Gas Safety Trust

DIDR
Carbon Monoxide Incident Report

A detailed review of carbon monoxide incident information, for 2012/13, produced from the investigation of domestic incidents which involved mains natural gas and piped LPG in Great Britain, including an assessment of incidents involving solid fuel and oil appliances

Working in partnership

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Prepared by **Downstream Gas Ltd**
Website:www.downstreamgas.co.uk/

Funded by **The Gas Safety Trust**
Website: www.gas-safety-trust.org.uk

This report has been prepared by Downstream Gas and is funded by The Gas Safety Trust as a continuation of the work established during a Joint Industry Programme (JIP) addressing carbon monoxide (CO) issues in 1996. This work identifies common concerns involved in CO incidents related to appliance and system design, the home environment, installation, servicing and maintenance. The conclusions reached are intended to help further improve safety, to target investment in CO incident prevention and to identify future research work.

This is the seventeenth report in a series that began with the publication of a first annual report in 1996 and covers the 12 months between 1st July 2012 and 30th June 2013. During this period details of 29 domestic mains gas incidents were submitted to Downstream Gas and their analysis constitutes the main part of the report. This report also appends the analysis of reported solid fuel and heating oil domestic incidents.

The Gas Safety Trust is pleased to fund the report in the knowledge that the information and data within will help reduce fatalities and serious injuries from accidental CO exposure.

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Executive summary

This report has been prepared by Downstream Gas and is the seventeenth annual report that has analysed accidental carbon monoxide (CO) poisoning incidents in Great Britain (GB) associated with the use of mains natural gas and piped Liquid Petroleum Gas (LPG) in the home. Since 2011, information, albeit less extensive than that for mains gas, has been collected concerning CO incidents associated with using solid fuel and oil.

This annual report covers the period from 1st July 2012 to 30th June 2013 inclusive.

This year 29 incidents were reported by investigators all of which involved the use of domestic mains natural gas and these resulted in 62 casualties (non-fatal) and two fatalities. This is marginally more than the number of incidents and fatalities last year (2011/12) but lower than the previous three years (2010/11, 2009/10 and 2008/9). The two fatal incidents this year were the second lowest number reported via RIDDOR since detailed records of incidents began in 1996. This is a significant reduction from the 21 to 24 fatalities and 70 to 104 incidents reported annually during the period 1996 to 2000. The number of non-fatal casualties has risen from 46 last year to 62 this year. Additionally, there were 21 more minor casualties recorded than last year (i.e. those not needing hospitalisation).

One of the natural gas fatal incidents involved the blockage of a chimney serving a gas fire[1]. The other involved an old open flued floor-standing boiler which had not been serviced for many years.

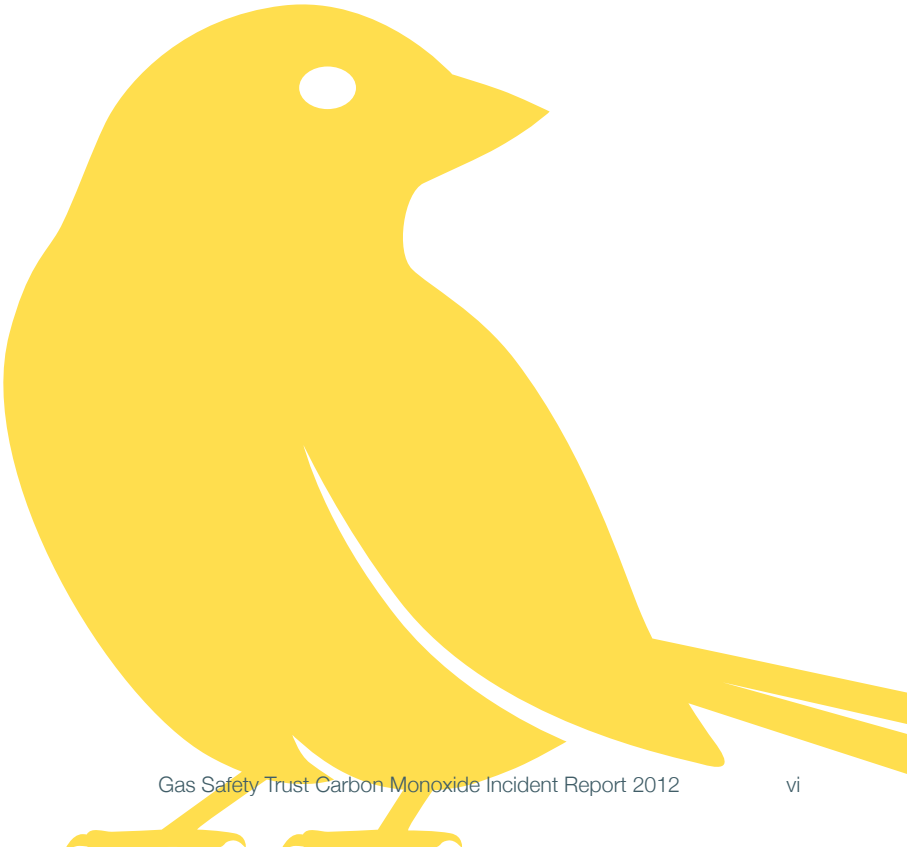
Conclusions and recommendations from this year's report include the following:-

