The Allen Consulting Group

The risk of carbon monoxide poisoning from domestic gas appliances

Decision Regulation Impact Statement

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Report to the Department of Resources, Energy and Tourism

The Allen Consulting Group

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Acronyms and Glossary

ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
BCR	Benefit cost ratio
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COAG	Council of Australian Governments
COHb	Carboxyhaemoglobin
Department	The Department of Resources, Energy and Tourism
GTRC	Gas Technical Regulator's Committee
kW	Kilowatt
LPG	Liquefied petroleum gas
NO_x	NO (Nitric Oxide) and NO_2 (Nitrogen dioxide)
NPV	Net present value
OBPR	Office of Best Practice Regulation
PV	Present value
QRA	Quantitative Risk Assessment
RIS	Regulation Impact Statement
RV	Recreational vehicle
Strategy	The GTRC Gas Appliance (Carbon Monoxide) Safety Strategy
VSL	Value of a Statistical Life
VSLY	Value of a Statistical Life Year

Executive summary

The Allen Consulting Group was commissioned by the Department of Resources, Energy and Tourism (the Department) to undertake this Decision Regulation Impact Statement (RIS). This RIS explores the costs and benefits of a number of regulatory approaches to address the risk of Carbon Monoxide (CO) poisoning from domestic gas appliances. It has been commissioned following a motion passed by the Federal Parliament[1] and has been developed with the assistance of the Gas Technical Regulators Committee (GTRC).

The document is part of a two-phase work program to be undertaken by the Allen Consulting Group. The first phase was to produce a Quantitative Risk Assessment (QRA) on the potential options to reduce the incidence and harm of CO poisoning. The QRA explored the health effects arising from CO poisoning before investigating the risk of carbon monoxide poisoning in the community from domestic household gas appliances.

The second task in the work program was to develop this RIS exploring the impact of a number of regulatory options. The RIS is a central component of the Council of Australian Government's (COAG) regulation impact assessment process. It is a document prepared to outline to outcomes of our analysis and the outcome of stakeholder consultations. The objective of any RIS is to formalise and provide evidence of the key steps taken during the development of a regulatory proposal, including an assessment of the costs and benefits of each option.

Nature and extent of the problem

The RIS focuses on the risk of accidental and unintentional CO poisoning in domestic households and recreational vehicles (RVs) from the regular use of gas appliances. This RIS does not attempt to address issues of inappropriate misuse of appliances nor does it look to address intentional cases of CO poisoning.

Domestic gas appliances are a common feature of Australian homes. Just under half of Australian dwellings now use mains gas as a domestic energy source. Gas appliances are also common in recreational vehicles where gas is often used to fuel cooking appliances, water heaters and refrigeration units.

Gas is a potentially dangerous fuel and, if used incorrectly, can lead to illness, injury and death. Properly installed and maintained gas appliances pose minimal risk to the health of gas users. Faulty or incorrectly installed gas appliances, however, may produce high levels of CO from the incomplete combustion of gas.

[1] The motion that was passed requested the Ministerial Council on Energy work with the Gas Technical Regulators Committee to explore issues related to carbon monoxide (CO) poisoning from gas appliances and recreational vehicles. The Ministerial Council on Energy was also requested to develop the *Gas Appliance (Carbon Monoxide) Safety Strategy*, which examines the issue of carbon monoxide poisoning in residences and the most effective options to mitigate the risk of poisoning. For further information see http://www.sharmanstone.com/MediaandSpeeches/MediaReleases/tabid/73/articleType/ArticleView/articleId/310/Carbon-Monoxide-the-silent-killer.aspx

CO is an invisible, odourless and tasteless gas that can cause significant health problems at very low atmospheric concentrations. Children, the elderly and individuals with existing heart problems are typically more likely to experience more severe effects from CO poisoning at lower CO concentrations.

The QRA estimated that one death and 21.3 injuries are caused by CO poisoning by gas appliances each year in Australia. This is summarised in the table below. Further information on the estimation of the number of CO injuries per year is provided in the QRA.[2]

Table ES 1.1

RISK OF CO POISONING IN AUSTRALIA

Injury	Estimated risk
Deaths per year	1.00
Injuries per year	21.30
Deaths per million exposed population	0.07
Injuries per million exposed population	1.55

Source: The Allen Consulting Group QRA table 3.2.

A range of regulatory mechanisms are in place that ensure that gas appliances on the market and their installation is safe, and the effectiveness of these measures is reflected in the low rate of deaths and injuries associated with the use of gas appliances. For a number of reasons however, these measures may not be adequate in each and every instance. In many cases consumers do not realise that they are at risk of CO poisoning and, given that it is an odourless and colourless gas, consumers often fail to realise they are being exposed to the potentially dangerous gas.

A number of problems have been identified that can potentially increase the risks of CO poisoning. These include:

- a lack of awareness of the risks of CO poisoning amongst consumers;
- the use of portable gas appliances in recreational vehicles;
- reduced adventitious ventilation to improve energy efficiency in residential buildings;
- inadequate maintenance of gas appliances; and
- lack of awareness of the risks of CO poisoning across tradespeople.

Objectives of government action

The objective of this intervention is to reduce the risks associated with CO poisoning from gas appliance use in a cost-effective manner.

[2] The QRA estimated the number of injuries via a top-down and bottom-up approach. In this RIS, the top down figure is used, unless specified otherwise.

Options to achieve government objective

The QRA conducted in the development of this RIS considered the effectiveness of a number of potential strategies to mitigate the risks of CO poisoning. The strategies included a range of options to address risks associated with appliances, installation and operation. Given the findings of the QRA, some options have been deliberately excluded from this analysis and dismissed as infeasible.

The options presented in this RIS chapter reflect the findings of the QRA and the requirements of the COAG RIS guidelines. They have been developed in consultation with the Department and the GTRC. The options are outlined in the following table.

Table ES 1.2

OUTLINE OF OPTIONS

Option	About	How the option addresses the problem	Applies to
1. Status quo	Business as usual	Allows problem to continue	na
2. Consumer education and public awareness	A targeted campaign to raise awareness of the risk of CO poisoning and options to self-mitigate	Fills information gaps that exist relating to gas appliance in households and RVs and across the trades	Households and RVs with gas appliances
3. CO alarms	Requires alarms to be fitted in all households with gas appliances at the time of sale or lease and in RVs at the time of registration	Alerts consumers in the event of CO spillage	Households and RVs with gas appliances
4a. Permanent ventilation *	Requires households to ensure permanent ventilation requirements are satisfied at the time of sale or lease	Prevents harmful impacts related to insufficient air for appropriate appliance operation such as incomplete combustion and adverse flow	Households with natural draught open flued space heaters and indoor water heaters and flueless heaters (not RVs)
4b. Mechanical ventilation mechanisms *	Requires households to install mechanical ventilation systems prior to sale or lease of a household	Prevents harmful impacts related to adverse flow	Households with natural draught open flued space heaters and indoor water heaters (does not impact flueless heaters)
5. Future improvements to natural draught open flued appliances	Requires engineering improvements to natural draught open flued space heaters and water heaters	Prevents CO spillage	Households with natural draught open flued space heaters and indoor water heaters

* Adequate ventilation for gas appliances is also required to reduce the build up of other pollutants from gas appliances such as Radon emissions, NOx and vapour emissions.

Source: The Allen Consulting Group in consultation with the Department and the GTRC.

Impact analysis

Options were assessed relative to the status quo. The status quo acts as a benchmark against which benefits attributable to the new regulation can be assessed. This base case allows decision makers to assess whether the costs associated with the proposed regulatory options are outweighed by the benefits of these options when compared to continuing the 'business as usual' approach.

The net impacts of each option are detailed in Table 6.1. The table reports each option's:

- Net Present Value (NPV) — calculated by subtracting the present value of each option's costs from the present value of each option's estimated benefits; and
- Benefit Cost Ratio (BCR) — is a relative measure that reports the ratio of the benefits to costs (in present value terms).

Table ES 1.3

SUMMARY OF NET IMPACTS

Option	PV benefits, $ 000's	PV costs, $ 000's	NPV, $ 000's	BCR
2. Public awareness *	745	740	5	1.01
3. CO alarms	2 080	2 364 375	-2 362 295	0.00
4a. Permanent ventilation	15 117	434 858	-419 741	0.03
4b. Mechanical ventilation mechanisms	15 775	579 306	-563 531	0.03
5. Future improvements to natural draught appliances	16 265	30 860	-14 600	0.53

Note: PV = Present Value. All present values are estimated using a 7 per cent discount rate.
* The cost of the campaign has been calculated relative to the estimated benefits. That is, this campaign has been designed to be cost effective.

Source: The Allen Consulting Group.

Clear from the table above, Option 2 has the highest NPV of all the options considered. The NPV is slightly positive, indicating that the projected benefits are in line with the expected costs. For all other options the NPV is negative, indicating that the expected costs outweigh the expected benefits.

Option 2 also has the highest BCR, reflecting the relatively low expense required to generate an impact.

All other options returned a negative NPV — suggesting that the costs of intervention are greater than any benefit that might be received. The poorest performing option was Option 3, which would see a net cost imposed on the community of more than $2.3 billion (in present value terms).

Implementation

The analysis in this RIS assumes that measures will be effective 1 July 2013. However, this timing is indicative only, with the implementation schedule of any policy response yet to be determined.

In addition, although the measure will be implemented through state and territory legislation, for the purposes of conducting this RIS and assessing alternatives, it has been assumed that the Commonwealth, states and territories would act together to implement cost effective schemes.

Consultation

A Consultation RIS was provided to stakeholders for comment and to enable further development of the policy proposals. Stakeholders were given three weeks to provide written comment on the Consultation RIS.

The key points raised by stakeholders were that:

- stakeholders broadly supported the analysis contained in the RIS;
- most stakeholders were keen to ensure any proposed regulation will not impose significant costs on consumers or business;
- opinions on CO alarms was split between those advocating their expanded use as demonstrated by the UK example, and other stakeholders who warned the alarms were unreliable and could increase the level of risk by providing consumers with a false sense of security;
- if used correctly, gas appliances in RVs posed minimal risk to their occupants. However, stakeholders acknowledged that un or ill-informed consumers may be sealing RV ventilation to prevent cold air entering. Consumers may also be incorrectly using portable appliances that were initially (and only) designed for outdoor use. These activities pose a significant risk of CO poisoning in RVs;
- a number of different Standards and Codes guide the work of various tradespeople that undertake work that can potentially effect the safe operation of gas appliances. The poor integration of the various Standards and Codes that govern the range of tradespeople involved in house construction can increase the risk of CO poisoning. Ensuring consistency across Standards and Codes may improve clarity for tradespeople and ultimately safety for consumers;
- replacing marketing pamphlets with public awareness messages in bills places an opportunity cost on industry; and
- 3-way fridges and other portable gas appliances operated in an enclosed area pose a risk of CO poisoning in the community.

Recommended option

Following the analysis of the benefits and costs of each option, and taking on board feedback from stakeholders, a public awareness campaign as outlined in Option 2 emerged as the recommended approach.

Chapter 1

About this report

The Allen Consulting Group was commissioned by the Department of Resources, Energy and Tourism (the Department) to undertake this Decision Regulation Impact Statement (RIS). This RIS explores the costs and benefits of a number of regulatory approaches to address the risk of carbon monoxide (CO) poisoning from domestic gas appliances. It has been commissioned following a motion passed by the Federal Parliament[3] and has been developed with the assistance of the Gas Technical Regulators Committee (GTRC).

The document is part of a two-phase work program to be undertaken by the Allen Consulting Group. The first phase was to produce a Quantitative Risk Assessment (QRA) on the potential options to reduce the incidence and harm of CO poisoning.

The QRA explored the health effects arising from CO poisoning before investigating the risk of carbon monoxide poisoning in the community from domestic household gas appliances. Once relative risks were identified and quantified this information was used to determine the overall level of risk of CO poisoning in the community in absolute terms. The QRA is summarised in the box below.

This report forms the Final RIS.

[3] The motion that was passed requested the Ministerial Council on Energy work with the Gas Technical Regulators Committee to explore issues related to carbon monoxide (CO) poisoning from gas appliances and recreational vehicles. The Ministerial Council on Energy was also requested to develop the *Gas Appliance (Carbon Monoxide) Safety Strategy*, which examines the issue of carbon monoxide poisoning in residences and the most effective options to mitigate the risk of poisoning. For further information see http://www.sharmanstone.com/MediaandSpeeches/MediaReleases/tabid/73/articleType/ArticleView/articleId/310/Carbon-Monoxide-the-silent-killer.aspx

Box 1.1

QUANTITATIVE RISK ASSESSMENT ON THE RISK OF CO POISONING FROM DOMESTIC GAS APPLIANCES

The QRA was undertaken to assess the level of risk of carbon monoxide (CO) poisoning from gas appliances in Australian households and recreational vehicles. It is part of a two-phase work program to be undertaken by the Allen Consulting Group. The second phase is to produce a Regulation Impact Statement (RIS) on potential options to reduce the incidence and harm of CO poisoning in households and recreational vehicles.

The QRA focussed on a number of common gas appliances found throughout Australian households. This included heaters (natural draught, balanced flued and flueless), internal domestic hot water systems and cooktops. Gas appliances in recreational vehicles — which also pose a concern — were largely unable to be quantified due to data limitations. The GTRC also notes that there have been issues with 3-way fridges, and further work on this specific appliance may be required.

Strategies to reduce the risk of CO poisoning were assessed by the degree to which they addressed certain risk factors. Eleven strategies were developed based on earlier consultation between members of the Ministerial Council on Energy and Gas Technical Regulators Committee (GTRC), and these strategies were assessed in terms of their ability to mitigate the risk of CO poisoning.

In general, this analysis shows that strategies addressing the risk of adverse flow and insufficient air for combustion were the most successful at reducing the risk of CO poisoning. This was due to these being the dominant risk factors for spillage and combustion disruption respectively. Requiring all new appliances be room-sealed appliances was also an effective strategy over the longer term.

The least effective strategies (from a pure efficacy point of view) included increased appliance standards for existing appliance technologies and increased training. Given the stringency that already applies to appliance safety standards and gasfitter/plumber accreditation it was unlikely that suggested increases would have a material effect. Moreover, these strategies did not address the key sources of risk. Mandatory appliance maintenance and the mandatory installation of CO alarms in rental properties were also found to be relatively ineffective, given the relatively low proportion of rental dwellings and issues regarding the efficacy of alarms.

Source: The Allen Consulting Group.

1.1 Preparing a RIS

This report is the final RIS regarding the proposal to introduce new regulation to reduce the risk of CO poisoning. It has been developed in accordance with the regulatory principles set out in the COAG (2007) guide for Ministerial Councils and national standard setting bodies, *Best Practice Regulation.*[4]

Preparing a RIS ensures that all relevant information to the decision making process is documented, and that the decision making processes are made explicit and transparent.

A RIS should identify the following (Australian Government 2010):

- the problem or issues that give rise to the need for action;
- the desired objectives;
- a range of options (regulatory and non-regulatory, as applicable) that may constitute feasible means for achieving the desired objectives;

[4] The OBPR's *Best Practice Regulation Handbook* has also been a very useful resource for the analysis.

- an assessment of the impact (costs, benefits and, where relevant, levels of risk) of a range of feasible options for consumers, business, government and the community;
- a consultation statement;
- a conclusion and recommended option; and
- a strategy to implement and review the preferred option.

1.2 Consultation

Feedback was sought from a range of stakeholders and this informed the development of this RIS. Chapter 8 provides a summary of the stakeholder consultations undertaken in developing this RIS.

1.3 Structure of this report

The remainder of the report is set out as follows:

- Chapter 2 — provides a definition of the problem;
- Chapter 3 — outlines the objective of government action;
- Chapter 4 — discusses a suite of options to achieve that objective;
- Chapter 5 — details the likely impacts of each option;
- Chapter 6 — provides a summary of preliminary findings for discussion;
- Chapter 7 — discusses an appropriate implementation and review strategy;
- Chapter 8 — highlights issues raised by stakeholders through the consultation process; and
- Chapter 9 — outlines the recommended option.

