

The submission also noted: 'A further issue is the lack of quantitative data on reported incidents of carbon monoxide poisoning in RVs. This has created a concern because the warnings of the dangers are frequently met by denial on the basis that no hard data is available.'

Quantifying the Risk

Even very low levels are reported as better avoided. The World Health Organisation lists even 5-20 ppm (parts per million) as impairing performance and a need to decrease exercise time and be vigilant. The International Mechanical Code limits 25 ppm as the maximum in parking garages. Kurt- (in 1978) reports 27 ppm as associated with a 21% increase in cardio respiratory complaints and the World Health Organization reported 30 ppm as the earliest onset of exercise-induced angina.

At about 35 ppm (parts per million) it starts becoming really serious – with headache and dizziness within six to eight hours, 200 ppm (about 0.02%) causes a slight headache within two to three hours, plus loss of judgment; at 800 ppm (0.08%) there is dizziness, nausea, and convulsions within 45 min, insensibility within two hours and death within three hours. At 1600 ppm (still a mere 0.16%), there is 'headache, tachycardia, dizziness, and nausea within 20 min. Death occurs in less than two hours. Even at 6400 ppm (0.64%) death occurs inside 20 minutes; and at the far from high 12,800 ppm (1.28%) you become unconscious after 2-3 breaths and will be dead in less than three minutes.^[7]

To gain some concept of the above levels, the natural atmospheric level is about 0.1 ppm. The exhaust from a warm car's exhaust (that lacks a catalytic converter) is 7000 ppm. ^[8]

The above is reflected in the USA's relevant (OHSA) regulations that limit long-term workplace exposure levels to less than 50 ppm (0.005%) averaged over an 8-hour period. In addition, employees are to be removed from any confined space if an upper limit ('ceiling') of 100 ppm is reached.' ^[9]

The build-up of carbon monoxide is often exacerbated by blocked ventilation, so the risk of brain damage at lower levels of exposure, particularly where ventilation is poor, is only too real. The elderly, children, and people with heart and respiratory problems are likely to suffer from the effects sooner and more severely, as may heavy smokers.

There are many CO exposure limits set by government organisations. For a detailed listing, click [here](#). The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) lists a maximum allowable short term limit of 9 ppm. The EPA has set two national health protection standards for CO: a one-hour TWA (i.e. Time Weighted Average) of 35 ppm, and an eight-hour TWA of 9 ppm. These standards make it clear that any carbon monoxide reading over 9 ppm should be investigated and acted upon.

Offering Advice

The advice that 'it is only dangerous if you do not stay awake' shows an astonishing naïve lack of understanding of the early symptoms. It is in itself dangerous, but to advise others accordingly is naive almost beyond credibility.

For anyone still doing this, and some still are, it is advisable to bear in mind that, were someone to die as a result of following such advice, the consequent charge may extend to manslaughter. Further, those inciting others to perform an illegal act may be committing a criminal offense.

Appliances - Defined

It is thus for very good reasons that the use of any gas for the purpose of direct space heating in a caravan is illegal in every state of Australia and that any cooking appliance used for space heating, by any form of burning gas is defined as a 'gas appliance'.

Many argue that a ceramic pot or whatever is 'not an appliance', but overlook that devices are legally definable in terms of intent - not necessarily of content. A screwdriver may thus be defined as a device for dealing with screws, or in dangerous areas at night, may be defined as an offensive weapon. The same reasoning extends to a gas cylinder; or a can of petrol that, if carried onto a plane, will almost certainly be designated as a bomb.

Ceramic Pots

A ceramic device placed over a lighted gas stove for the purpose of space heating is thus liable to held to be an 'appliance' that is intended to be a space heating device for that usage - and therefore prohibited.

The reason why it is so dangerous to do this with (say) a ceramic flower pot or steel or cast iron plate, is that the flame is trapped within an area where air may not flow freely, and thus the gas is not fully burned. Then, that seemingly innocent setup is a carbon monoxide generator – and in some cases exhibits that by burning with that tell-tale yellowish flame, or forming and depositing soot.

The above was confirmed to me unequivocally by a Gas Regulator some years ago: when asked specifically if placing a ceramic pot or steel plate over a gas ring, or leaving the door open on a lighted oven, with the intent to heat an interior space, it becomes, by definition a space heater, he responded 'my bloody oath'!