- The risk of someone in the private rented sector being involved in a reportable CO incident where mains natural gas was the fuel remains greater than in any other housing sector. The two main risk factors recorded were an older appliance (four of the seven incidents with full reports involved appliances installed in 1988 or before) and a lack of appliance servicing. Measures that could be considered in order to address the elevated risk of a CO incident in the private rented sector include; requiring an operative to make a combustion performance measurement on open flued boilers and warm air units when carrying out a Landlord's Safety Check; requiring CO alarms to be installed with a record made of details on the Landlord's Safety Check form; promoting or even requiring regular servicing of appliances.
- This year the second lowest number of fatalities was recorded since detailed records began in 1996 within the mains natural gas and piped LPG sectors and there is a continuing trend towards fewer fatalities. Figures for the number of CO incidents have been repeatedly quoted in the media and tend either to be grossly inflated or ill-defined in terms of the fuel/energy sector to which they refer. There is no doubt that to focus upon specific fuel sectors would offer the greatest opportunity to improve CO safety. It is positive that HSE are now quoting the average numbers of gas related fatalities over the last five years rather than an inflated number that relates to the situation more than 15 years ago.
- Incidents involving open flued boilers have again figured disproportionately in the number of CO incidents reported. This year, using an open flued boiler presented at least 4.2 times the risk of being involved in a RIDDOR reportable incident than one with a room-sealed boiler. Bearing in mind that such a trend has persisted since the collation of detailed CO incident data began and that both fatalities involved an open flued appliance, this serves to emphasise the importance of regularly servicing open flued appliances.
- Lack of servicing or sub-standard servicing was the most frequently reported preventable contributory factor in a gas related CO incident. Owner occupiers and private landlords in particular should be aware of the importance of regular servicing in accordance with British Standards and the appliance manufacturer's instructions.

1 Further details are awaiting potential legal proceedings.

- Since information on gas related CO incidents started to be collated in the DIDR format in 1996, incidents have been recorded only if a victim required some form of medical treatment (even if treatment was refused) or diagnostic tests.

There is a trend that those victims of gas related CO incidents are showing less signs of serious injury. Whilst this is welcome, it should be noted that the use of CO alarms may well be contributing to the early identification of a problem. Both alarm manufacturer's instructions and gas emergency service providers will tend to advise someone who thinks they are feeling unwell at the scene to seek medical attention. This in turn tends to result in hospital attendance for a blood test and, very often, a modest elevation in blood carboxyhaemoglobin (COHb) level is identified as a consequence. Categorisation, therefore, of a RIDDOR reportable incident caused by a CO alarm activation, does not necessarily mean serious injury has been suffered and therefore, it may be helpful in future to classify such events as a 'CO alarm activation'.



1 Introduction

1.1 Context

In GB, Downstream Incident Data Report (DIDR) forms are completed by investigators following the investigation of accidental CO poisonings associated with the use of mains natural gas or piped LPG in the home. The information received has been gathered, placed on a database, analysed and presented in a series of consecutive annual reports from 1996/7 to 2011/12. The initial reports were funded by the Health and Safety Executive (HSE) with the CORGI Trust taking over the funding for the reporting period starting in April 2006.

This is the seventeenth report in the series and is the sixth produced by Downstream Gas for the Gas Safety Trust (formerly The CORGI Trust). It covers incidents reported and confirmed during the 12 months between 1st July 2012 and 30th June 2013.