Chapter 2

The nature and extent of the problem

This chapter provides an analysis of the nature and significance of the underlying policy problem. The RIS focuses on the risk of accidental and unintentional CO poisoning in domestic households and recreational vehicles (RVs) from the regular use of gas appliances. This RIS does not attempt to address issues of inappropriate misuse of appliances (as outlined in Box 2.1), nor does it look to address intentional cases of CO poisoning. It is generally not feasible to legislate against misuse as it effectively duplicates legislation designed to prevent misuse in the first place. In this instance legislation is already in place that requires appliances to be categorised and certified accordingly. If that legislation were followed misuse would not occur and any possible fatalities resulting from that misuse be avoided. However, should proposed regulatory options inadvertently also address instances of inappropriate misuse or intentional CO poisoning, this will be included when determining the benefits of proposed regulatory options and be included in the final recommendations.

Box 2.1

INAPPROPRIATE MISUSE OF GAS APPLIANCES

Inappropriate misuse of gas appliances happens when gas appliances are used for means other than that which they were designed for. Some potential examples of the inappropriate misuse of gas products include:

- using outdoor heating equipment in enclosed spaces;
- using portable gas appliances in settings with inadequate ventilation; and
- using gas appliances for purposes other than they were designed for, including using gas ovens or stovetops for room heating.

In the majority of situations this arises from ignorance. While the general public have some awareness of the flammability of gas there is likely to be little awareness of the risk of CO poisoning from inappropriate use of portable appliances. Gas appliances designed for outdoor use are currently required to have warning labels advising of the dangers associated with use in poorly ventilated areas. However, it is only in the last few years that the principal appliance of concern, the portable fridge, has been required to have large obvious labels about this use. Developing regulations to prevent the inappropriate misuse of appliances is beyond the scope of regulation assessed in this RIS.

Source: The Allen Consulting Group

The chapter outlines:

- the prevalence of gas use in Australian houses and RVs;
- the physiological effects of CO poisoning;
- how CO poisoning from gas appliances occurs;
- the extent of the problem to be addressed by Government regulation;
- a clear definition of the problem;

- existing regulations in Australia and overseas regarding gas appliances; and
- the case for Government action to regulate to reduce the risk of CO poisoning from gas appliances.

This RIS is looking to address the problem of accidental and unintentional CO poisoning from domestic gas appliances. The QRA found that accidental CO poisoning is responsible for, on average, 1 death per year and an estimated 21.3 injuries.

2.1 Gas appliances in Australian households and recreational vehicles

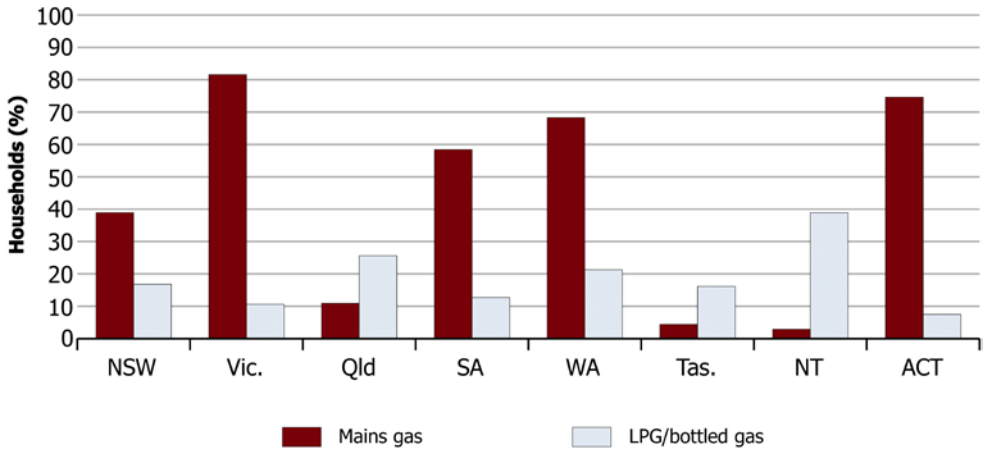
Domestic gas appliances are a common feature of Australian homes. Gas is a potentially dangerous fuel and, if used incorrectly, can lead to illness, injury and death. Properly installed and maintained gas appliances pose minimal risk to the health of gas users. Faulty or incorrectly installed gas appliances, however, may produce high levels of CO resulting from the incomplete combustion of gas.

Households

Just under half of Australian dwellings now use mains gas as a domestic energy source. This is unevenly spread across Australia ranging from 82 per cent of households in Victoria to just 3 per cent in the Northern Territory. A further 17 per cent of households use liquefied petroleum gas (LPG) as a source of energy (ABS 2011). The State and Territory breakdown of domestic gas use is provided in Figure 2.1 below. The rate of gas use is likely to continue to grow as gas appliances remain an attractive alternative to appliances powered by electricity (see National Appliance and Equipment Energy Efficiency Committee 2004).

Figure 2.1

GAS AS AN ENERGY SOURCE IN DOMESTIC SETTINGS



Source: ABS 2011

Common domestic gas appliances include space heating, hot water services, ovens and cooktops. The prevalence of gas appliances in domestic homes is reported in Table 2.1.

Table 2.1

HOUSEHOLDS WITH VARIOUS GAS APPLIANCES

Appliance	Per cent of households	Number of households	Exposed population
Heaters	**31.4**		
Natural draught*	20	1 729 524	4 524 120
Balanced flue*	8.4	726 400	1 900 130
Flueless*	3	259 429	678 618
Cooktops	**43.6**	**3 770 361**	**9 862 582**
Hot Water Services	**37.2**		
External*	37	3 199 619	8 369 622
Internal*	0.2	17 295	45 241
Total population in households with gas connections	**60.9**	**5 266 399**	**13 775 945**

* Distribution across appliance types estimated.

Source: ABS 2011a and the Allen Consulting Group

Recreational vehicles

Gas appliances are also commonly installed in Recreational Vehicles (RVs). Gas is often used to fuel cooking appliances, water heaters and refrigeration units. Gas appliance use in these vehicles can pose an additional danger if not installed correctly due to the small areas within which these appliances are operated.

Provided the gas appliance is installed correctly, has an effective flue in place to remove combustion products, is maintained and there is appropriate ventilation, CO produced by a faulty gas appliance should not accumulate within the RV and cause health problems for those living inside. When the production of CO is combined with a failure to fully extract the combustion products, internal CO concentrations can reach potentially dangerous levels. The GTRC has indicated that issues with gas appliances in RVs mainly result from the incorrect installation of 3-way fridges.

Recreational vehicles are also prone to additional risks of CO poisoning if portable appliances are used in indoor situations where there is inadequate ventilation. A high proportion of the 50,653 registered RVs in Australia use gas powered appliances[5]. This risk is not confined to the traditional RV (caravan/motor home). Notably the two fatalities in Queensland actually took place in vehicles and not RV's.

[5] Some boats also use gas to fuel appliances, however these risks are not considered here.

2.2 CO poisoning

CO is an invisible, odourless and tasteless gas that can cause significant health problems at very low atmospheric concentrations. CO binds more strongly to haemoglobin than oxygen, with exposure to CO resulting in a reduction in an individual's oxygen-carrying capacity. Table 2.2 shows a range of health effects that result from CO poisoning for a typical healthy adult, in terms of the percentage of carboxyhaemoglobin (COHb) in the blood. Children, the elderly and individuals with existing heart problems are typically more likely to experience more severe effects from CO poisoning at lower CO concentrations.

Table 2.2

HEALTH EFFECTS OF COHB BLOOD LEVELS ON HEALTHY ADULTS

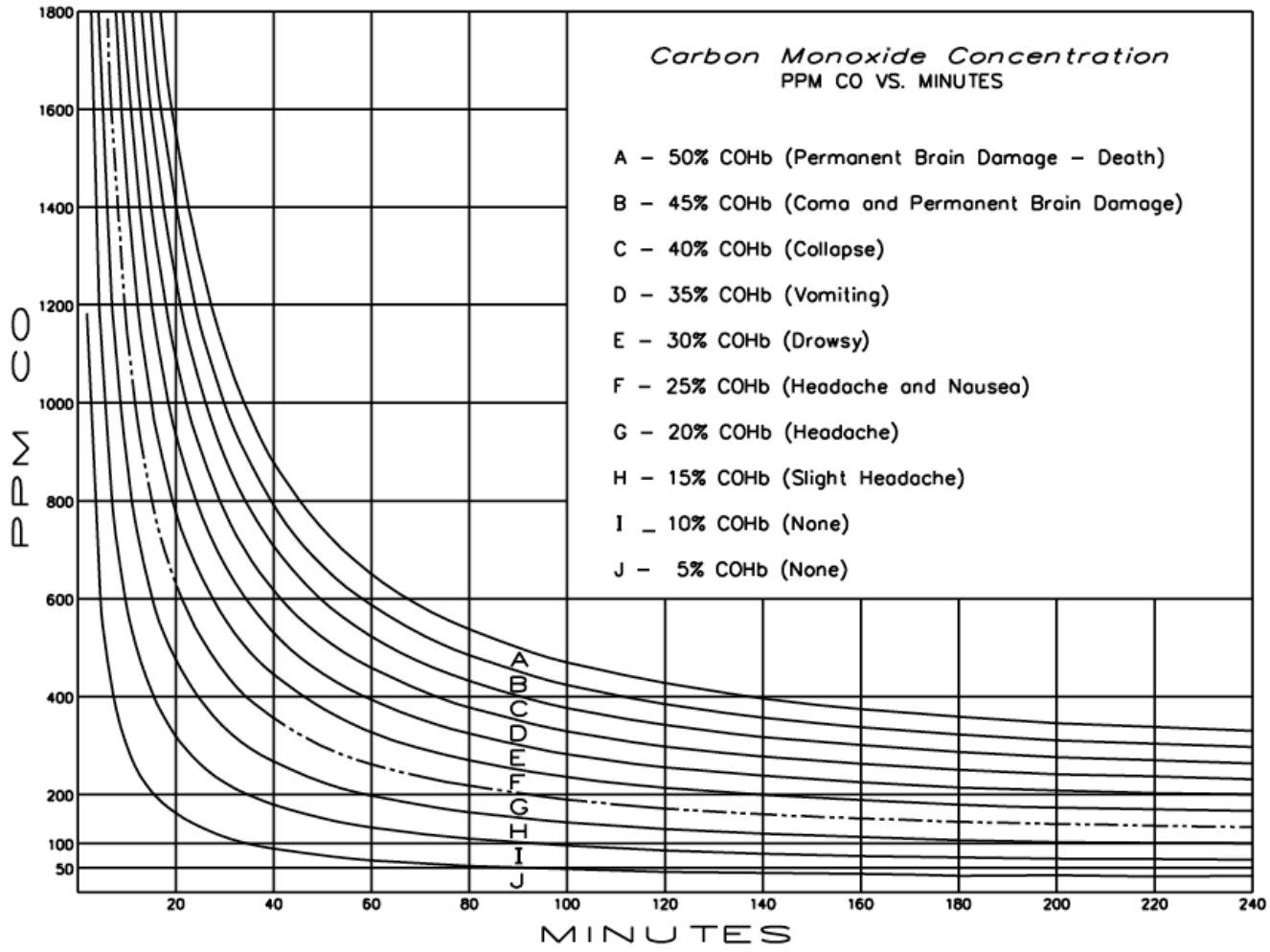
Effects	% COHb
Normal range in non-smokers due to endogenous CO production	0.3–0.7
No proven physiological changes	0.7–2.9
Cardio-vascular changes in cardiac patients	2.9–4.5
Usual values observed in smokers, impairment in psychomotor tests	4–6
Cardio-vascular changes in non-cardiac patients (increased cardiac output and coronary blood flow)	7–10
Slight headache, weakness, potential burden on foetus	10–20
Severe headache, nausea, impairment in limb movements	20–30
Severe headache, irritability, confusion, impairment in visual acuity, nausea, muscular weakness, dizziness	30–40
Convulsions and unconsciousness	40–50
Coma, collapse, death	50–70

Source: UK Department for Communities and Local Government 2009.

Mortality and morbidity rates from CO exposure are dependent on both concentration of CO and time of exposure. Lower concentrations of CO are increasingly harmful as exposure time is prolonged. The relationship between CO concentration and exposure time is represented in Figure 2.2 below. Again, this represents a model case, with significant variation surrounding the health consequences of different CO exposures amongst individuals.

Figure 2.2

EXPOSURE TIME AND CO CONCENTRATION – IMPACTS ON HEALTH



Source: Underwriters Laboratories 1996.

2.3 Requirements for CO poisoning from gas appliances

The mechanism by which CO from gas appliances can build up in domestic settings was explored thoroughly in the QRA. In summary, a build up of excess CO in an occupied space requires both:

- burner disruption leading to the production of CO by a gas appliance; and
- the failure to discharge combustion products from the dwelling.

Whilst burner disruption leads to negative consequences such as increased fuel costs and reduced appliance performance, burner disruption alone will not cause CO poisoning provided combustion products are effectively removed from an appliance and vented externally. Likewise, the failure to discharge combustion products alone is not sufficient to cause CO poisoning, although it may lead to other problems. CO poisoning requires two independent events – burner disruption and unsafe discharge – to occur simultaneously for CO to be released internally and potentially reach dangerous concentrations.

There are a number of possible ways that a flue system can fail and combustion products can accumulate internally. These include:

- a blockage in the flue preventing the efficient flow of combustion products;
- a faulty connection between the flue and the appliance;
- poor flue maintenance;
- damage to the flue resulting in combustion products being released into the house;
- the use of flueless heaters that release combustion products internally; and
- a negative pressure gradient developing from the use of extraction fans in well-sealed dwellings, resulting in a reversal of the airflow in a natural draught flue and the spillage of combustion products internally.

Likewise, there are a number of faults that can lead to the production of CO by gas appliances. These factors include:

- insufficient air for combustion;
- the use of an inappropriate gas supply for the appliance;
- disruption of the burner due to the build up of contaminants such as lint and insects.

When an appliance fault results in the production of CO and the flue system fails to remove combustion products, the concentration of CO in domestic dwellings can rise to potentially harmful levels.

2.4 How significant is the problem?

Deaths from acute CO poisoning are reasonably well documented by gas regulation authorities. Over the last ten years, there has been an average of one death per year in Australia as a result of CO poisoning from the use of gas appliances. CO fatalities from gas appliances across Australian states and territories is summarised in Table 2.3.

Table 2.3

CO FATALITIES PER AUSTRALIAN STATE/TERRITORY OVER THE LAST 10 YEARS

State / Territory	Fatalities	Fatalities per year per million head of population in residences with a gas connection[1]
Victoria	4	0.081
South Australia	4	0.352
Queensland	2	0.129
Western Australia	0	0.000
Tasmania	0	0.000
ACT	0	0.000

[1] Assuming equal distribution of residents in households with and without gas connections. At the time of publication, the data for New South Wales and the Northern Territory was not available.
Source: Allen Consulting Group, Gas Technical Regulators Committee 2011, ABS 2011.

Although cases of fatal CO poisoning in Australia are reasonably well documented, the rate of non-fatal cases of CO poisoning in Australia is less well defined due to a lack of data, misdiagnosis and under-reporting. Further, hospital statistics from Australia do not differentiate between CO poisonings from gas appliances and CO poisonings arising from other sources. The Australian data regarding CO poisonings is explained below.

Box 2.2

AUSTRALIAN HOSPITAL DATA FOR CO INJURIES

Using data from the last four years, CO poisoning results in 364.5 hospital separations per year, with an average length of stay per separation of 2.50 days (AIHW 2011 based on method in Commonwealth of Australia 2008).

These hospitalisations figures are confounded by two factors.

- The figure reported will overestimate the rate of CO hospitalisations from gas appliances, as it includes all CO poisoning hospitalisations such as from the build up of car exhaust fumes in a confined space. It also does not distinguish between intentional and non-intentional cases of CO poisoning.
- Alternatively, the figure for hospitalisations for CO poisoning will underestimate the total number of CO poisoning cases due to misdiagnosis and underreporting of sub-lethal exposures to CO. Similarities between the symptoms sub-lethal CO poisoning common illnesses such as influenza can result in cases of CO poisoning being misdiagnosed (see Barret, Danel and Faure 1985) or for individuals to not seek medical help.

As a result of these factors it is difficult to accurately estimate the true rate of hospitalisation due to accidental CO poisoning from the operation of gas appliances.

