



**NATIONAL CARAVAN
COUNCIL LIMITED**

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Gas Regulator Blockages

There have been lots of rumours, accusations and counter accusations flying round the industry for some time with comments of 'nothing is being done about the issue'. Well, nothing could be further from the truth. A great many people have been working on the problem and it is time to put the few known facts on the table.

Let's start at the beginning. In mid 2005, complaints began to arise about blocked regulators in touring caravans and motorhomes. These blockages all occurred in the new 30mbar type bulkhead-mounted regulators designed to meet BS EN 12864 Annex D and were fitted into caravan and motorhome units complying BS EN 1949. The units affected seemed to have been made across a wide spectrum of dates from mid 2003 to the present day.

Examination of the blocked regulators revealed that a yellow, oily fluid was present in the regulator in varying quantities. In most cases there were only a few drops, but in a few isolated cases tens of millilitres could be found. . This oily liquid was sometimes fairly fluid and at other times very viscous. This fluid had come into contact with the rubber seat of the regulator, causing it to swell and block the inlet.

Of all the regulators available to OEMs, the GOK unit supplied by Truma was by far the most common, being installed into all but one of the principle vehicle manufacturer's products, hence it came as no big surprise that almost every single complaint involved their product. Similarly, Calor Gas Ltd was keenly involved as well because they have the largest share of this LPG market and their gas cylinders were connected to the regulators that were failing. There was also some evidence that the problem had a geographic nature, as it seemed to emanate around specific points in the northeast, northwest and southern England and south Wales. Both butane and propane cylinders were involved.

The immediate assumption was 'if it's liquid, then it must be coming out of the gas'. However, analysis of the liquid by both Calor and GOK found that the oily fluid contained plasticisers . These materials are entirely man made, used in rubber and plastics and are added to give the material flexibility and resilience across a wide temperature range. It is not a constituent of LPG.

Both Calor Gas and Truma/GOK began their own investigations immediately into the problem to try to ascertain the cause. Appliances were set up with the identical regulator and connected to cylinders and operated continuously. These ran for weeks with no hint of a problem. To this day, no-one has replicated the field problem under laboratory conditions.

What is the extent of the problem? Some unfortunate users have had several failures consecutively, but based on the leisure vehicles sold since the regulator was first launched it is estimated that there is about a 4 % incident rate nationally.

What has been found so far? The problem isn't just related to Calor Gas. Incidents have now been reported in installations operating on Butagas, Total Gas and Flo-gas. A few incidences of the fluid being found in other makes of regulator have been reported, but as far as we know they did not stop working.

The 30mbar type of installation described earlier in this article is quite unique in the UK as it has a bulkhead-mounted regulator. Older, (pre 2003) touring caravans and motorhomes used a cylinder-mounted regulator, as do many caravan holiday homes and boats to this day. No incidents of this blockage have been reported from those sectors of the trade.

No failures have been reported from domestic LPG installations either by the gas suppliers or CORGI. This seems to plant the incidences very firmly just in the newer touring caravan and motorhome products.

We need to be very mindful that the gas bottlers and suppliers do just what they say they do. They do not distil the gas or treat it in any way. The gas is delivered from the various oil refineries around the country in bulk form as propane or butane ready for use. The bottlers take this and put into the various sizes and types of cylinder. Quality checks are carried out daily to ensure that the gas complies with the relevant British Standard, BS 4250.

The regulator manufacture also carries out strict quality checks to ensure that his product complies with the relevant Standard and no evidence has been found that it does not comply. A mesh type filter is provided in the inlet to prevent solids entering the device, but of course this is ineffective against liquids.

So, we appear to have gases and a regulator that comply with the relevant requirements in every way. So what else could cause it? The only other components in the system are the high-pressure pigtailed from cylinder to regulator. These are made of rubbers and contain phthalates or other plasticisers.

To try and find the answer we have to look at the different mechanisms involved and what has changed. Prior to 2003 with the cylinder mounted regulator, the hose connecting the regulator to the caravan pipework was at operating pressure of 28 or 37mbar and when the user turned off the gas appliances in the caravan, the flow stopped and the pressure in the hose remained substantially the same. This pressure is far lower than that which would cause the gas to re-condense out.

The situation now is that when the user turns off the gas inside the caravan, the regulator closes and the high-pressure pigtail is then full of gas at the same pressure as is in the cylinder. As the thermal mass of the hose plus gas is much lower than the cylinder plus gas, it can cool more quickly and allow the gas to recondense out on the inside of the hose and regulator. A similar effect can be witnessed every time a kettle is boiled, with the steam recondensing to water in the spout.

The hoses themselves are made to meet BS 3212 and as part of that Standard they are required to pass a test that allows them to absorb up to 15% by weight of n-pentane (another member of the propane and butane family of chemicals that is liquid at room temperature) and also they shall not lose more than 10% by weight when the pentane is re-evaporated off. All of the hoses in use pass these tests, but the results for the extraction can show a surprising variance.

Now go back to the gas, and although it says propane or butane on the cylinder, you may be surprised to learn that it actually is a complex 'cocktail' of hydrocarbons, with quite varied boiling points. These gases easily liquefy at room temperature and cylinder pressure so it would be quite expected for them to condense out on the hose inner lining. When you then start to look at some of these other hydrocarbons in chemical terms you find that they have different properties from each other when in contact with rubbers and plastics, some being classed as more 'aggressive' than others.

We have to consider the installation again now. In touring caravans complying with BS EN 1949, the regulator has historically been mounted vertically, in some cases relatively low in the cylinder compartment. Given that there is a restriction on hose lengths (max 450mm) caravan manufacturers positioned the regulator such that it allowed choice for the user in terms of cylinder size. With the outlet facing downward and the inlet upward, the high-pressure pigtail actually had a vertical downward section into the regulator. Obviously any liquid in the hose could run downwards into the regulator under gravity.