1.2 Scope

The gas industry has clear mandatory obligations and responsibilities in terms of reporting gas related CO incidents. These are specified in the Gas Safety Management Regulations (GSMR) 1996 and in particular place duties upon the supplier of mains natural gas and piped LPG.

Regulation 7(14) of GSMR states that: -

> *Where an incident notifiable under regulation 6(1) of the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 has arisen as a result of an escape of carbon monoxide from incomplete combustion of gas in a gas fitting, the person who supplied the gas shall, as soon as is reasonably practicable after receiving notice of the incident, cause an investigation to be carried out so as to establish, so far as is reasonably practicable, the cause of the escape and accumulation of the carbon monoxide gas.*

The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations are frequently referred to as the RIDDOR regulations.

Regulation 6(1) states that:-

> *Whenever a conveyor of flammable gas through a fixed pipe distribution system, or a filler, importer or supplier (other than by means of retail trade) of a refillable container containing liquefied petroleum gas receives notification of any death or major injury which has arisen out of or in connection with the gas distributed, filled, imported or supplied, as the case may be, by that person, he shall forthwith notify the Executive of the incident, and shall within 14 days send a report of it to the Executive on a form approved for the purposes of this regulation.*

The Executive is the Health and Safety Executive.

The Guidance to Regulation 6(1) states that:-

> *The trigger for a report to the HSE under regulation 6(1) is the receipt by the person on whom the reporting duty is placed of 'notification' of a flammable gas incident causing a death or a major injury* ***other than one*** *reportable under regulation 3(1).*

Regulation 3(1) relates to a fatality or major injury as a result of an accident arising out of or in connection with work whether or not the person was at work. It also covers hotel or care home residents, pupils or students and customers in shops.

For this report it may be interpreted that Regulation 6(1) covers domestic premises.

As specified in GSMR, a CO incident has to fulfil specific criteria in order to be formally reported. Such an incident is notifiable under regulation 6(1) of the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 and for this reason is frequently known as a RIDDOR reportable incident.

Primarily, following the inhalation of a substance (in this case CO) the incident has to result in:

- an acute illness requiring medical treatment or
- a loss of consciousness

An acute illness means:

- one that progresses rapidly to a crisis after the onset of symptoms and
- has severe symptoms

Medical treatment covers:

- hospital treatment
- treatment by a general medical practitioner or
- treatment by a firm's medical and nursing staff

Treatment by a paramedic is also included here.

Based on the gas industry's duty to investigate CO related incidents, the DIDR process was set-up to achieve the systematic gathering of details from incident investigations in order to help identify trends and common underlying features.

When the gas emergency service provider or a registered gas operative attends the site of a possible RIDDOR reportable incident involving CO poisoning, the incident is first notified and an investigation organised by the gas supplier. It should be noted that such incidents will usually be a result of acute poisoning, i.e. exposure to significant levels of CO and not be a consequence of exposure to low levels of CO over a prolonged period which is frequently described as chronic CO poisoning.

The statistics in the main body of the report include an analysis of the data collected for confirmed CO incidents that relate to the use of mains gas or piped LPG in the home.

The reporting of LPG incidents is limited to those associated with piped LPG from permanent tanks or cylinders. Incidents related to portable LPG cylinders are not RIDDOR reportable but occasionally completed reporting forms are received by Downstream Gas and these are included in Appendix A for completeness.

Incidents that occur in domestic properties attached to shops, offices, restaurants, etc are only included if the causes were related to the domestic use of gas. Incidents involving multiple residential properties such as student accommodation and sheltered housing are included but care homes are excluded as the latter are work related premises. Occasionally, DIDR forms are received from incidents in non-domestic premises and so for completeness, any received are included in Appendix B and do not feature in the main statistical analysis of data of the report.

There may be occasions when an investigation report is delayed, for example whilst waiting on the result of an inquest or a trial. No reports were received in this reporting year that provided incident information from previous years.

An incident investigation and systematic reporting scheme developed for heating oil, kerosene and solid fuels based on the gas forms was started in July 2010. It is a cross industry initiative co-ordinated by Downstream Gas between the Gas Safety Trust, OFTEC and HETAS. HETAS is the solid fuel advisory service and competence assessor for operatives who install, commission, service and maintain appliances and OFTEC represents the interests of homeowners, registered technicians and trade association members, providing advice and information on oil-fired heating and cooking.