Source: The Allen Consulting Group

The most comprehensive body of research into accidental CO poisoning from gas appliances has been undertaken in the UK. This data is summarised in Table 2.4 below.

Table 2.4

INCIDENCE OF FATAL AND NON-FATAL CO POISONING IN THE UK

Year	CO fatalities	CO injuries	CO injuries per fatality
2006-07	10	184	18.4
2007-08	13	191	14.7
2008-09	15	289	19.3
2009-10	9	292	32.4
2010-11	14	343	24.5
Average	**12.2**	**259.8**	**21.3**

Other sources, such as the Gas Safety Trust (http://www.gas-safety-trust.org.uk/report-reveals-fatalities-carbon-monoxide-poisoning-have-tripled) report higher figures than these, however the Health and Safety Executive figures are the most reliable data source in this case.

Source: Health and Safety Executive 2011,

This data was used to inform the QRA undertaken as part of this work program. An estimate of the injuries from CO poisoning by gas appliances in Australia is summarised in the table below. Further information on the estimation of the number of CO injuries per year is provided in the QRA. The QRA estimated the number of injuries via a top-down and bottom-up approach. In this RIS, the top down figure is used, unless specified otherwise.

Table 2.5

RISK OF CO POISONING IN AUSTRALIA

Injury	Estimated risk
Deaths per year	1.00
Injuries per year	21.30
Deaths per million exposed population	0.07
Injuries per million exposed population	1.55

Source: The Allen Consulting Group QRA table 3.2.

2.5 Problem to be addressed

The RIS is focussed on reducing the risk posed by CO poisoning from gas appliances in the community.[6]

A range of appliance and installation standards support the safe operation of gas appliances in the community. The effectiveness of these measures is reflected in the low rate of deaths and injuries associated with the use of gas appliances. For a number of reasons however, these measures may not be adequate. In many cases consumers do not realise that they are at risk of CO poisoning and, given that it is an odourless and colourless gas, consumers often fail to realise they are being exposed to the potentially dangerous gas.

A number of problems have been identified that can potentially increase the risks of CO poisoning. These issues are summarised in Table 2.6 and further discussed below. It should be noted, that although these problem sources are likely to be relevant to a number of consumer groups, some groups may be inherently more susceptible to the consequences of CO poisoning than others. For example, consumers who own certain appliances, belong to certain age brackets, or undertaking renovations, might all face higher risks of CO poisoning than their counterparts.

[6] The problem to be addressed in this RIS is similar to other "safety" RISs such as the RIS on Moveable Outdoor Soccer Goals (ACCC 2009), Consumer Product Safety Standard for Bicycle Helmets (ACCC 2009), Consumer Product Safety Standards for Basketball Rings and Backboards (ACCC 2005) and the Regulation of Treadmills (ACCC 2008)

Table 2.6

ISSUES INCREASING RISK, EXISTING REGULATIONS AND IDENTIFIED PROBLEMS

Issue	Existing regulations	Problem
Lack of awareness of the risks of CO poisoning amongst consumers	None	Consumers are unaware of the risks of CO poisoning and they ways by which they can reduce this risk
Portable gas appliance use in recreational vehicles	Australian Standards	People are more likely to use appliances designed for outdoor use Small spaces associated with RVs results in the rapid increase in CO concentration in the cases of faulty appliances
Improved energy efficiency in residential buildings	Building Code of Australia. Australian Standards	Minor renovations and alterations (such as the installation of an exhaust fan or improved weather sealing) can potentially result in conditions that are not safe for the operation of gas appliances
Inadequate maintenance of gas appliances	Recommendations from appliance manufactures and regulators	A lack of regular maintenance results in the development of problems leading to increased CO release that would otherwise be prevented
Lack of awareness of the risks of CO poisoning across tradespeople	Building Code of Australia. Australian Standards	Other tradespeople may undertake changes to a building that can negatively affect the operation of a gas appliance. This can include an electrician installing an exhaust fan or improvements being made to the weather sealing of a house

Source: The Allen Consulting Group.

Consumer awareness

Consumers are often not aware of the risks of CO poisoning from domestic gas appliances. Consequently consumers are unable to identify factors that are leading to the increased risk of poisoning, including the use of powerful exhaust fans such as rangehoods and bathroom exhaust systems without adequate ventilation, incomplete combustion by the burner and inadequate air supply for the operation of gas appliances.

Once CO has been produced and spilt into the internal environment, consumers are unable to detect the presence of CO as it is undetectable by sight or smell. In such situations consumers are unaware of the need to act to vent CO from the internal environment and stop CO production by the offending appliance.

State and Territory gas regulators currently run a number of awareness campaigns that include increasing the awareness of CO poisoning[7]. These campaigns focus primarily on the role of regular appliance maintenance to identify situations where gas appliances are not working correctly. The effectiveness of these campaigns has not been evaluated in most States and Territories, however data from South Australia indicates that only 29 per cent of consumers have their appliances serviced as frequently as the commonly recommended servicing schedule of once every two years, with over a third of consumers never servicing their appliances.

No consumer awareness campaigns have adequately addressed the risks of adverse flow and the importance of adequate ventilation for the safe operation of gas appliances. These were identified in the QRA as the major source of risk of CO poisoning in the community. Furthermore, little awareness information addresses the potential for powerful exhaust fans and improved building sealing on the operation of gas appliances. These issues have been identified as leading to an increasing risk of CO poising from gas appliances in the community. The lack of consumer awareness of these issues is increasing the risk of CO poisoning in the community.

Gas appliance use in recreational vehicles

Recreational vehicles (RVs) containing gas or other fuel burning appliances are a potential source of CO poisoning risk in the community. RVs pose an increased risk of CO poisoning. This is due to both poor maintenance and installation of gas appliances combined with the small area within RVs which gas appliances operate. As a result, faulty appliances can rapidly increase the CO concentration in RVs to potentially dangerous levels. Gas is commonly used in RVs to fuel space heating, water heating, cooking and refrigeration devices.

Gas appliances in RVs pose a significant risk and the GTRC is currently reviewing the installation requirements for 3-way fridges in RVs to reduce the risk posed by these appliances.

The risk of CO poisoning in recreational vehicles (including cars and vans) is also heightened by the increased frequency of the internal use of outdoor appliances in these cases. Outdoor appliances are not designed to meet the same standards as indoor appliances, and their use indoors is considered as inappropriate misuse. It is generally the result of ignorance. This led to the deaths of two men in separate incidents in vehicles in Queensland in 2007 and 2009.

[7] These awareness campaigns include Energy Safe Victoria's *Beware of carbon monoxide – it's a silent killer* campaign (http://www.esv.vic.gov.au/About-ESV/Campaigns/Beware-carbon-monoxide), South Australia's *Importance of ventilation for indoor gas appliances* campaign (http://www.sa.gov.au/subject/Water%2C+energy+and+environment/Energy/Electricity+and+gas+safety/Gas+safety/Using+gas+safely+and+maintaining+gas+appliances/Importance+of+ventilation+for+indoor+gas+appliances), amd Western Australia's *Safe use of gas* campaign (http://www.commerce.wa.gov.au/energysafety/Content/Consumers/Safe_use_of_gas/index.htm)

Improved energy efficiency in residential buildings

This issue is being addressed in response to increasing risk in the community. Houses are increasingly being retrofitted to improve energy efficiency by reducing the rate at which air is exchanged between the inside of a house and the outside environment. This air exchange results in the transfer of heat, requiring increased energy use to maintain temperatures within a dwelling. As a result, houses are increasingly being fitted with better sealing around windows and doors to reduce the rate of air exchange between the inside and outside environments.

Improved house sealing can produce problems on two accounts. Firstly, the reduction in the frequency of air exchanging between the internal and external environments can result in a lack of air being available for complete combustion in cases where appliances, such as natural draught space heaters, draw air for combustion from the internal environment. Prolonged operation of these appliances in confined spaces with insufficient ventilation can reduce the level of air for combustion. As oxygen is consumed for combustion, well-sealed houses may develop a situation where the combustion efficiency of the burner is compromised, resulting in the production of CO.

Secondly, increasing the air tightness of houses is often associated with the installation of extraction fans in bathrooms and other areas to remove moisture-rich air. Combining the use of powerful extraction fans with increased weather sealing can produce a negative pressure gradient between the internal and external environments. When this pressure gradient develops air will travel from the higher-pressure external environment into the lower pressure environment inside the house. When this situation develops often air is drawn into the house through the flue of a natural draught open flued gas appliance. When this occurs the airflow of the flue is reversed, resulting in the spillage of combustion products into the internal environment. This is called adverse flow.[8]

Inadequate maintenance of gas appliances

As a general rule, most state based Gas Technical Regulators recommend gas appliances to be serviced at least once every two years. Most gas users, however, do not get their appliances serviced this frequently, with a proportion of gas consumers responding that they never get their appliance serviced (McGregor Tan, 2011).

Regular appliance servicing reduces the risk of CO poisoning by allowing a licensed gasfitter the opportunity to undertake a visual inspection of the gas appliances to check for faulty burner operation, flue blockage and other potential hazards.

[8] For further information on adverse flow see the Gas Technical Regulators Committee (2011) *Gas Appliance (Carbon Monoxide) Safety Strategy*.

Lack of awareness of the risks of CO poisoning across tradespeople

The safe and effective operation of gas appliances relies on a number of building conditions being maintained. Adequate ventilation, unobstructed chimneys with protected openings, and the maintenance of at least equal pressure between the inside of a building and outside environment are all requirements for the proper operation of gas appliances that can potentially be altered by work undertaken by other tradespeople. In some situations the work of tradespeople and do-it-yourself renovators can hinder the safe operation of domestic gas appliances, for example, installing an extraction fan in a bathroom or toilet in a dwelling that contains a natural draught open flued space heater.

2.6 Existing regulations and current policy

Gas regulations in Australia vary across jurisdictions. The common gas regulations in Australia are outlined below, as well as differences across jurisdictions.

In Australia

Gas regulators mandate that gas appliances be installed by an appropriately licensed gasfitter. Requiring that only properly trained individuals undertake work to install gas appliances:

- reduces the risk of a faulty connection between an appliance and its flue, which can potentially lead to the spillage of combustion gases internally;
- limits potentially hazardous situations;
- covers issues regarding insufficient ventilation and the development of negative pressure situations that will potentially increase risk as the thermal efficiency of newly built and renovated houses improve.

Training, however, will only address these issues at the time of installation of the gas appliance and will provide no protection for adverse flow arising from the installation of extraction fans or increased weather sealing that occurs after the installation of a gas appliance. Other tradespeople involved in building construction and do-it-yourself renovators are often uninformed about the influence that powerful extraction fans and improved building sealing can have on the safe operation of gas appliances.

Some states have specific legislative requirements for gas appliances including, in some cases, limiting the types of rooms and buildings in which flueless heaters may be installed. The current regulatory framework is summarised in Table 2.7 below.

Jurisdictions also require that installed appliances be certified under the appropriate Australian Standards. The Building Code of Australia Housing Provisions Part 3.12.3 (b) (ii) makes allowances for gas appliances, excluding “a permanent building ventilation opening that is necessary for the safe operation of a gas appliance” for consideration of a building meeting minimum energy efficiency standards.

The Building Code of Australia has no jurisdiction over minor modifications, meaning that small retrofit projects may not be protected by its requirements.

Table 2.7

GAS APPLIANCE REGULATIONS BY STATE

State	Regulation	Summary
NSW	Gas Supply (Consumer Safety) Regulation 2004	Only certified gas appliances to be installed. All installations to be done by a qualified gasfitter according to AS 5601.
Vic	Gas Safety (Gas Installation) Regulations 2008	Gasfitting work must comply with AS 5601. A person cannot install a flueless space heater or a connection device for a flueless space heater as a new installation in residential premises (including caravans and boats). However a person can replace an existing LPG flueless space heater with a new LPG flueless space heater provided it meets specific NOx and CO/CO_2 emission requirements. Flueless heaters cannot be installed in hospitals and other health centres, educational institutions or childcare centres.
Qld	*Petroleum and Gas (Production and Safety) Act 2004* and Petroleum and Gas (Production and Safety) Regulation 2004	All gas appliances must be approved and certified by an approving authority approved by the Chief Inspector. A person must not carry out gas work on gas appliances unless the person holds a license to carry out the work The principal safety requirement for gas installation work is AS/NZS5601. Regulations relating to the quality of gas, specifications and testing of meters, and construction of mains. Gas installations in premises, caravans and vessels must be certified.
SA	Gas Regulations 1997	Gasfitting work must comply with AS/NZS 5601 and be undertaken by a licensed gas fitter. The regulations also have provisions about gas supply, residential energy efficiency, price regulation and gas quality.
WA	Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999	Gas appliances must be installed by a gasfitter with a current gasfitting licence applicable to the appliance in question. Appliance must be flued if installed in bedroom or any type of bathroom, unless the room has a volume greater than 30 m^3 and has 2 ventilation openings (satisfying specific requirements) and the installation is approved by an inspector. A gas space heating appliance that is not fitted with a flue must not be installed in a private dwelling unless the appliance is fitted with an approved oxygen depletion sensing system. Flueless space heaters cannot be installed in schools or childcare centres in any location where children may be exposed to combustion products for anything longer than short periods of time. In marine craft a gas appliance cannot be installed in an unventilated space or a space that contains explosive or highly combustible materials. If natural ventilation is insufficient, it must be augmented by mechanical means. Gas water heaters may only be installed in the galley and must be approved by an inspector.
TAS	Gas (Safety) Regulations 2002	Gasfitting must comply with AS/NZS 5601. Provisions about gas quality. Gas plant safety plans and management. Gas appliances must be installed by a licensed gasfitter. The gasfitter must demonstrate correct operation of the appliance to the consumer after installation. A certificate of compliance may be needed for some complex installations.
NT	N/A	
ACT	Gas Safety Regulation 2001	Gasfitting work must be carried out by licensed gasfitters. Only certified appliances to be used.

Source: State and Territory legislation, Allen Consulting Group analysis.

International regulations

Examples of gas appliance and CO related legislation from the United States and United Kingdom are provided below.

United States

Around 34 US States have regulations requiring the use of CO alarms in certain settings. In some States (e.g. Oklahoma, Texas) the use of CO alarms is only mandatory in childcare centres; in other States (e.g. Washington, Arkansas) the rule applies only to new dwellings; and in others (e.g. Alaska, Colorado) it applies to both new and existing dwellings.

Some states limit the requirement to dwellings of a certain size (e.g. dwellings of three stories or less in Georgia, single- and two-family homes in New Jersey). Most regulations specify a location where the CO alarm must be installed (e.g. within 10 feet of any sleeping area in Minnesota, at the fuel burning appliance in Michigan), although some are silent on the exact location (e.g. Montana). Overall the majority of States require CO alarms to be installed in the vicinity of bedrooms[9].

United Kingdom

In the UK the *Gas Safety (Installation and Use) Regulations 1998* specify that a gas appliance may not be installed in a bath or shower room unless it is a room sealed appliance. Also, gas appliances of more than 14 kW gross heat input may not be installed in bedrooms unless it is a room sealed appliance. Any new gas appliance installations must be tested to ensure the connections are gas tight.

Landlords are obliged to maintain gas appliances and flues in safe condition. This includes performing safety checks within 12 month of the appliance being installed, with safety checks at least every 12 months thereafter. Records of safety checks must be kept for a period of two years.

The UK also has regulations in place that outline minimum ventilation requirements to accompany the use of gas appliances. These requirements are outlined in Table 2.8 below. This table is provided “For Information Only”, because the ventilation requirements are considered insufficient to overcome adverse flow resulting from extraction fans and rangehoods.