In motorhomes, the available space for the gas cylinders is generally much more confined as it lies within the body of the vehicle and the regulator tends to be mounted higher. Usually the cylinder compartment will only accept the smaller size cylinders. This may explain why the failure rate on motorhomes does not relate to the relative sales figures as the failure rate here is only some 5% of the total complaint, and yet they represent some 30% of sales.

One touring caravan manufacturer uses a regulator made by COMAP and this regulator has been universally mounted at high level and in a horizontal plane. There have been no substantiated reports of failure of this regulator due to the contamination problems described previously.

We should perhaps say here that the caravan manufacturers have also done nothing wrong as they have complied fully with the requirements of BS EN 1949 and the regulator manufacturer's instructions.

So what do we think was the cause? An unfortunate combination of circumstances is the most likely answer and there are several theories that have been considered including:

- 'Contaminated' gas, but as there are continual quality checks made by the refiners and bottlers, this seems unlikely. There have also been no reported incidents from LPG users other than touring caravans and motorhomes that appears to reinforce this view. There is, however another aspect which has been put forward and cannot be ignored, and that is that the problem only appeared in mid 2005, some 2 years after the initial installations had been commissioned and hence 'something' may have changed, with the only obvious variable being the gas.
- 'Faulty' regulators or regulator components, but there is no evidence for this either.
- Carry over of 'heavy ends*' from the gas cylinder into the regulator, but tests have failed to show anything more than minute quantities being transferred under normal usage conditions. (* 'Heavy ends' are the trace quantities of higher molecular weight hydrocarbons and unavoidable oils present in the bulk gas that do not evaporate off with normal cylinder use and gradually build up due to multiple refills in the period between regular cylinder inspections).
- Re-condensation of gas in the high-pressure hose, which then causes extraction of the plasticiser. These drops of gas and plasticiser sit on the hose inner surface until the user makes a sudden demand for gas and these gas/plasticiser droplets would then suddenly vaporise and create microdroplets of the plasticiser to occur in the gas stream. These could then be readily drawn into the regulator by gravity as the hose has always had a downward section. Droplets in the hose section running 'downhill' 'back to the cylinder would travel in that direction. Of course, if these droplets on the inner hose wall become large enough then they may in fact trickle directly into the regulator unaided. This particular theory is feasible, but almost impossible to prove or disprove without lengthy testing.
- Gas supply system design that encourages flow of condensate into the regulator.

Counter arguments say that the volume of liquid found in some cases is too great for the amount of material that could be extracted from the hose, but we only know that the fluid contained some plasticiser, not a 100% concentration. It is possible that a part of the liquid contained higher boiling point paraffins (The generic name for members of the butane and propane family of hydrocarbons) that had recondensed. This may explain why when hoses from failed systems have been cut open, the insides were dry as the plasticiser would be re-absorbed by the rubber fairly quickly and the hydrocarbons evaporate when exposed to the open air.

An examination of the domestic and many holiday home environments finds some interesting comparisons. High-pressure hose and changeover devices are 'de rigueur' and they use the same gas and hoses, but have no reported problems. This strengthens the argument that the answer may lie in the system design.

The good industry practice here is that the hose should always lie such that gravity will allow any condensate to flow back into the cylinder. It is of particular interest that the Standard for domestic LPG installations, BS 5482 part 1, includes a specific requirement to ensure that hoses rise continuously to any regulator installation for this very reason.

All returned, empty cylinders are checked and cleaned periodically by the gas bottlers to remove any 'heavy ends' and condensate extractions that may have collected. These 'heavy ends' and condensate extractions have much higher boiling points (up to 300°C), than the paraffin type gases, and do not boil off when gas is being used.

What for the future? The strong recommendation of all parties is to mount the regulator so that the hose rises continuously from the cylinder outlet to the regulator inlet. Caravan and motorhome manufacturers have adopted this practice for the 2007 models. Processes are to be started to try and revise relevant Standards to reduce the extraction rate of hoses, to try and tighten gas quality and improve the system design criteria in BS EN 1949, but this will be a long task and it will be quite some time before any revision can be published.

One obvious solution would be to go to bottle mounted regulators again, but that has significant safety implications as the appliances now being fitted into caravans are designed for a 30mbar propane and butane gas appliance grouping, and in that respect are totally unique to the UK gas industry. Mixing of the old 28 and 37mbar regulators with the new appliances could mean that they could be operating outside their design parameters. Equally, using the new 30mbar regulator on older appliances could have safety implications with incompatible pressures. The regulators and hoses are available in the public retail domain and as such the general public will not be aware of these potential hazards of any misapplication of these components and we must protect against that danger. This was the logic behind the choice of bulkhead regulators from the outset.

The current field problem, whilst not doubting its frustrating implications for victims, is not a safety issue and the industry has an overriding duty to ensure ongoing safety. There are many users of LPG within the UK outside of the caravan and leisure industries, and due consideration of incorrect utilisation here was a significant factor in the original deliberations.

So, it would appear that nobody has done anything wrong, but collectively a set of circumstances has arisen that created the problem. The European base Standard, EN1949, was many years in compilation with leading gas authorities across Europe involved prior to its publication and the potential for the current field situation to arise was not raised as an issue.

The question is 'why has the problem only arisen in 2005/2006, when these regulators have been in use since September 2003'? The only considered response to that is that the susceptibility has always been there; it just needed the right conditions to initiate it.

We have recently become aware of exactly the same problem occurring in Australia and New Zealand in caravans and they are offering the same advice as ourselves quite independently.

Incidences have also been reported in France, but evidence here is sketchy and uncorroborated.