Provisional assessments of risk for domestic CO incidents caused by installations fuelled by solid fuel and oil are presented in Appendix D. This information has been gathered by investigators working on behalf of HETAS and OFTEC.

1.3 Coverage

The information gathered during an incident investigation relies on the investigators, working on behalf of gas suppliers, completing a DIDR form for each CO incident and sending it to Downstream Gas for entry onto the database. Fatalities resulting from those incidents confirmed to have been caused by accidental exposure to CO and reported to Downstream Gas via DIDR forms have been reconciled with information recorded by the HSE via RIDDOR.

Non-fatal casualties are reported to the HSE and the gas supplier in the same way. However, the gas supplier carries out an initial assessment of the incident (usually by contacting the gas user) in order to determine whether CO was likely to have been involved. A decision is then taken to either carry out a full investigation or record it as non-CO related and hence not take any further action.

The HSE does not conduct any such checks and logs all such RIDDOR reports as CO related. It is inevitable, therefore, that this results in the number of non-fatal CO incidents recorded by the HSE being significantly greater than the number of incidents that are actually confirmed as being CO related.

The primary aim of the work in analysing those incidents that are confirmed as CO related is to examine in detail the circumstances of all such incidents to reveal any common concerns and conclusions that will help to improve gas safety in the future. It is therefore important that detailed investigations are carried out on as many incidents as possible that meet the legal criteria for an investigation. There is a duty in law on the gas supplier to carry out such investigations and it should be recognised by both HSE Inspectors and the gas suppliers alike that this needs to happen irrespective of whether the HSE intends to take any further legal action or not.

There are instances in this report where a particular demographic factor relating to the risk of being involved in a CO incident (for example the number of incidents reported to have occurred in a particular type of occupancy) is compared to the number that would have been expected if every classification (in the case of occupancy type this is owner-occupied, rented in the social sector and privately rented) had been equally at risk.

Sometimes the number of reported incidents was lower than expected, in which case the demographic factor indicated lesser risk than would be expected, and vice versa. In this way, commentary can be given on whether demographic factors such as housing sector, property type, period of property construction, glazing type, casualty age range, etc indicated levels of risk that were greater than or less than those anticipated. As an example, if gender was the demographic factor and 40 females had been reported as non-fatal casualties during the year compared to 20 males, then because the population is split 50:50, corresponding to an expected number of 30 for each gender, this would indicate that females are more at risk of being casualties than males.

The risk of an accidental CO poisoning associated with the use of natural gas has been calculated and expressed in terms of fatalities, casualties or incidents per million people deemed to be at risk per year. People considered at risk are those living in properties with at least one gas appliance (i.e. those supplied with mains natural gas nationwide). Risk rates associated with particular appliance types have been estimated by taking the number of people at risk as those living in homes with the particular appliance type installed.

In order to report annual trends, fatality, casualty and incident rates are presented for the yearly periods starting from the 1st July 1996.

Section 2 of this report analyses data in the same sequence as it is featured on the DIDR form and interprets information making use of appliance and other population statistics, where available. Section 3 then draws conclusions and where appropriate makes recommendations.

- **Appendix A** covers incidents involving portable refillable LPG that are reported to Downstream Gas.
- **Appendix B** covers non-domestic incidents which may be reported to Downstream Gas.
- **Appendix C** covers details of incidents that occurred in previous years for which information was made available this year.
- **Appendix D** covers detailed information and provisional risk assessment for domestic CO incidents caused by installations fuelled by solid fuel and oil. This information has been gathered by investigators working on behalf of HETAS and OFTEC, the trade associations for solid fuel use and oil use.
- **Appendix E** features charts which present summarised information for 2012/13 which enables the reader to assess elements of this year's data and compares these with data from previous years.

1.4 Media reporting

CO fatalities and injuries are tragic events which can be avoided so we should never become complacent in the pursuit of a zero injuries target.

Quite often CO incident figures reported in the media quote around 50 fatalities per year, although Public Health England has reduced this figure to 40 more recently. It should be remembered, however, that this figure is the total of all CO fatalities across the range of fossil fuels such as solid fuel, oil, portable bottled LPG, wood and natural gas and involves a wide variety of equipment e.g. boilers, fires, garage compressors, generators, barbecues and stoves.