[9] http://www.systemsensor.com/co/pdf/State-CO-Code-Summation.pdf

Table 2.8

UK REQUIREMENTS FOR PERMANENTLY OPEN AIR VENTS

Flueless appliance type	Maximum appliance rated heat input	Volume of room, space or internal space (m^3)	Free area of permanently open air vent (mm^2)
Cooker, oven hotplate or grill or combination thereof	Not applicable	<5 5 to 10 >10	10 000 5 000 No permanently open vent needed
Instantaneous water heater	11kW (net)	5 to 10 10 to 20 >20	10 000 5 000 No permanently open vent needed
Space heater not in an internal space	0.045kW (net) per m^3 volume of room	All cases	10 000 PLUS 5 500 per kW input (net) in excess of 2.7kW (net)
Space heater in an internal space	0.090kW (net) per m^3 volume of internal space	All cases	10 000 PLUS 2 750 per kW input (net) in excess of 5.4kW (net)

Source: The Building Regulations 2010, Approved Document J, p47

2.7 A case for intervention

Consumers with gas appliances face inherent risks that are the result of a number of injuries and fatalities each year. These are present despite existing regulations and do not appear to be the consequence of any particular market or regulatory failure.

Moreover, the risk of CO poisoning in households is likely to rise due to a number of factors including:

- improvements to sealing of houses, particularly in retrofitted houses;
- the installation of powerful exhaust fans in bathrooms;
- increasing gas consumption rate of some gas appliances; and
- higher energy efficiency of gas space heating appliances resulting in lower flue temperatures and less flue pull.

Public awareness campaigns to date have focussed on broad campaigns to encourage gas users to have their appliances installed and regularly serviced by licensed gas fitters. Awareness campaigns have not addressed the effect that powerful exhaust fans and improvements to dwelling sealing can have on the risks of CO poisoning.

It should be noted that the risks of harm are not unique to gas appliances. Certainly many products across the economy — including electrical appliances, toys, sporting equipment, foods, tools and hardware, automobiles and many other manufactured goods — will not only be subject to inherent risks of harm, but are likely to have more risks associated than gas appliances.

Nonetheless, it has been established the risks of CO poisoning are real and that a case for cost effective intervention exists in order to reduce associated harms.

Chapter 3

Objective of government action

Prior to assessing options to address the identified problems, it is important to establish the objectives of government action. The objective should be sufficiently broad to allow consideration of a range of alternative solutions.

The objective of this intervention is to reduce the risks associated with CO poisoning from gas appliance use in a cost-effective manner.

Chapter 4

Options to achieve Government objective

As part of the RIS process, it is necessary to develop, describe and consider the different options that can be used to achieve the government objective stated in the previous chapter. COAG RIS guidelines require that the options considered represent the spectrum of regulatory approaches — including explicit regulation, co-regulation and non-regulatory approaches. In addition, these guidelines require that the RIS specify the option that is most preferred out of the options considered.

The QRA conducted in the development of this RIS considered the effectiveness of a number of potential strategies to mitigate the risks of CO poisoning. The strategies included a range of options to address risks associated with appliances, installation and operation. Table 4.1 provides a summary of each risk mitigation strategy included in the QRA and Box 1.1 provides a summary of the QRA.

Importantly, the QRA identified that some appliances were inherently riskier than others. Natural draught open flued space heaters were found to have more associated risk than any other appliances. Natural draught open flued heaters are exposed to most risk factors along with open flued internal water heaters. Further the population exposed to these risks, 4.5 million persons, makes up about a third of all gas customers in the country. The risk of CO poisoning from this appliance was estimated at about 4.9 injuries per year per million persons and accounts for 98 per cent of the risk of all CO poisonings in the country.

The main sources of risk in the households that have natural draught space heaters are from insufficient air for combustion and adverse flow. These are the dominant risk factors for combustion disruption and spillage respectively. Generally speaking, the most effective mitigation strategies addressed these risk factors.

It is recognised that a wide range of options could be employed to address the risks of CO poisoning. The QRA was partly undertaken to identify the level of risk in the community and those strategies which would be most effective at mitigating this risk (see Table 4.1).

Given the findings of the QRA, some options have been deliberately excluded from this analysis and dismissed as infeasible. Options excluded from the RIS have been identified in the table.

Table 4.1

SUMMARY OF RISK MITIGATION STRATEGIES CONSIDERED IN THE QRA

Nature of risk	Risk mitigation strategy	Description	Per cent reduction in overall risk	Considered in this RIS
Appliance	CO alarms (rental)	Mandatory installation of CO alarms in rental properties.	3.02	Yes (sensitivity analysis)
Appliance	CO alarms (all)	Mandatory installation of CO alarms in all residential properties.	11.31	Yes (Option 3)
Installation	Improved training	Improving training requirements for tradespeople, educating the public about using licensed gas fitters.	0.01	No — impact too small
Installation	Ventilation for appliance operation	Ensure adequate adventitious air or install permanent ventilation openings.	45.72	Yes (Option 4)
Installation	Ventilation for removal of products of combustion (flueless)	Mandate the installation of permanent ventilation openings for flueless heaters.	0.00	No — impact too small
Installation	Ventilation design	Design housing ventilation to ensure that negative pressures do not develop*.	47.71	Yes (Option 4)
Installation	Room sealed appliances (phase out natural draught appliances)	Mandate use of room sealed appliances in new installations.	50 after 10 years	Yes (Option 5, amended)
Installation	Timers inserted into exhaust fans	Retrofitting timers to all exhaust fans to limit the time they can be in continuous use, thus decreasing the possibility for extended periods of negative pressure.	9.54	Yes (Option 5, amended)
Operation	Public awareness	Raise public awareness of CO hazards, importance of maintenance.	2.43	Yes (Option 2)
Operation	Appliance maintenance	Mandatory maintenance of appliances every two years in rental properties.	0.01	No — impact too small
Operation	Appliance maintenance	Mandatory maintenance of appliances every two years in all residential properties.	2.44	No — impact too small

* For the proper operation of extraction systems in 5 or 6-star buildings, this will require adequate design to ensure the star rating is achieved. This may involve motorised dampers and/or push-pull systems. AS 1668 would require amendments to achieve these performance standards.
Source: The Allen Consulting Group, based on Tables 4.1 and 5.3 of the QRA.

The options presented and discussed in this chapter reflect the findings of the QRA and the requirements of the COAG RIS guidelines. They have been developed in consultation with the Department and the GTRC and include:

- Option 1 — the status quo (the baseline case);
- Option 2 — public awareness campaign (the non-mandatory option);
- Option 3 — mandatory installation of CO alarms in all residences with gas appliances;
- Option 4 — proposed changes to ventilation requirements; and
- Option 5 — engineering improvements to natural draught appliances.

The options are outlined in the following table and are discussed in greater detail below.

Table 4.2

OUTLINE OF OPTIONS

Option	About	How the option addresses the problem	Applies to
1. Status quo	Business as usual	Allows problem to continue	na
2. Consumer education and public awareness	A targeted campaign to raise awareness of the risk of CO poisoning and options to self-mitigate	Fills information gaps that exist relating to gas appliance in households and RVs and across the trades	Households and RVs with installed gas appliances Can also apply to use of portable appliances in vehicles/confined spaces
3. CO alarms	Requires alarms to be fitted in all households with gas appliances at the time of sale or lease and in RVs at the time of registration	Alerts consumers in the event of CO spillage	Households and RVs with gas appliances
4a. Permanent ventilation *	Requires households to ensure permanent ventilation requirements are satisfied at the time of sale or lease	Prevents harmful impacts related to insufficient air for appropriate appliance operation such as incomplete combustion and adverse flow	Households with natural draught open flued space heaters and indoor water heaters and flueless heaters (not RVs)
4b. Mechanical ventilation mechanisms *	Requires households to install mechanical ventilation systems prior to sale or lease of a household	Prevents harmful impacts related to adverse flow	Households with natural draught open flued space heaters and indoor water heaters (does not impact flueless heaters)
5. Future improvements to natural draught open flued appliances	Requires engineering improvements to natural draught open flued space heaters and water heaters	Prevents against CO spillage	Households with natural draught open flued space heaters and indoor water heaters

* Adequate ventilation for gas appliances is also required to reduce the build up of other pollutants from gas appliances such as Radon emissions, NOx and vapour emissions.

Source: The Allen Consulting Group in consultation with the Department and the GTRC.

4.1 Status quo (the baseline case)

Cost-benefit analysis seeks to estimate the incremental or induced impacts to stakeholders that can be directly attributed to the proposed options. In order to do so, it is necessary to have some idea of what would have happened if none of these options were exercised — effectively, if the current policy approach were maintained.

This status quo option is used to assess the benefits of any proposed regulatory or non-regulatory interventions. For each option, the status quo acts as a benchmark against which benefits attributable to the new regulation can be assessed. This base case allows decision makers to assess whether the costs associated with the proposed regulatory options are outweighed by the benefits of these options when compared to continuing the 'business as usual' approach.

In this assessment, the status quo includes not only a continuation of what happens now, but also future trends (that is, projected change) that can reasonably be expected to have an impact on the problems identified in Chapter 2. Future trends in the churn of house sales ad rental properties were considered when modelling these options. The modelling reflects current government policies, existing regulation and standards and trends within the market.

4.2 Non-regulatory option — Consumer education and public awareness

Option 2 is a non-regulatory option. It aims to improve the safety of gas appliances by increasing the level of awareness of the signs and dangers of CO poisoning in the community. This would complement the existing public awareness measures by identifying and improving the awareness of those at high risk of CO poisoning.

It aims to improve the safety of gas appliances (including portable appliances) in households and RVs by increasing the level of awareness of the signs and dangers of CO poisoning in the community. Consumers would be educated on how they can mitigate their exposure to CO poisoning through:

- appliance choice and proper use;
- the importance of regular servicing by a suitably qualified practitioner and adequate ventilation; and
- available instruments, including:
  - CO alarms;
  - exhaust fan timers;
  - oxygen depletion switches; and
  - other available technologies.

To be effective the awareness campaign will need to be carefully targeted towards those consumer groups most at risk of a CO poisoning event. High-risk groups could be targeted through the information campaign to ensure the most effective results. The campaign could identify the more susceptible population such as young children, the elderly, and those with heart conditions. Owners of natural draught space heaters could be targeted, as could gas appliance use in enclosed spaces such as RVs.

Further work will be necessary to identify the high risk groups across Australia, which vary depending on the types of gas appliances used in each region. Further work will consider the gas appliance types most used in each state and territory, and the existing public awareness measures in place. This will allow identification of the high risk groups and appliances, gaps in existing measures and priorities to ensure additional public awareness campaigns add the most value.

Cost constraints may also limit what is feasible. Appropriate information campaigns could include:

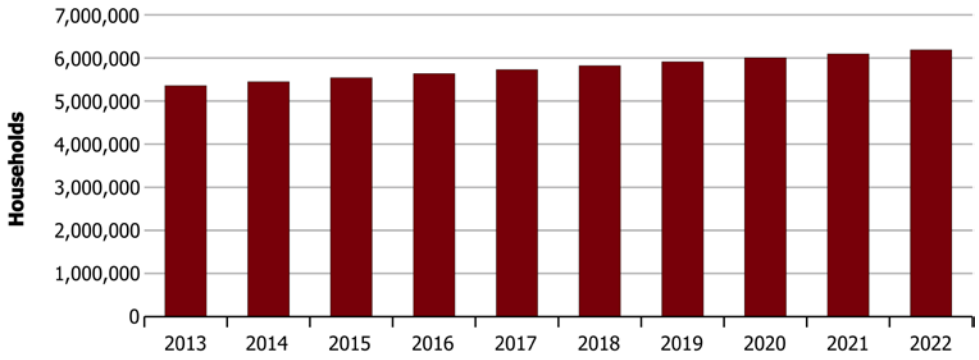
- undertaking a marketing campaign in cooperation with gas retailers and other industry groups to raise awareness of the potential dangers of CO poisoning and how to mitigate any risks;
- servicing schedule stickers on gas appliances advising of the date the next scheduled appliance service is due, or stickers which outline the signs and symptoms of faulty gas equipment and remind the owner to have some ventilation while the appliance is operating;
- working with industry and community groups to develop and display appropriate warnings on high risk appliances such as portable gas appliances and 3-way fridges; or
- educating DIY renovators and tradespeople to consider the conditions necessary for safe operation of gas appliances and the potential for CO poisoning when they are sealing houses or installing exhaust fans. This would need to highlight the need for adequate ventilation to provide sufficient air for combustion for the safe operation of gas appliances and to prevent negative pressure situations arising from the use of powerful extraction fans. There are also important considerations for the proper installation of CO alarms.

The campaign should also explicitly target inappropriate use of portable appliances as this can be effectively undertaken with any campaign on installed appliances. In this case it will be necessary to work closely with the leisure industry and general community groups, along with appropriate marketing to members of the public interested in caravans, camping and recreation.

For this RIS, it is assumed that all households with a gas appliance will be impacted by this option (Figure 4.1). (The proportion of households that act upon this information is treated separately and is accounted for in the option's effectiveness.)

Figure 4.1

ESTIMATED NUMBER OF HOUSEHOLDS AFFECTED BY OPTION 2



Source: The Allen Consulting Group.

This option will also have an impact on RVs that use gas appliances. Similar to households, all RV owners will be impacted by this option. And again, the response to this campaign is accounted for in the analysis of the option's effectiveness.

4.3 Regulatory options

Three regulatory options have been considered for this RIS:

- The mandatory installation of CO alarms in all residences with gas appliances.
- Changes to ventilation requirements to ensure the safe operation of gas appliances.
- Changes to natural draught open flued appliances.

Property owners will be required to comply with the regulatory options prior to the sale or rental of their property. Owners of RVs will be required to comply at the time of registration (Option 3 only). This is deemed to be the most cost-effective option as opposed to mandating all households/RVs to comply with the regulation from a set date, which will involve significantly higher compliance, monitoring and administration costs.

Box 4.1 provides a detailed overview of the approach to calculating the number of households that will be impacted by the regulation, as well as assumptions about the proportion of exposed households and property 'churn rates'. It is estimated that the number of gas-connected households will grow from 5.4 million in 2013 to 6.3 million by 2023. The number of households with higher risk appliances (natural draught open flued space heaters and flueless heaters) will increase in proportion from nearly 2 million in 2013 to 2.3 million in 2022. This is shown in Figure 4.2.

Box 4.1

CALCULATING THE NUMBER OF GAS-CONNECTED HOUSEHOLDS THAT WILL BENEFIT FROM THE REGULATORY OPTIONS

In order to estimate the benefits to gas-connected households of complying with the regulatory options, it is necessary to first calculate the number of exposed households that will actually comply with the regulation. This is determined by the mechanism which implements the policy. Here, property owners are required to comply with the regulation at the time of lease or sale.

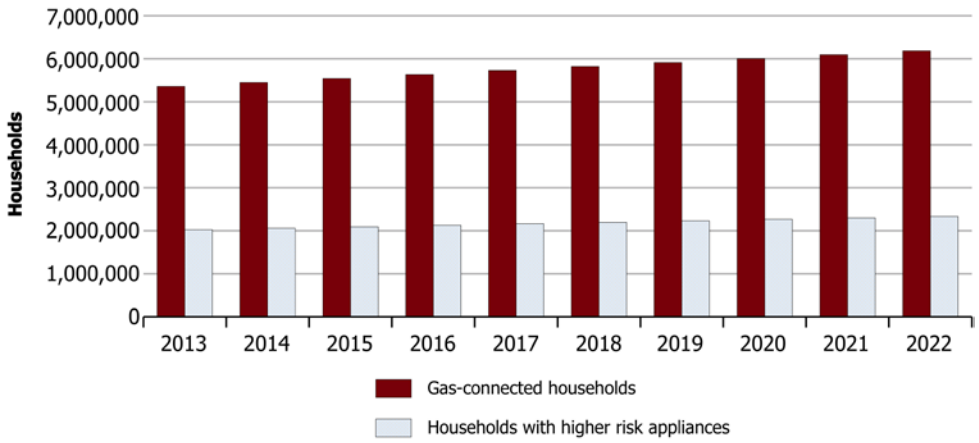
The general approach to calculating the rate of uptake by gas-connected households is described below.