References to local usage are currently (mid-2019) in Australian Standard AS/NZS AS 5601.2013 with an Amendment for LP Gas Installations in caravans and boats for non-propulsive purposes being published by Standards Australia on 11 May 2016.

A summary called Guide to Gas Installations in Caravans & Mobile Homes (and containing all of the above references) is available free from The Office of Gas Safety (or its equivalent in each state) but relates primarily to the previous Standard. It is also available on the Internet (Google the above title).

Related Risks

Product Safety Australia advises that there are also other common products that can and do emit carbon monoxide. These include:

Barbeques that burn charcoal, gas or wood

Fireplaces that use charcoal, gas or wood

Portable cookers that use gas or kerosene

Portable and outdoor heaters that use gas or kerosene

Electric generators that are diesel or petrol fuelled and

Electrical equipment that is diesel or petrol-powered (e.g. blowers, chainsaws, pumps and welders).

New Zealand

Until 2010 the Gas Standard (AS 5601) related only to Australia - primarily because Australia's LP gas is either propane or mostly propane with a small proportion of butane, whilst NZ uses propane and up to 50% butane. Appliances built to burn one form of LP gas can be hazardous when used to burn another. The Gas Regulators' view was that (as with using Autogas illegally to replace LP gas) that this posed an unacceptable safety risk respectively to New Zealand and Australian consumers.

This issue has now been resolved: including by 'Australian RV appliances increasingly being certified for use with Universal LPG Gas to accommodate the NZ market': written advice from the NZ Office of Energy Safety, 18/09/2012. (This Universal LP gas issue affects only Australian gas appliances made for the NZ market).

Safe RV Heating

Germany's Webasto and Eberspächer companies produce very similar diesel-powered space and space-plus-hot-water power heaters. Truma now has a generally similar LP gas powered equivalent. Both draw fresh air in from outside and exhaust to the outside too. There is also a range of similar units from Diesel Heating Australia.

These are the only form of heating that can be recommended for annexes, caravans and motor homes. They are fully covered in the author's *The Campervan and Motorhome Book*, and also the second Edition of the author's *The Camper Trailer Book* published in August 2018. The Eberspächer product in some countries is marketed under the Dometic name, and sold by Dometic.

How to Detect Carbon Monoxide

The **only** way to detect carbon monoxide is via a pocket detector – or a permanently fixed one for all caravans and motor homes. They are readily available from virtually all hardware stores.



What to do if Carbon Monoxide is detected

Turn off the source of the carbon monoxide if possible to do without risk of endangering yourself or others. Then move to fresh air.

If indoors, move outside to fresh air immediately.

If you are outdoors, move far away from the source of the carbon monoxide (possibly a petrol or diesel engine generator, outboard motor, etc.)

Call the emergency services if anyone is exhibiting symptoms of carbon monoxide poisoning – e.g. headache, dizziness, nausea etc.

Referenced Papers

I normally research topics thoroughly prior to writing anything technical - but rarely include such references in material intended for general reading. I include references (from referred papers from major journals etc) here however in an attempt to stave off 'that's just your opinion' responses.

References (general)

Gas Installation Code AS 5601.2013 with an Amendment for LP Gas Installations in caravans and boats for non-propulsive purposes published by Standards Australia on 11 May 2016.

Published by Standards Association of Australia.

Report of the (SA) Technical Regulator 2005-2006, Annual Report (p.7).

Office of Gas Safety (Vic) – Guide to Gas Installations in Caravans & Motor homes.

Similar guides are available from all state gas regulatory bodies.

New Zealand (facts and data)

Permanent Exemption of LPG appliances from the Trans-Tasman Mutual Recognition Arrangements.

(Regulation Impact Statement for Consultation - 2008.)

References (papers)