The information contained within this report originates from the data captured within the RIDDOR process which is thoroughly investigated, reviewed and critiqued before being published. The RIDDOR statistics relate to CO fatalities and injuries linked to mains natural gas and piped LPG within GB and the number of fatalities confirmed from CO last year and this year were one and two respectively. This is from a population of homes with gas numbering approximately 20 million nationwide and is lower than the provisional figure quoted by HSE (nine in 2012/13)[2]. The HSE figures have been scrutinised and after discussion with HSE, only two cases are confirmed as accidental CO fatalities relating to the domestic use of mains natural gas or piped LPG.

The current situation regarding CO incidents clearly shows how the numerous safety initiatives implemented over the last 25 years have resulted in a significant reduction in the number of reported fatalities and injuries. The following initiatives are all considered to have contributed to this downward trend in CO fatalities and injuries linked to mains natural gas and piped LPG.

- The introduction of the flue gas analyser
- The removal of open flued water heaters from bathrooms and bedrooms
- Increased user awareness enhanced by the OFGEM supplier licence review
- Landlord legislation
- Boiler scrappage schemes
- The requirement for new gas boilers to be condensing from June 2005
- The use of CO alarms
- Gas Distribution Networks making use of CO detection
- The focus of CO Charities, industry and government
- UK legislation that restricts the gas quality of distributed mains natural gas to within Wobbe Number limits that have been shown to minimise the potential for CO incidents to occur (see GSMR, 1996)

2 Gas RIDDOR Table 2008/9 to 2012/13, Ref 1. Note 2012/13 is provisional data.

It is nonetheless important, however, to ensure the numbers of injuries reported in the media, fatal or otherwise, accurately reflect those associated with the specific fuel sector concerned. This will go some way towards making sure the lessons learned and implemented in the mains natural gas and piped LPG sectors are adopted to promote safer practices in other fuel sectors, most if not all of which are far less regulated.

This issue has now been taken on board by the HSE. Historically, HSE has quoted a figure for fatal injuries in the mains natural gas and piped LPG sectors of 30 per year. Given the numbers have fallen significantly over recent years, the HSE has now agreed to use the average number over the last five years and in so doing provide a more accurate perspective. The average number of fatalities associated with the use of mains natural gas over the last five years, including 2012/13, has been 6.8.

It should be borne in mind that the legal drivers for investigating and reporting CO related incidents in these other energy sectors are far less than those compelling investigation and reporting in the mains natural gas and piped LPG sectors.

The solid fuel and oil sectors are working with the gas industry to help reduce the number of injuries, both fatal and non-fatal, from CO and by providing detailed incident information for this report are expressing their commitment in this respect.

Since August 2013, Downstream Gas has been undertaking media monitoring in order to identify articles in the Press that report CO incidents. A report on this work is anticipated in early 2015 which will enable incident articles in each fuel sector to be cross-checked with reports received from incident investigators.

2 Analysis of DIDR forms

2.1 Preliminary overview

There were 29 domestic mains natural gas incidents reported to Downstream Gas that met the criteria for inclusion during the 12 month reporting period (1st July 2012 to June 30th 2013). One further LPG incident was notified to Downstream Gas by the HSE. The LPG incident is outside the criteria as specified in Section 1.2 because it involved LPG stored in portable bottles. This LPG incident was a triple fatality and its details are noted in Appendix A.

Gas related incidents reportable under RIDDOR are usually monitored by gas suppliers and the HSE so that investigations can be arranged promptly. British Gas and CORGI Technical Services provide an incident investigation service for gas suppliers. On occasions the HSE engages Gas Safe Register to investigate incidents. There have been rare occasions when HSE has requested the support of the Health and Safety Laboratory with incident investigation. During this year, 16 confirmed CO related incidents were investigated by British Gas, 11 by CORGI Technical Services, one by Gas Safe Register and one on behalf of the HSE[3].

A fully detailed DIDR report is submitted following an investigation by a trained investigator, who completes all sections thereby providing detailed information on the circumstances of an incident including, for example, the appliance installation, safety devices found on site and dwelling characteristics. This year fully detailed reports were received for 18 of the 29 natural gas incidents.