- ***Identify the proportion of impacted households*** — these are the households deemed to be at risk of CO poisoning, i.e. exposed to the risk. Option 2 and Option 3 will impact on all households with gas connections. This was determined by the ABS to be 60.9 per cent of all households. Option 4, conversely, will only impact on households with specific risky appliances. This was estimated to be 23 per cent in the QRA.
- Assuming a constant proportion of gas-connected households, the number of exposed households can be extrapolated into the future using data on household projections.
- ***For options 3, 4a and 4b, identify the rate at which properties are leased and sold (the churn rate***) — the property churn rate determines the rate of uptake of the regulations by households. It follows that the higher the churn rate (i.e. the more houses are transacted on the marketplace), the higher the rate of uptake. For this RIS, a churn rate of 11.0 per cent has been assumed, with the rate reducing in subsequent years. A decreasing churn rate has been assumed to avoid double-counting households that have already adopted the regulation but are transacted on the marketplace.
- ***Calculate the number of households at risk, which have adopted the regulation*** — this can be obtained by multiplying the proportion of gas-connected households and the churn rate. The intuition behind this is that a proportion of gas-connected households get leased or sold each year, and therefore are required to install CO alarms or update their ventilation systems.
- Once the number of gas-connected households who have adopted the regulation is determined, the cumulative number of households who have adopted the option can be calculated for the life of the policy. The duration of the policy is assumed to be ten years.

Source: Allen Consulting Group.

Figure 4.2

HOUSEHOLDS WITH GAS CONNECTIONS AND HIGHER RISK APPLIANCES



Source: Allen Consulting Group

The sections below, in addition to describing each regulatory option, provide an overview of the cumulative number of gas-connected households that have adopted the regulation. The cumulative households are crucial in determining the benefits that are accrued to the community from complying with the regulation.

Option 3 — Mandatory installation of CO alarms

Option 3 would require the installation of battery powered CO alarms in bedrooms and in rooms with gas appliances in residential buildings, as well as in recreational vehicles that contain gas appliances.[10] The installation of CO alarms may reduce the risk of CO poisoning associated with appliance failure, although they will not prevent the appliance failure itself.[11]

The GTRC examined the use of CO alarms in the *Gas Appliance (Carbon Monoxide) Safety Strategy*. The strategy examined the installation of alarms that were hard wired into the electricity supply of a home, and in an option also connected to the gas supply. These controls are in excess of the central option explored in this RIS, however modelling exploring variations on this central case is touched upon in Section 6.2.

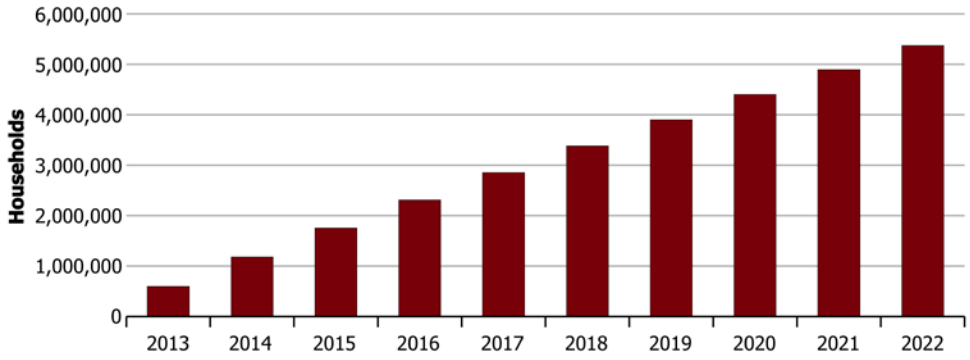
[10] This option corresponds to requirements d) and e) of the terms of reference for the GTRC's *Gas appliances (CO) safety strategy*.

[11] Questions still remain over the efficacy of CO alarms. Ryan and Arnold (2011) recently found that half of the CO alarms tested either alarmed before CO concentrations had reached dangerous levels, or failed to alarm at potentially dangerous concentrations of CO. Further, most CO alarms installed would be expected to be run on battery power. A NSW survey of smoke alarm use indicated that 9.5 per cent of households tested their smoke alarm less than once a year, with this trend expected to be replicated in CO alarms. CO alarms also require proper installation procedures to be followed to ensure correct functioning. Many of these issues were discussed in the QRA.

The overall effectiveness would be determined by the rate of turnover in the housing and rental market. It is estimated here that around 600 thousand exposed households will have working CO alarms installed at the start of the policy year in 2013. This makes up 11 per cent of all gas-connected households, and it is based on the property churn rate. By 2022, the number of households with working CO alarms is predicted to be 5.4 million — approximately 90 per cent of all gas connected households (see figure below).

Figure 4.3

ESTIMATED NUMBER OF HOUSEHOLDS AFFECTED BY OPTION 3



Source: Allen Consulting Group Analysis using ABS data.

RVs will be required to install a CO alarm at the time of registration. As this is an annual requirement, the adoption rate for RVs will be much faster than for households.

It should be noted that CO alarms are expected to have a life span of 5 years, with households assuming to replace expired alarms as long as it has expired within the policy period.

Option 4 — Changes to ventilation design of extraction systems

Gas appliances require adequate sources of air for combustion. The absence of sufficient air for combustion results in vitiation and the production of CO. The effect of exhaust fans on the room air pressure is currently not considered in residential premises. In combination with the increasing air tightness of dwellings to maintain higher energy efficiency ratings, the potential for adverse flow from the use of exhaust fans is exacerbated.

Negative pressure and inadequate extraction are both alleviated by better ventilation design and installation. This option considers two alternatives that will provide for appropriate ventilation design of extraction systems and to allow for correct appliance operation. These being:

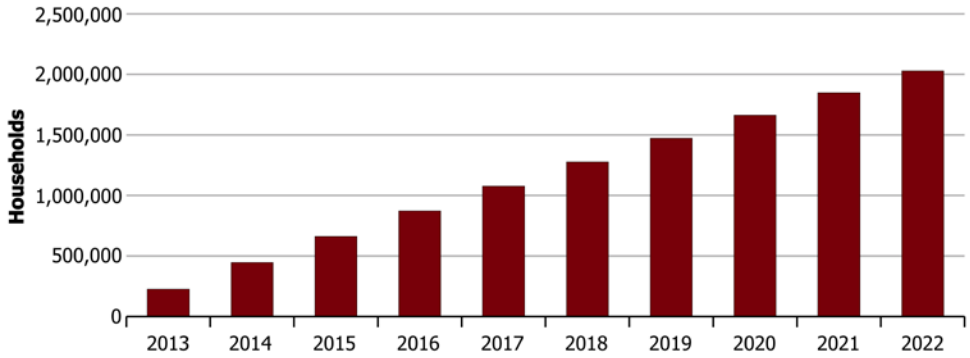
- Option 4a — permanent ventilation to provide adequate air for proper combustion by gas appliances; and
- Option 4b — mechanical ventilation mechanisms linked to extraction systems.

Implementing this option will require property owners to adopt required ventilation standards prior to selling or leasing their home. It is important to note that only properties with flueless heaters and natural draft open flued space heaters will be impacted by this option. The proportion of households affected by this option is 23 per cent of all total households (see Table 2.1).

At the start of the policy it is estimated that around 225 thousand households will have upgraded ventilation systems. By the end of the policy in 2022, the number of households that have upgraded ventilation systems will reach 2 million — about 87 per cent of households with this type of appliance. This is illustrated in Figure 4.4.

Figure 4.4

ESTIMATED NUMBER OF HOUSEHOLDS AFFECTED BY OPTION 4



Source: Allen Consulting Group analysis using ABS data.

It is not expected that the risk of CO poisoning in RVs will be impacted by either permutation of this option.

It should be noted that an asset life span of 20 years have been assumed for appliances and building fabric.

Option 4a — Permanent ventilation

This strategy requires adequate adventitious air or, alternatively, ventilation openings to allow for proper combustion by gas appliances.

WA and SA already require permanent ventilation openings for flueless heaters. This option would see all states and territories adopt these standards.

Option 4b — Mechanical ventilation mechanisms

Alternatively, this sub-option would require that all gas-connected households install mechanical ventilation mechanisms to extraction systems. Mechanical ventilation mechanisms might include push-pull ventilation or motorised openings linked to extraction fans.

Option 5 —Future improvements in the control systems of natural draught open flued space heaters

Future improvements to natural draught open flued appliances would either eliminate or greatly reduce the risk of a number of CO poisoning risk factors. This option requires significant improvements in the control systems of natural draught open flued space heaters and should provide a level of safety that is comparable to that of room sealed appliances.

This option will look to appliance makers to develop and implement improvements to natural draught appliances to eliminate the risk of adverse flow. Such improvements include the use of temperature sensors in the flue to detect changes in temperature indicative of a reversal of flow, with gas supply to the appliance being shut off when adverse flow is detected.

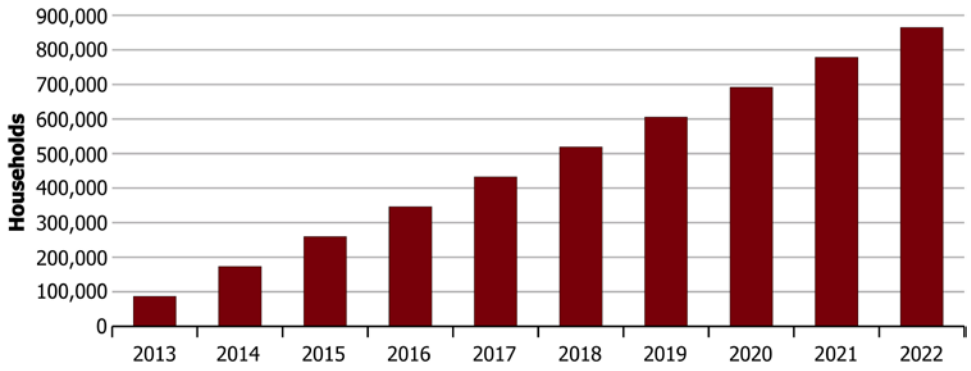
This strategy will gradually reduce the overall risk as higher risk natural draught open flued appliances are phased out over time. The number of households that will be affected by this option is affected by the rate at which the appliance is replaced. It has been assumed that around 5 per cent of natural draught open flued appliances will be replaced each year with appliances that have improvements in its design. Appliances are assumed to have a 20-year asset life and the proportion of natural draught open flued appliances is expected to remain the same throughout the policy period.

The estimated number of households expected to be affected by this option is illustrated in Figure 4.5.

As with Option 4, it is not expected that the risk of CO poisoning in RVs will be impacted by this option.

Figure 4.5

ESTIMATED NUMBER OF HOUSEHOLDS AFFECTED BY OPTION 5



Source: The Allen Consulting Group.

Chapter 5

Impact analysis

This chapter assesses the costs and benefits of the options set out in Chapter 4, compared with the 'base case' option of no change to the current approach. Importantly, the analysis considers only the *incremental* impacts an option has on the base case.

The costs of the options considered are evaluated over a 10 year period. The nature of the options however, is such that benefits are 'locked in' for several years thereafter. Benefits are assumed to accumulate for the life of an asset affected while the policy is in place.

The base case, direct costs and benefits, indirect benefits and other impacts are outlined below.

5.1 The status quo

The status quo provides a base case description of what is likely to happen in the absence of any further policy intervention from governments. The costs and benefits of the options described in Chapter 4 are estimated as the difference between the costs (or benefits) already being incurred in the base case, and the *additional* cost (or benefit) that can be attributed to the option being considered.

To establish this base case, it is necessary to develop a scenario of the 'status quo' for the period being considered.

The base case is characterised by the following assumptions:

- the market penetration of gas appliances in Australian households and RVs;
- the inherent risks associated with gas appliances (as documented in the QRA);
- market trends relating to:
  - the use of different gas appliances; and
  - building design including energy efficiency requirements; and
- existing regulations and standards.

5.2 Direct benefits

All benefits considered reflect the incremental change to the business case — assuming existing regulations and policy measures remain in place.

A number of the options considered have the effect of locking in a stream of benefits to the community. Benefits are expected to accrue for the duration of an asset's expected lifetime. Specifically, the following assumptions have been made for specific options.

- Option 3 — assumes that CO alarms have an asset life of 5 years and that households will replace expired alarms during the lifetime of the policy. Up to the end of the policy's 10-year life, the benefits of households with CO alarms will therefore increase, and drop off after that as alarms begin to expire and are not replaced.
- Option 4 (including sub-options a and b) — assumes a 20-year asset life for ventilation systems. The benefits that accrue to households with upgraded ventilation systems will therefore display an upward trend until the end of the 10-year policy life. After that, benefits do not immediately reduce but continue to plateau for another 10 years. This is because households are no longer required to upgrade their ventilation systems, but ventilation systems that were installed during the policy period will continue to function. Benefits will begin to diminish 20 years after the inception of the policy, as the first batch of upgraded ventilation systems expire.
- Option 5 — assumes a 20-year asset life for natural draught gas appliances, with a constant rate of appliance replacement. This option also assumes that consumers do not move away from natural draught appliances in favour of other appliances, despite the increase in cost of these improved appliances.

Reducing the risk of CO poisoning — cost savings

In general, the direct benefits of the proposed options are gauged by their expected impact on the risk of CO poisoning. It was estimated in the QRA that gas appliances were responsible for approximately 21.3 accidental CO poisonings each year, plus one fatality.

To calculate the value of a statistical life, this analysis sought guidance from the OBRP (see Box 5.1). Following this guidance the value of a statistical life (VSL) employed here is $3.96 million.

Depending on the severity of the incident, an individual who suffers from a non-lethal CO poisoning will:

- require medical attention; and
- incur quality of life costs associated with the injury.[12]

It is estimated that the average non-lethal CO poisoning will require 2.5 days in hospital and 5 days of reduced 'life quality'. The impact on quality of life has been calculated by taking a pro rata estimate of the Value of a Statistical Life Year (VSLY), and weighting this by a the appropriate 'disability weight' for unintentional poisoning as estimated by the Australian Institute of Health and Welfare (AIHW 1999). This equates to about $278 per day.[13]

The associated costs of a CO poisoning are estimated in Table 5.1. In any given year, it is estimated that non-lethal incidents of CO poisoning incur a cost of approximately $123,567.

[12] An alternative measure might have considered lost productivity from time off work. Base on measure of average weekly earnings, this estimate would equate to a per incident cost of CO poisoning of $5748.

[13] Where the VSLY is estimated at $171 000, and the disability weight is 0.593.

Box 5.1

VALUING FATALITIES — THE VALUE OF A STATISTICAL LIFE AND STATISTICAL LIFE YEAR

The concept of the value of a statistical life (VSL) is used when there is a need to calculate the benefits of a regulation or policy. VSL is based on the willingness to pay for a reduction in the risk of physical harm, and therefore places an estimate on the financial value society places on reducing the average number of deaths by one. A related concept is the value of statistical life year, which estimates the value society places on reducing the risk of premature death, expressed in terms of saving a statistical life year.

Various methods can be used to measure society's willingness to pay to reduce the risk of death. These include surveying individuals on what they would pay to save or prolong life; observing how much consumers pay for products that reduce the risk of death or injury (e.g. safety equipment for a car); and observing how much workers are willing to pay for an improvement in workplace safety.

A review of empirical studies relevant to Australia noted that the VSL is estimated to range from $3 million to $15 million, and it was concluded that the most credible VSL estimate is $3.5 million for VSL and $151,000 for the value for statistical life year (in 2007 dollars) (Abelson 2007).

It is important to note, however, that estimates can vary according to the characteristics of the people affected and the nature of the risk or hazard. For instance, the VSL is like to be higher if it is based on younger people with longer to live and particularly painful deaths are likely to attract a higher willingness to pay to avoid.

Consistent with the advice of international regulatory agencies, the Office of Best Practice Regulation (OBPR) advises that regulation impact statements use a VSL that is derived from previous studies. In particular the Abelson (2007) estimate of VSL, which is based on recent empirical evidence and is assessed to ensure that it is comprehensive and rigorous, is recommended to be used by the OBPR.

Based on the above, the current dollar VSL used in this analysis is $3.96 million and the VSLY is $170,900.

Source: The Allen Consulting Group and the OBPR. (2007).

Table 5.1

ESTIMATING THE COSTS OF A NON-LETHAL CO POISONING

Cost	Days	Value per day ($ Jun 2011)	Total ($ Jun 2011)
Hospital stay	2.5[a]	1 785[b]	4 413
Quality of life impact	5	278[c]	1 389
Total per incident			**5 801**
Number of non-lethal incidents			21.3
Total expected costs			**123 567**

Note:
(a) based on average of days per separation from 2006-07 to 2009-10.
(b) based on cost per separation (CPI adjusted to June 2011) divided by number of days per separation calculated according to (a)
(c) based on the disability weight for poisoning and the value of a statistical life year.
Source: The Allen Consulting Group; OBPR 2007; AIHW 1999, AIHW Australian Hospital Statistics 2009-10 and AIHW Separation statistics by principal diagnosis in ICD-10-AM, Australia 2008-09 to 2009-10.