1. Varon J, Marik PE, Fromm RE Jr, Gueler A (1999). “**Carbon monoxide poisoning: a review for clinicians**”. *The Journal of Emergency Medicine* 17 (1): 87–93.
2. McDowell R, Fowles J, Phillips D (November 2005). “**Deaths from poisoning in New Zealand: 2001-2002**”(Free full text). *The New Zealand Medical Journal* 118
3. Raub JA, Mathieu-Nolf M, Hampson NB, Thom SR (April 2000). “**Carbon monoxide poisoning-a public health perspective**”. *Toxicology* 145 (1): 1–14.4.
*Henry CR, Satran D, Lindgren B, Adkinson C, Nicholson CI, Henry TD (January 2006). “**Myocardial Injury and Long-term Mortality Following Moderate to Severe Carbon Monoxide Poisoning**”*
5. Prockop LD, Chichkova RI (Nov 2007). “**Carbon monoxide intoxication: an updated review**”. *Journal of the Neurological Sciences* 262 (1-2): 122–130.
6. Thom SR (October 2002). “**Hyperbaric-oxygen therapy for acute carbon monoxide poisoning**”. *The New England Journal of Medicine* 347 (14): 1105–1106
7. **Carbon Monoxide**: National Academy of Sciences, Washington, D.C. 1977. pp. 29. [ISBN 0-309-02631-8](#).
8. Struttman T, Scheerer A, Prince TS, Goldstein LA (Nov 1998). “**Unintentional carbon monoxide poisoning from an unlikely source**”. *The Journal of the American Board of Family Practice* 11 (6): 481–484.
9. “**OSHA Fact Sheet: Carbon Monoxide**”. *United States National Institute for Occupational Safety and Health*.http://www.osha.gov/OshDoc/data_General_Facts/carbonmonoxide-factsheet.pdf.
10. **Compressed breathing air – the potential for evil from within** http://dspace.rubiconfoundation.org/xmlui/bitstream/handle/123456789/7964/DHM_V38N3_breathing_gas.pdf?sequence=1.

Collyn Rivers (© 2019 RV Books, Church Point, NSW Australia.

Contact: RV Books (previously Caravan & Motorhome Books), and Solar Books (previously Successful Solar Books) can be contacted at info@rvbooks.com.au, or by mail at PO Box 356 Church Point, NSW 2105 (Australia).

Websites: rvbooks.com.au and solarbooks.com



The [Pocket CO](#) Detector/Dosimeter, can protect you and your family from dangerous levels of CO anywhere. Its loud alarm and bright red light will warn you of dangerously high levels. It is simple to use, weighs less than an ounce, and fits on a key chain. Also, Pocket CO's digital readout allows you to monitor even low levels of CO.

What Our Customers Say:

We are a volunteer first aid squad and like to keep the Pocket CO clipped to our blood pressure case. This way, every time that we enter a home or business to treat a patient, we run a quick test to assure that we are safe.

Anthony J. Pellegrino, Captain, Shrewsbury First Aid Squad, New Jersey

Last Wednesday I took off from Langley BC to Powell River and back to Langley in a Piper Cherokee for a dual cross country ride; this is a bit over two hours flight, and most of the way is along the Pacific coast. After I started the engine we heard some sort of beep in the cabin, so we looked at the instruments, checked cell phones, our headsets, everything seemed OK, plus none of us heard that kind of beep in a Cherokee before. It took us about a half hour of flight to figure out that the Pocket CO was beeping (was the first time using it, completely forgot I had it until my flight instructor asked me to check that "thing" hanging around my neck). When I read it, it showed 63ppm; so we closed the heaters, and opened all vents, until the reading dropped to 3ppm, that is a more "normal" figure. By now we were well above Vancouver, but because of the low reading we decided to keep going and not go back to Langley. Apparently the CO peaked to 90ppm (if I read the 12hrs log correctly), that was probably during our climb when we used full power. My flight instructor wanted to ground the airplane, but the end result was the school installed a new chemical indicator! The mechanics got a bit touchy, because the airplane just got back from a 100hrs check, they said there was no way we had any CO in the cabin, but I've seen the numbers, and I don't really care what they say: I fly the airplane. I knew this little device could save my skin one day, I didn't expect it so soon! I had a few more flights since then, with different airplanes, all show a very low CO number.

Ion, Canada, May 2010

Just wanted to let you know that I am one of your success stories. I purchased a Pocket CO monitor for use in my research. It came in handy one day when a new CO alarm in my home started to go off. Using the Pocket CO, I was able to determine that the CO alarm wasn't faulty—we had CO in the house! We traced the source to a vent pipe that was never married to our hot water heater. I'm a big fan of your product which is inexpensive, portable, and very easy to use. It's a great addition to home CO alarms, and I always take mine with me when I travel. Thanks!!

Eric L., Emergency Physician/Medical Toxicologist, Colorado, January 2010

I just bought the Pocket CO detector a few weeks ago for my airplane. While flying I noticed it get up to over 100 ppm. So, today I closely inspected the exhaust manifolds and found a hidden hole in the exhaust stack. I never would have known about it if I hadn't bought Pocket CO! Thanks!

Doug M., Southern California, December 2009