Table 5.2 reports the estimated total cost of CO poisonings. This includes the costs of lethal events as well as injuries. This calculates the total costs of CO poisonings at $4.1 million a year.

Table 5.2

ANNUAL COSTS OF CO POISONING

Item	Number	Cost per incident, $	Total cost, $
Non-lethal CO poisoning	21.3	5 748	123 567
Lethal CO poisoning	1.0	3 962 222	3 962 222
Total cost			**4 085 789**
Cost per gas-connected household (2011)	5 357 424	**na**	**0.76**

Source: The Allen Consulting Group analysis using various sources from the OBPR (2008), ABS (2011) and AIHW (2011).

A cost breakdown is also provided for each appliance type, as shown in Table 5.3. In terms of CO poisoning costs, natural draft open flued heaters are the costliest appliances to the community and accounted for approximately 99 per cent of total cost. This equates to about 75 cents per household with a natural draught appliance.

Table 5.3

COST BREAKDOWN ACCORDING TO APPLIANCE TYPE

Appliance	Estimated number of CO poisoning incidents from gas appliances per year	Total cost, $	Cost per household, $
Natural draught heater	22.1	4 044 393	0.75
Balanced flue heater	0	0	0.00
Flueless heater	0.1	10 118	0.00
Cooktops	0	0	0.00
Internal domestic hot water services	0.2	40 077	0.01
Total value	**22.3**	**4 094 588**	**0.76**

Source: The Allen Consulting Group, based on the findings of the QRA.

Calculating benefits

Estimating the benefits of the options requires using the calculations on the number of impacted households from Figure 4.1 to Figure 4.5. The number of households which have adopted the options were calculated for each option, with assumptions made on the proportion of gas-connected households, the property churn rate and the asset life of the options. The only option that did not require a property churn rate to be used was the non-regulatory (consumer education) option, since it was assumed that all gas-connected households would benefit from the option.

The per-household benefit of each option was calculated in the following way.[14]

- ***Step 1*** — calculate the proportion of gas-connected households to estimate the number of households that are exposed to the risk of CO poisoning. For the regulatory options, identify the rate at which houses are sold and leased on the property market (churn rate) to determine the rate of uptake of the regulation. Then calculate the cumulative number of exposed households that have implemented the option for each year. The calculations for this step are shown in Figure 4.1 to Figure 4.5 from the previous chapter.
- ***Step 2 —*** identify the cost savings per household, as determined by calculating the reduction in cost of CO poisoning per household (i.e. benefit per household). Each option reduces the risk of CO poisoning to a different degree, hence each option produces benefits to a different extent. The percentage reduction in cost for each option has been determined in the QRA, and reproduced in Table 5.4 below. In terms of benefits attained, the option that provides the largest reduction in cost (i.e. the most benefits attained) is Option 4b.
- ***Step 3*** — calculate the benefit to the community of implementing the regulations by multiplying the number of exposed households that have implemented the options by the cost savings per household for each option (that is multiply the estimates from Step 1 and Step 2).

Table 5.4

RISK MITIGATION RATES

Option	Per cent reduction in risk
1. Status quo	na
2. Consumer education and public awareness	2.43
3. CO alarms[a]	11.31
4a. Permanent ventilation	45.72
4b. Mechanical ventilation mechanisms	47.71
5. Future improvements to natural draught appliances	50 after 10 years

[a] the above calculation has been estimated for a battery powered CO alarm unit in rooms with gas appliances and bedrooms. Were this unit to be hardwired, it is likely to present a more effective option.

Source: The Allen Consulting Group as estimated in the QRA.

[14] Although not explicitly modeled, the benefits to RV owners is captured implicitly in the reduced economy wide costs of CO poisoning. This is because the cost of CO poisoning estimated in Table 5.2 includes the risks posed to RVs.

It is important to note that Option 2 and Option 3 will impact on all gas-connected households (60.9 per cent of all households), while Option 4a and 4b (upgrading of ventilation systems) will only impact on households with flueless heaters and natural draught open flued heaters (23 per cent of total households). The resulting benefit per household for each option is shown in Table 5.5.

Table 5.5

BENEFIT PER HOUSEHOLD FOR EACH OPTION

Option	Expected cost per impacted household*, $	Per cent reduction in risk	Benefit per impacted household, $
2. Consumer education and public awareness	0.76	2.43	0.02
3. CO alarms	0.76	11.31	0.09
4a. Permanent ventilation	2.02	45.72	0.92
4b. Mechanical ventilation mechanisms	2.02	47.71	0.96
5. Future improvements to natural draught open flued appliances	2.02	50 after 10 years	na ^

* The expected cost per household reflects differences in the impacted population and the underlying risks of appliances as reported in Table 2.1 and Table 5.3.
^ For this option, benefits accrue over time as households replace natural draught open flued appliances. Replacing this appliance with an improved appliance will remove almost all risk for these households.

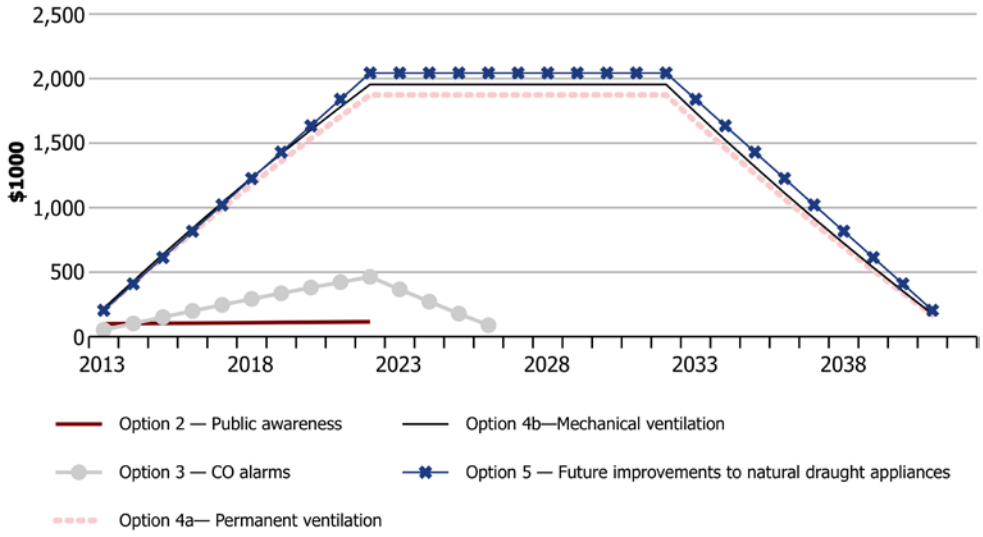
Source: The Allen Consulting Group.

To calculate the community wide benefit of an option, the per household benefits were multiplied by the cumulative number of gas-connected households which have implemented the regulatory option. For example, it was estimated that Option 2 would reduce the cost of CO poisoning by 2.43 per cent. This represents a cost reduction of 2 cents per household and would impact on 5.4 million households in the first year. This would provide a total benefit of around $108,000.

The results of the above calculation over time are provided for each option in Figure 5.1. Table 5.6 reports the present value of each option evaluated using a 7 per cent real discount rate. Option 5 reports the most benefits ($16.3 million) — this is because it is able to provide a significant reduction to the highest risk appliances.

Figure 5.1

EXPECTED STREAM OF BENEFITS BY OPTION



Source: The Allen Consulting Group.

Table 5.6

PRESENT VALUE OF OPTION BENEFITS

Option	Present value benefits, $ 000's
2. Public awareness	745
3. CO alarms [a]	2 080
4a. Permanent ventilation	15 117
4b. Mechanical ventilation mechanisms	15 775
5. Future improvements to natural draught appliances	16 265

Note: all present value estimate using a 7 per cent real discount rate. [a] the above calculation has been estimated for a battery powered CO alarm unit. Were this unit to be hardwired, it is likely to present a more effective option.

Source: The Allen Consulting Group.

5.3 Direct costs

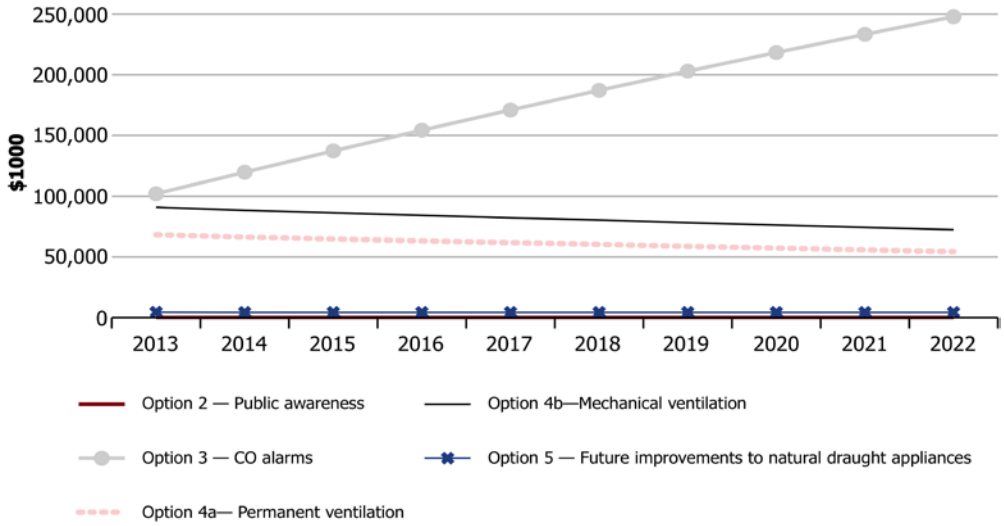
Like direct benefits, all direct costs considered reflect the incremental change to the business case. The costs of administering and complying with existing regulations and policy measures continue as before.

Unlike benefits however, the nature of each option's direct costs are specific to the option in question.

Figure 5.2 presents the stream of costs incurred by each option and Table 5.7 summarises those costs in present value terms. How these values were calculated is discussed in detail below. The most feasible option is Option 2, with a present value of less than $1 million. The costs of the options range as high as $2.4 billion (Option 3).

Figure 5.2

EXPECTED STREAM OF COSTS BY OPTION



The cost of the public awareness campaign has been calculated relative to the estimated benefits. That is, this campaign has been designed to be cost effective.

Source: The Allen Consulting Group.

Table 5.7

PRESENT VALUE OF OPTION COSTS

Option	Costs, $ 000's
2. Public awareness ^	740
3. CO alarms [a]	2 364 375
4a. Permanent ventilation	434 858
4b. Mechanical ventilation mechanisms	579 306
5. Future improvements to natural draught appliances	30 860

[a] the above calculation has been estimated for a battery powered CO alarm unit. Were this unit to be hardwired, it is likely to present a much higher cost option.
^ The cost of the campaign has been calculated relative to the estimated benefits. That is, this campaign has been designed to be cost effective.

Source: The Allen Consulting Group.

Costs of Option 2 — Consumer education and public awareness

This option is a non-regulatory option under which improved safety outcomes are achieved through an awareness campaign and consumer education. This option does not mandate any changes to appliance design, installation or operation and consequently does not impose any costs on industry or consumers.

The scale of the proposed public awareness campaign has been designed to reflect the expected benefits this campaign would achieve. In particular it is important to note that most states and territories have campaigns that highlight the risks of CO poisoning. [15] This option would reflect *additional* efforts to address the key risks.

The costs of this option fall solely on governments and include the costs of materials used to advertise and educate on the dangers of gas appliances.

The present value of the costs of this option is $740,000 over a ten-year period. The cost of the campaign has been calculated relative to the estimated benefits. That is, this campaign has been designed to be cost effective.

Households

Under this option, there are no costs to households.

Industry

Under this option, whilst there is no material outlay for industry, any information pamphlets or other material would take up space that could otherwise be used for product promotion (ie bill inserts), and industry may be burdened with this opportunity cost.

Considering the low cost needed for this option to be cost effective, industry would be encouraged to assist with public awareness, particularly over the longer term. For example, recreational vehicle organisations or other groups could distribute government information to their members.

In their response to the GTRC's Draft Strategy, the Energy Retailers Association of Australia Limited (ERAA) stressed the importance of consulting with retailers before undertaking a public awareness campaign.

> If bill inserts are to be recommended, retailers need to be consulted prior to any timeframes being determined in order to provide retailers the necessary lead times. In a competitive market, bill insert space is generally given over to product promotion, and taking this away from retailers removes an important means of communicating with their customers.
>
> ERAA 2011, pg. 1.

[15] For example:
in NSW — http://www.maritime.nsw.gov.au/campaigns/co.html
in Victoria — http://www.esv.vic.gov.au/About-ESV/Campaigns/Beware-carbon-monoxide
in SA — http://www.safework.sa.gov.au/show_page.jsp?id=2312
in Queensland — http://www.msq.qld.gov.au/Safety/Carbon-monoxide-and-boats.aspx
in WA — http:// www.commerce.wa.gov.au/worksafe/PDF/Guidance_notes/guide_carbon_monoxide_poisoning.pdf

Government

The cost to government of this option will be $740,000 over ten years. This is based on running an information campaign at a cost that reflects the benefits that could be expected from the accompanying reduction in risk. As mentioned above, this campaign has been designed to be cost effective.

Considering the relatively low cost of this option over 10 years, the awareness campaign must be targeted towards high risk people and appliances, and participation by industry may be necessary to achieve the best results.

Again, a number of campaigns already highlight the risks of CO poisoning in most states and territories. The costs to Government reflect an *increased* effort to address the key risks.

Government costs are lower under this option, relative to the other options as this is a non-regulatory option.

Costs of Option 3 — Mandatory installation of CO alarms

It is estimated that this option will impose a cost on the economy of $2.4 billion (in present value terms) over ten years. This includes:

- $2.4 billion borne by households; and
- $1.2 million borne by government.

A range of other possible designs for this option was considered in the analysis for this RIS. The analysis of these other options is summarised in Section 6.2.

Households

CO alarms are readily available for purchase from a number of hardware stores and retailers across the country. Kidde and First Alert are the major suppliers of CO alarms globally. Alarms can operate on battery power or mains power, and can be easily installed in a similar manner to a smoke alarm.

Unlike smoke alarms, there is currently no minimum Australian Standard for CO alarms. The quality of alarms can range considerably, as can the price. In their Draft Strategy, the GTRC estimated the initial capital cost of installing CO alarms at around $100 a unit.[16] Other responses to the Draft Strategy argued that reliable CO alarms were available in the $70-$100 range.

This analysis has reflected on this range and assumed a cost per unit of $85. It is likely that over time the costs of CO detectors will fall as economies of scale and competitive opportunities arise.

Per household, the costs of this option have been calculated as follows.

- Initial capital costs of $340, for four battery powered CO alarms fitted.
- $68 ongoing, average replacement cost per annum (based on a five year life cycle).

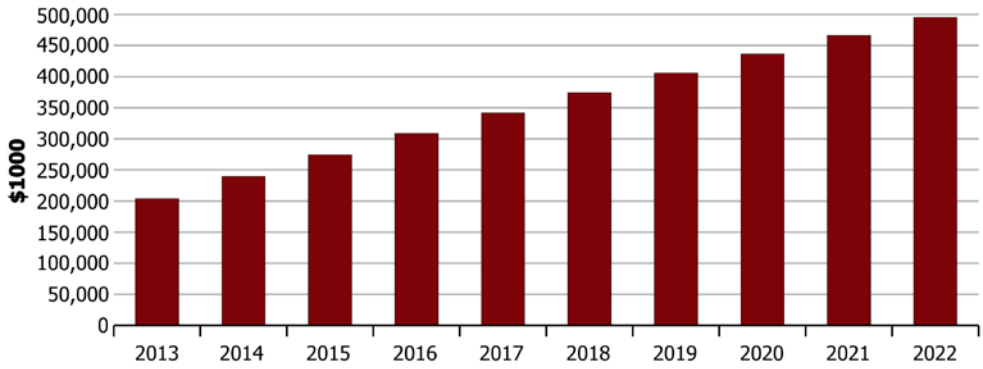
[16] The GTRC estimated initial capital costs at between $300 and $500 (dependent on the number of alarms installed). These units would need to be hardwired by a licensed electrician which would have additional costs as well.

Only those households who do not have a CO alarm already installed will be required to pay this cost. Precisely how many households have a CO alarm installed (to the specifications described in the Option) is unknown. It is likely however, that this figure will be negligible and inconsequential for this analysis.

In the initial year of the program, the total cost to the household sector will exceed $203.7 million (reflecting the penetration profile in Figure 4.3), rising to almost $495.5 million in the tenth year of the program. A profile of the annual costs of this option to the household sector is presented in the figure below.

Figure 5.3

HOUSEHOLD COSTS ASSOCIATED WITH OPTION 3



Source: The Allen Consulting Group.

Industry

Industry is likely to be significantly involved in the installation of some CO alarms. This analysis it has been assumed that any costs incurred by industry will ultimately be passed onto the consumer.

Government

It is estimated that the cost to government of this option will be $300,000 in the first year, and $150,000 each year after. This is based on the following.

- Developing standards is estimated to cost $200,000 initially to develop the standards, plus $50,000 per year to ensure appliances on the Australian market meet these standards — The development of these standards will be necessary to ensure that any CO alarms sold on the Australian market will meet minimum requirements necessary to ensure that the installation of CO alarms meets the government's policy goals. Internationally, standards are available in jurisdictions where CO alarms are employed and mandated more widely. These could serve as a basis for developing this option.
- Compliance and monitoring costs of $100,000 per year — similar to smoke alarms, declaration of the installation of a CO alarm will be required on the appropriate vendor forms in each state and territory. Piggybacking on this existing scheme in place is expected to keep the costs of compliance and monitoring low.

Costs of Option 4 — Changes to ventilation design of extraction systems

Conceptually, while the scale of costs incurred under Options 4a and 4b may differ, the nature of these costs are likely to be quite similar.

In total it is estimated that the present value of direct costs of these sub-options are:

- $434.9 million for Option 4a; and
- $579.3 million for Option 4b.

Households

Both sub-options will require households to undertake building works and invest some capital. Per-household costs for sub-options 4a and 4b are reported in Table 5.8.

Table 5.8

PER HOUSEHOLD COSTS ASSOCIATED WITH OPTIONS 4A AND 4B

Item	Option 4a, $	Option 4b, $
Capital equipment	100	200
Labour	200	200
Total	300	400

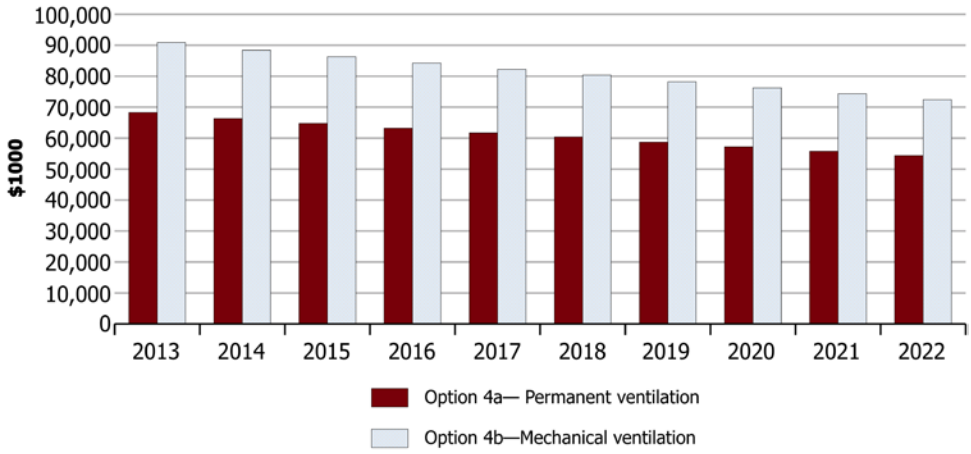
Source: The Allen Consulting Group.

The household costs calculated assume two gas appliances per household, each requiring their own ventilation, whilst it was assumed that a household would have a single exhaust fan requiring linked ventilation.

Consistent with the proposed roll out of the option, it is assumed that costs are incurred at the time of construction, sale or lease (see Figure 4.4). Households accrue costs over a 10-year period as is shown in Figure 5.4.

Figure 5.4

HOUSEHOLD COSTS ASSOCIATED WITH OPTIONS 4A AND 4B



Source: The Allen Consulting Group.

In addition it is likely that these options (Option 4a in particular) may impact on the energy performance of a house. While the Building Code of Australia provides an exemption for gas appliance ventilation requirements when calculating energy efficiency performance — this is not reflected in the household's energy bills.

Requiring additional ventilation is likely to reduce a household's energy performance and increase energy bills. A precise measure of how this can be expected to impact on a household has not been estimated here.

Industry

Industry is likely to be significantly involved in this option. In this analysis it has been assumed that any costs incurred by industry will ultimately be passed onto the consumer.

Government

It is estimated that the cost to government of this option will be an average of $205,000 per year for both sub options. (It is not expected that the two sub-options will impose significantly different costs on the public sector.) This is based on the following.

- Developing standards $200,000 in the first and sixth years — Standards will be developed in the first year and reviewed in the sixth.
- Training $200,000 in the first year and $50,000 each year after — Under option 4a, gasfitter licensing bodies would be expected to provide information to licensed gasfitters regarding the ventilation requirements for the operation of gas appliances. Under option 4b, this information will be provided to licensed electricians.

- Compliance and monitoring costs of $100,000 per year — similar to smoke alarms, declaration of the installation of the mandated ventilation will be required on the appropriate vendor forms in each state and territory. Piggybacking on this existing scheme in place is expected to keep the costs of compliance and monitoring low.

Costs of Option 5 — Future improvements in the control systems of natural draught open flued space heaters

The direct costs of this option are difficult to quantify as they depend on the development of a technology not yet commercially available.

Indicatively however, this option would impose costs on only newly constructed households (and households undergoing a significant reconstruction) seeking to install a natural draught open flued space heater. It is estimated that around 86,500 households will fit this description in any one year.

Households

Households will be burdened with the cost of improvements to appliances. This is expected to cost an additional $50 per upgraded natural draught open flued appliance.

The cost per household assumed an asset life for natural draught open flued heaters of 20 years and an equal distribution of appliance ages; hence 5 per cent of natural draught appliances will be replaced each year. It also assumes that there would be no shift in consumer preferences away from natural draught appliances; hence all consumers who are replacing their natural draught appliances will purchase an upgraded natural draught appliance.

Industry

The industry will be required to develop new appliances with the appropriate technology to ensure safe operation. The costs of developing these appliances would be expected to be passed on to consumers.

Government

It is estimated that the cost to government of this option will be $200,000 in the first year, and $50,000 each year after. This reflects the cost of developing standards for the new appliances in the first year, and ensuring appliances on the Australian market meet these standards in the years that follow.

Chapter 6

Findings for discussion

Under best practice regulation guidelines, government intervention can be justified when there is evidence of a fundamental problem that needs to be addressed, and:

- it can be demonstrated that existing regulations do not adequately address the problem; and
- the benefits of intervention to the community outweigh the costs and provide the greatest net benefit to the community of all options considered.

This chapter compares the impacts of each option, as identified in the previous chapter. A sensitivity analysis is provided on key parameters to illustrate how susceptible results are to any assumptions made during the analysis.

6.1 Net impacts

The net impacts of each option are detailed in Table 6.1. The table reports each option's:

- Net Present Value (NPV) — calculated by subtracting the present value of each option's costs from the present value of each option's estimated benefits; and
- Benefit Cost Ratio (BCR) — is a relative measure that reports the ratio of the benefits to costs (in present value terms).

While there is a relationship between an option's NPV and BCR, the two measures report impacts differently. The NPV is an absolute measure of an option's impacts; the BCR is a relative measure. Where an option reports a positive NPV, then this suggests that option returns a positive impact on the community (that is, the benefits of that option outweigh the costs). Where this occurs, the BCR will be greater than 1 — indicating that for every dollar of cost incurred, the option generates more than $1 in benefits.

A negative NPV suggests the opposite — that the costs of intervention exceed the benefits. Where this is true, the reported BCR will be less than 1.

Table 6.1

SUMMARY OF NET IMPACTS

Option	PV benefits, $ 000's	PV costs, $ 000's	NPV, $ 000's	BCR
2. Public awareness ^	745	740	5	1.01
3. CO alarms	2 080	2 364 375	-2 362 294	0.00
4a. Permanent ventilation	15 117	434 858	-419 741	0.03
4b. Mechanical ventilation mechanisms	15 775	579 306	-563 531	0.03
5. Future improvements to natural draught appliances	16 265	30 860	-14 595	0.53

Note: PV = Present Value. All present values are estimated using a 7 per cent discount rate. [a] the above calculation has been estimated for a battery powered CO alarm unit. Were this unit to be hardwired, it is likely that the results would change.
^ The cost of the campaign has been calculated relative to the estimated benefits. That is, this campaign has been designed to be cost effective.

Source: The Allen Consulting Group.

As evident from the table above, Option 2 has the highest NPV of all the options considered. The NPV is slightly positive, indicating that the projected benefits are in line with the expected costs. For all other options the NPV is negative, indicating that the expected costs outweigh the expected benefits.

Option 2 also has the highest BCR, reflecting the relatively low expense required to generate an impact.

6.2 Sensitivity testing

A sensitivity analysis is conducted below that consists of:

- an assessment of how the analysis is affected by the choice of discount rate;
- an assessment of a range of alternative options for installation of CO alarms; and
- a break-even analysis that provides a gauge the robustness of the results.

Alternative discount rates

The choice of an appropriate discount rate is one of the most important parameters in any evaluation of this kind. The central case presented above is based on a 7 per cent discount rate consistent with the OBPR's guidelines.

The table below illustrates how the analysis would differ using alternative discount rates. A higher discount rate would tend to 'punish' benefits and costs that occur in the future (and promote those impacts that occur in the short term). A lower discount rate would do the opposite.

Table 6.2

NPV OF IMPACTS, ALTERNATIVE DISCOUNT RATES

Option	3 per cent, $ 000's	7 per cent, $ 000's	10 per cent, $ 000's
2. Public awareness ^	10	5	1
3. CO alarms	-2 954 973	-2 362 294	-1 924 831
4a. Permanent ventilation	-499 454	-419 741	-357 308
4b. Mechanical ventilation mechanisms	-672 482	-563 531	-478 860
5. Future improvements to natural draught appliances	-10 751	-14 595	-15 259

^ The cost of the campaign has been calculated relative to the estimated benefits. That is, this campaign has been designed to be cost effective.

Source: The Allen Consulting Group.

Other options for CO alarms

This RIS also explored the costs and benefits of a number of alternative options for CO alarms. These options reflect the range of possible CO alarm related intervention strategies that could be implemented. These options are outlined in the table below.

Table 6.3

ANALYSIS OF ALTERNATIVE CO ALARM OPTIONS

Alternative option	Description	Benefits, $ 000's	Costs $ 000's	NPV $ 000's	BCR
Hard wired alarms	This option explores the mandatory installation of CO alarms hardwired to mains power. This option is similar to that considered in the *Gas Appliance (Carbon Monoxide) Safety Strategy*	2 299	4 517 846	-4 515 547	0.001
Alarms in houses with natural draught open flued space heaters only	Under this option CO alarms will only be required in houses with natural draught space heaters	2 080	777 279	-755 200	0.003
Alarms in rental houses only	Under this option alarms will only be required to be installed in rental properties	448	632 163	-631 715	0.001
Alarms in RVs only	Alarms will only be required in RVs with gas appliances (assumed to be 75% of registered RVs). CO alarms will be required for renewal of registration.	23	9 913	-9 890	0.002
Two alarms in all dwellings	This option considers the installation of two alarms per dwelling, rather than alarms in all rooms with gas appliances and bedrooms, as in the primary option	1 040	1 182 784	-1 181 744	0.001

Source: The Allen Consulting Group

Under no alternative scenario do CO alarms produce a positive NPV.

Break-even analysis

Although the analysis undertaken for this RIS has made every effort to draw upon the evidence available, it has been necessary to make some assumptions. One was to test sensitivity of the analysis to these assumptions is through a break-even analysis.

A break-even analysis illustrates the extent to which a variable must increase (or decrease) in order for the NPV to fall (or rise) to zero. For example, the break-even analysis would illustrate the proportion that costs must rise in order for there to be no net benefit to the community. If the required change is unreasonable then the results of the central case can be interpreted as relatively robust.

The results of the break-even analysis are reported in Table 6.4. The results can be interpreted as follows.

- Where options reported a negative result in the central case, the analysis reports the extent to which either costs must fall or benefits must rise before that option breaks even (an NPV of 0, and a BCR of 1).

- Where options reported a positive result in the central case, the analysis reports the extent to which either costs must rise or benefits must fall before that option breaks even (an NPV of 0, and a BCR of 1).

Table 6.4

BREAK EVEN ANALYSIS

Option	Required change in costs, per cent	Required change in benefits, per cent
2. Public awareness ^	-0.6	-0.6
3. CO alarms	99.9	113 546
4a. Permanent ventilation	96.5	2 777
4b. Mechanical ventilation mechanisms	97.3	3 572
5. Future improvements to natural draught appliances	47.3	90

^ The cost of the campaign has been calculated relative to the estimated benefits. That is, this campaign has been designed to be cost effective.

Source: The Allen Consulting Group.

The results further demonstrate that the proposed regulatory options are a considerable way from providing value for money.

6.3 Impact on business compliance costs

Any costs accrued by business from the options considered are likely to be either minimal or recouped from consumers. The options are not expected to impose any business compliance costs.

6.4 Impact on competition

The options are not expected to have any impact on competition. This is because the options are not expected to:

- alter the competitive relations faced by existing businesses in a way that would reduce the intensity of competition in the market as a whole;
- restrict entry for new businesses;
- raise prices by imposing new costs on producers, facilitate information exchange among producers or lead to the exit of some incumbent firms in a way that raises the prospect of collusion;
- include minimum standards and requirements that will reduce the range of price and quality combinations available in the market;
- limit market growth; or
- have anti-competitive effects in markets that are upstream or downstream of the real estate or property assessors' industries.

Chapter 7

Implementation and review

The analysis in this RIS assumes that measures will be effective 1 July 2013. However, this is indicative only as the timing of the implementation of any option is dependent on the outcomes of the Decision RIS.

In addition, although the measure will be implemented through state and territory legislation, for the purposes of conducting this RIS and assessing alternatives, it has been assumed that the Commonwealth, states and territories would act together to implement cost effective schemes.

Chapter 8

Consultations

A Consultation RIS was made available for comment on the SCER website (http://www.scer.gov.au). Stakeholders were given three weeks to respond to the Consultation RIS.

Stakeholders were invited to comment on any aspect of the Consultation RIS, with particular feedback sought on the following issues:

- Has the problem been accurately represented in this RIS?
- The assessment of costs and benefits of options:
  - Does the assessment fully reflect all potential costs and benefits of the options assessed?
  - Are there costs to industry or Government that have not been accounted for?
  - Are the assumptions underlying the analysis valid/reasonable?
- Identified risks and uncertainties associated with each option.
- Are there any additional data that could be used to inform the analysis? (Particularly with respect to the prevalence of certain appliance types and the extent to which the community has self regulated with CO alarms and/or additional ventilation requirements.)

Fifteen responses to the Consultation RIS were received. Respondents are listed in Appendix A. The remainder of this chapter provides a review of the key issues raised in these submissions.

8.1 Issues raised by stakeholders

Overall, the feedback on the Consultation RIS was positive, with stakeholders comfortable with the analysis contained in the RIS overall. A number of issues, however, were raised through the stakeholder submissions and these issues are outlined below.

Issue 1 — CO alarms

Divergent opinions were expressed regarding the efficacy of CO alarms as a risk mitigation strategy to prevent CO poisoning.

On the one hand, a number of stakeholders advocated for the increased installation and use of CO alarms. These stakeholders argued that the effectiveness of alarms has improved in recent years, and other issues such as the poor battery life of alarms has also been addressed. Stakeholders cited the European standard for alarms, EN50291, as an effective option for Australia to adopt.

Other stakeholders argued that the effectiveness of CO alarms was still questionable, with the use of alarms potentially leading to complacency amongst consumers about the potential risk of CO poisoning from installed gas appliances. The Master Plumbers' and Mechanical Services Association of Australia proposed that to ensure that:

> "consumers know what they are purchasing (CO alarms) should be marked: 'This CO alarm is and indicator of the presence of CO only, and will not prevent the possibility of CO poisoning'."

Some stakeholders, such as Gas Safe Australia, have disputed the costs of components of the CO alarm option explored in this RIS. It should be noted a range of potential variants for option 3 were explored in this RIS (Table 6.3) and none of these variants proved feasible alternatives. Other stakeholders provided an alternate view, such as the Housing Industry Association who argue that the cost of retrofitting alarms in the CO alarm option would be considerable.

Issue 2 — Recreational vehicles

Submissions from the Australasian Touring Caravan, Motorhome & Camping Club (ATCMCC) and the National Association of Caravan Clubs highlighted issues leading to an increased risk of CO poisoning in RVs.

The ATCMCC outlined that RVs produced today are required to have permanent ventilation, however the ATCMCC experience is that uninformed consumers have been known to block this ventilation in cold climates.

The second issue raised by both the ATCMCC and the National Association of Caravan Clubs relates to the use of portable appliances, and is discussed at Issue 5 below.

As outlined in their submission, the GTRC has also begun working to address issues with installed fridges by reviewing the installation requirements for 3-way fridges in RV's (and holiday homes).

Issue 3 — Inconsistencies across the range of Standards and Codes affecting the installation and operation of gas appliances

Stakeholder responses highlighted the wide range of Standards and Codes that have the potential to influence the installation and operation of gas appliances, and the difficulties this poses. As stated by the Master Plumbers' and Mechanical Services Association of Australia:

> "The Standards may not necessarily require being increased, but they could be cross referenced with each other so that there are no anomalies that only cause confusion...."

A ventilation opening designed for the safe operation of a gas appliance is excluded from consideration in the calculation of the buildings energy efficiency rating under Part 3.12.3(b)(ii) of the Building Code of Australia. As such, the Australian Building Code Board has argued that the energy efficiency requirements in the Building Code of Australia, if followed correctly, provides no barriers to developing buildings with the conditions necessary for the safe operation of gas appliances.

The existing exemption in the Building Code of Australia for appliance-related ventilation provides for the safe operation of gas appliances under normal operating circumstances. It was noted that problems can arise, however, when powerful exhaust fans such as rangehoods and bathroom exhaust systems are operated in conjunction with a gas appliance. In circumstances such as this, the ventilation requirements for the safe operation of a gas appliance are more demanding, as the ventilation system needs to prevent the development of negative pressure situations and adverse flow in the flue. Stakeholders stressed that once relevant sections in AS1668.2 are upgraded and references to other relevant standards governing gas appliances are included – thus alerting installers of exhaust systems of the importance of these parameters – it is expected that a gradual improvement in the level of understanding in the community will occur.

Stakeholders have also highlighted a number of other Standards that are inadequate for the safe operation of gas appliances. The GTRC in their submission highlighted the inconsistencies between *AS 1668.2 The use of ventilation and airconditioning in buildings – Ventilation design for indoor air contaminant control* and the requirements for the safe operation of natural draught gas appliances. Under this Standard negative pressures of up to 12 Pascals is considered acceptable, which the GTRC states is unworkable with natural draught gas appliances that often rely on pressure differences in the range of 2 to 4 Pascals to expel combustion products. The GTRC recommends the following:

> The National Construction Code (NCC) should require an adjustment of AS 1668.2 – *The use of ventilation and airconditioning in buildings – Ventilation design for indoor air contaminant control.*
>
> In addition NCC 2011 Volume Two 3.8.5.0 should be substantially reworded to reflect an upgraded AS 1668.2 in all cases.
>
> Once AS 1668.2 has been updated to reflect requirements in the ventilation of houses and the ventilation systems meet agreed performance requirements, they will then carry out what they were meant to achieve. With that achievement the issue of adverse flow occurring through the use of extraction fans will also be removed.

The submission from the Gas Appliance Manufacturers Association of Australia highlighted the importance of *AS 4575 – 2005 Gas appliances – Quality of servicing* in addressing the issue of the spillage of combustion products. The Standard requires that the spillage is assessed when an appliance is serviced, however, according to the Gas Appliance Manufacturers Association of Australia it is "unclear how many operatives in the field are aware of this standard".

Although the range of different, and at times contradictory, standards are clearly of concern within the industry, proposing major changes to the interaction of the range of standards governing different tradespeople is beyond the scope of this RIS.

Issue 4 — Costs to business of an awareness campaign

The public awareness campaign proposed in Option 2 includes using bill statements as a well-targeted approach to making gas users aware of the risks of CO poisoning. The Energy Networks Association and the Energy Retailers Association of Australia note that there is an opportunity cost to business associated with replacing marketing-related inserts with inserts regarding CO safety. These costs are now acknowledged in the discussion of this option.

Issue 5 — Portable gas appliances including 3-way fridges

In their submissions, the Australasian Touring Caravan, Motorhome & Camping Club (ATCMCC) and the National Association of Caravan Clubs highlighted the significant dangers associated with the use of portable, unflued gas heaters in RVs. The National Association of Caravan Clubs proposed the use of a "highly visible warning label .... attached to all new gas bottles and appliances" to combat this risk. This option may be explored as part of the public awareness campaign.

The GTRC's submission highlighted the risk posed by portable gas appliances, including inappropriate use of portable 3-way fridges used in motor vehicles.

3-way fridges are so named because they can be powered by 240-volt electricity from a standard power socket, 12-volt electricity from a car cigarette lighter and gas provided by a portable gas bottle. 3-way fridges can be installed appliances or portable appliances. A key danger from portable 3-way fridges arises when gas is used to power these fridges whilst they are in an enclosed space such as a motor vehicle.

3-way fridges and other portable appliances contribute to the risk of CO poisoning in the community. This is evidenced by the two fatal incidents in Queensland and the injuries from gas refrigerators in Victoria that were highlighted in the GTRC's submission.[17]

The RIS now proposes that the public awareness campaign also addresses the risks posed by 3-way fridges and portable appliances in the community.

8.2 Summary

The submissions from stakeholders made the following key points:

- stakeholders broadly supported the analysis contained in the RIS;
- most stakeholders were keen to ensure any proposed regulation will not impose significant costs on consumers or business;
- opinions on CO alarms was split between those advocating their expanded use as demonstrated by the UK example, and other stakeholders who warned the alarms were unreliable and could increase the level of risk by providing consumers with a false sense of security;
- if used correctly, gas appliances in RVs posed minimal risk to their occupants. However, stakeholders acknowledged that un or ill-informed consumers may be sealing RV ventilation to prevent cold air entering. Consumers may also be incorrectly using portable appliances that were initially (and only) designed for outdoor use. These activities pose a significant risk of CO poisoning in RVs;

[17] A further recent triple fatality in Tasmania is suspected to have been caused CO poisoning from a 3-way fridge, however the coroner is yet to confirm the cause of death.

- a number of different Standards and Codes guide the work of various tradespeople that undertake work that can potentially effect the safe operation of gas appliances. The poor integration of the various Standards and Codes that govern the range of tradespeople involved in house construction can increase the risk of CO poisoning. Ensuring consistency across Standards and Codes may improve clarity for tradespeople and ultimately safety for consumers;
- replacing marketing pamphlets with public awareness messages in bills places an opportunity cost on industry; and
- 3-way fridges and other portable gas appliances operated in an enclosed area pose a risk of CO poisoning in the community.

No submission was able to provide any significant new data to better inform the impact analysis or to make any material changes to the options and their analysis. Submissions identified a range of important auxiliary issues that are beyond the scope of this RIS.

Chapter 9

Recommended option

It has been established throughout the development of this RIS (and the QRA that preceded it) that the risk of CO poisoning is rising due to a number of factors. This includes:

- improvements to sealing of houses, particularly in retrofitted houses;
- the installation of powerful exhaust fans in bathrooms;
- increasing gas consumption rate of some gas appliances; and
- higher energy efficiency of gas space heating appliances resulting in lower flue temperatures and less flue pull.

The dangers of CO poisoning are well known to regulators and indeed, State and Territory regulators have already undertaken a range of initiatives to raise the public's awareness of these factors. Current awareness campaigns include:

- Energy Safe Victoria's *Beware of carbon monoxide – it's a silent killer* campaign[18];
- South Australia's *Importance of ventilation for indoor gas appliances* campaign[19];
- Western Australia's *Safe use of gas* campaign[20]; and
- a range of campaigns that highlight the risk of CO poisoning in a range of circumstances such as workplaces[21] and on marine craft[22].

To date, public awareness campaigns have been designed to encourage gas users to have their gas appliances installed and regularly serviced by licensed gas fitters.

The current stock of awareness campaigns however, have not addressed the major factors that contribute to the risk of CO poisoning from gas appliances as identified in the QRA. The principal risk identified in the QRA related to the effects of powerful exhaust fans in the development of negative pressure situations and a lack of adequate ventilation for the proper operation of gas appliances. Moreover, awareness campaigns also fail to specifically target the appliance types (also identified in the QRA) as posing the greatest the risk to the community — namely appliances with a natural draught flue. Consultations undertaken for this RIS have highlighted how little capability the public — including consumers and tradespeople involved in the building sector — has in recognising risks associated with gas appliances.

[18] http://www.esv.vic.gov.au/About-ESV/Campaigns/Beware-carbon-monoxide

[19] http://www.sa.gov.au/subject/Water%2C+energy+and+environment/Energy/Electricity+and+gas+safety/Gas+safety/Using+gas+safely+and+maintaining+gas+appliances/Importance+of+ventilation+for+indoor+gas+appliances

[20] http://www.commerce.wa.gov.au/energysafety/Content/Consumers/Safe_use_of_gas/index.htm

[21] http://www.safework.sa.gov.au/show_page.jsp?id=2312

[22] http://www.maritime.nsw.gov.au/campaigns/co.html and http://www.msq.qld.gov.au/Safety/Carbon-monoxide-and-boats.aspx

Tradespeople involved in building construction, 'do-it-yourself' renovators and consumers need to be informed about the risks that powerful extraction fans and inadequate ventilation can pose for the safe operation of natural draught gas appliances. Additional resources to assist regulators to design and implement a well-targeted awareness campaign will increase awareness in the community of situations that can increase the risk of CO poisoning and to take the appropriate measures to reduce those risks. The campaign could also highlight risks posed by other appliances including the risks of the inappropriate use of 3-way fridges in confined spaces such as cars and RVs.

On the basis of the above discussion, and subject to the underlying assumptions of the RIS, the analysis identified that a targeted public awareness campaign (as outlined in Option 2) as the option with the highest net present value. This was the only intervention that did not impose costs that were substantially greater than the expected benefits.

Whilst all options explored in the RIS were found to reduce the risk of CO poisoning, only the public awareness campaign was able to meet the Government's objective of reducing the risks associated with CO poisoning from gas appliance use in a cost-effective manner. As such, only this option could be recommended for implementation.

References

ABS (2011), *4602.0.55.001 - Environmental Issues: Energy Use and Conservation, Mar 2011*, Australian Bureau of Statistics: Canberra.

ABS (2011b) *3101.0 - Australian Demographic Statistics, Jun 2011*, ABS: Canberra.

ABS (2011c) *9309.0 –Motor vehicle census, Australia, 31 January 2011*, ABS: Canberra.

ABS (2011d) *4102.0 - Australian Social Trends, 2002*, ABS: Canberra.

ABS (2008), *4602.0.55.001 - Environmental Issues: Energy Use and Conservation, Mar 2008*, Australian Bureau of Statistics: Canberra.

Allen Consulting Group (2012), *The Risk of carbon monoxide poising from domestic gas appliances: Quantitative Risk Assessment*, prepared for the Department of Resources, Energy and Tourism, Canberra.

AIHW (2011), *Separation statistics by principal diagnosis in ICD-10-AM, Australia, 2008-09 to 2009-10*, <http://www.aihw.gov.au/hospitals-data-cube/?id=10737419429>, accessed 1 December 2011.

AIHW (2008), *Separation statistics by principal diagnosis in ICD-10-AM, Australia, 1998-99 to 2006-07*, < http://www.aihw.gov.au/data-cube/?id=10737418525&libID=10737418524>, accessed 5 December 2011.

AIHW (1999), *The burden of disease and injury in Australia*, cat. no. PHE17, Canberra.

Australian Government (2010), *Best Practice Regulation Handbook*, Canberra.

Barret, L, Danel, V and Faure, J (1985) "CO Poisoning, a Diagnosis Frequently Overlooked", *Clinical Toxicology, 23*(4-6), pp. 309-313.

Commonwealth of Australia (2008), *Horizon Scanning Technology Prioritising Summary - Masimo non-invasive pulse CO oximeter*, <http://www.health.gov.au/internet/horizon/publishing.nsf/Content/BB580B674729F620CA2575AD0080F351/$File/Masimo%20non-invasive%20pulse%20carbon%20monoxide%20oximetry%20for%20haemoglobin%20monitoring.pdf>, accessed 1 December 2011.

Council of Australian Governments (2007), *Best Practice Regulation, A guide for ministerial councils and national standard setting bodies*, October.

Department of Communities and Local Government (2009), *Study on the Provision of CO Detectors Under The Building Regulations: BD2754*, <http://www.communities.gov.uk/documents/planningandbuilding/pdf/1324663>, accessed 30 November 2011.

Department of Finance and Deregulation, *Best Practice Regulation Guidance Note, Value of a statistical life*, < www.finance.gov.au/obpr/docs/ValuingStatisticalLife.pdf>, accessed 7 December 2011.

Energy Safe Victoria (2011), *CO Alarms for Domestic Use*, Gas Information Sheet No. 36, accessed at http://www.esv.vic.gov.au/Portals/0/Gas%20Professionals/Files/Information%20sheets/36%20Carbon%20Monoxide%20Alarms%20201109222.pdf on 29 November 2011

Gas Technical Regulators Committee (2011) *Gas Appliance (Carbon Monoxide) Safety Strategy*, <http://www.ret.gov.au/Documents/mce/_documents/2011bulletins/GTRC_Draft_Gas_Appliance_(CO)_Safety_Strategy.pdf>, accessed 12 August 2011.

McGregor Tan Research (2011) *Consumer Safety Survey*, Office of the Technical Regulator: Adelaide.

National Appliance and Equipment Energy Efficiency Committee (2004), *Gas Space Heaters*, <http://www.*energyrating.com.au/library/pubs/sb200417-gasheaters.pdf>, accessed 1 December 2011.*

Question Consultants (2010), Preliminary Quantitative Risk Analysis (QRA) of the Texas Clean Energy Project, <http://www.netl.doe.gov/technologies/coalpower/cctc/EIS/final%20eis%20pdf/TCEP%20FEIS%20V1%20Appendix%20C.pdf>, accessed 1 December 2011.

SA Government (2009), Designing an energy efficient home, <http://sa.gov.au/subject/Water%2C+energy+and+environment/Energy/Energy+efficiency/Home+energy+efficiency/Designing+an+energy+efficient+home#ventilation>, accessed 9 December 2011.

Appendix A

List of stakeholder submissions

Stakeholders who provided submissions in response to the Consultation RIS are listed below.

- Gas Technical Regulators Committee (two submissions);
- Master Plumbers' and Mechanical Services Association of Australia;
- Energy Retailers Association of Australia;
- Housing Industry Association;
- Gas Appliance Manufactures Association of Australia;
- Gas Safe Australia;
- Energy Networks Association;
- GWA Group;
- Plumbing Industry Commission;
- The Australian Building Codes Board;
- Seeley International;
- Mr Des Hartree;
- The Australasian Touring Caravan, Motorhome & Camping Club; and
- The National Association of Caravan Clubs.

One further submission was received from a stakeholder who wished to remain anonymous.

Submissions that were not highlighted as confidential are available from the SCER website at http://www.scer.gov.au/workstreams/energy-market-reform/gas-appliance-safety-strategy/