Short reports only feature key facts including the incident date, geographical location, casualty details and the suspected cause together with the type of appliance involved and were not necessarily fully investigated by a qualified investigator. This year 11 such short natural gas reports were submitted by incident co-ordinators.

The reasons for not providing full investigation reports this year were: -

- The appliance had been replaced or repaired before a full investigation could take place (1)
- Cause identified as the misuse of the cooker (by registered operative or the gas emergency service provider) and HSE confirmed no further action was required (2)
- Incident resulted from the use of an appliance that had not been regularly maintained in an owner-occupied property and HSE confirmed that no further action was needed (3)
- Cooker incidents were judged not to require investigation by i) registered operative, ii) contractor for housing association and iii) local authority (3)
- RIDDOR raised but case closed by HSE (2)

Full reports formed 62% of the total submitted in 2012/13 and this was a little lower than last year (75%) and the previous year (64%)[4].

It should be stressed that once reported as a RIDDOR incident and confirmed as likely to have involved CO, the gas supplier has a legal duty to investigate fully.

The main reason for not providing a fully completed report was that the HSE did not direct their investigators (HSL/Gas Safe Register) to investigate further because, for example, it involved poorly maintained appliances in the owner-occupied housing sector or was a consequence of the owner-occupier not using a cooker properly.

There may be occasions when an investigation report is delayed, for example whilst waiting on the result of an inquest or a trial. No reports were received in this reporting year that provided incident information from previous years.

Each of the following sections includes an assessment of the information retrieved from the CO incident database for 2012/13 and, where appropriate, a discussion of the data. This discussion may compare this year's information with that from previous years or qualify this in terms of a wider context.

3 Details including who is investigating have yet to be received.

4 Ref 2.

2.2 Incident details

The numbers of CO incidents recorded each month, i.e. those involving fatal and/or non-fatal casualties between 1st July 2012 and 30th June 2013 inclusive, are plotted in Figure 1. For brevity in this report this will be referred to as the 2012/13 year. Figure 2 shows how these monthly figures break down in terms of fatalities and non-fatal casualties. The so-called heating season typically runs throughout the winter between September/October and April/May and the majority of CO incidents tend to occur during this period.

Figure 1 Monthly incident numbers

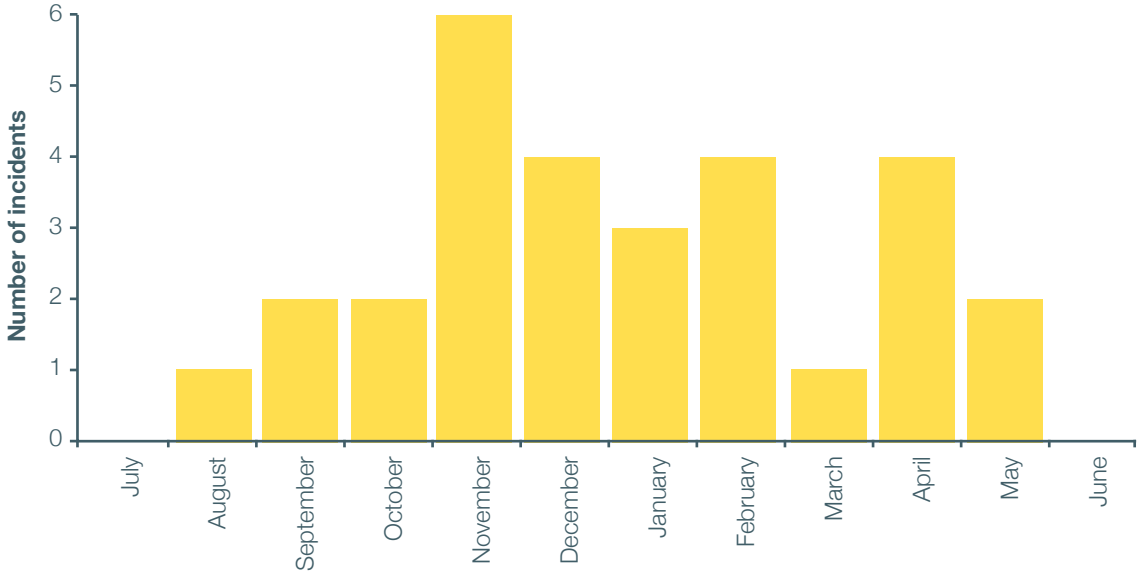
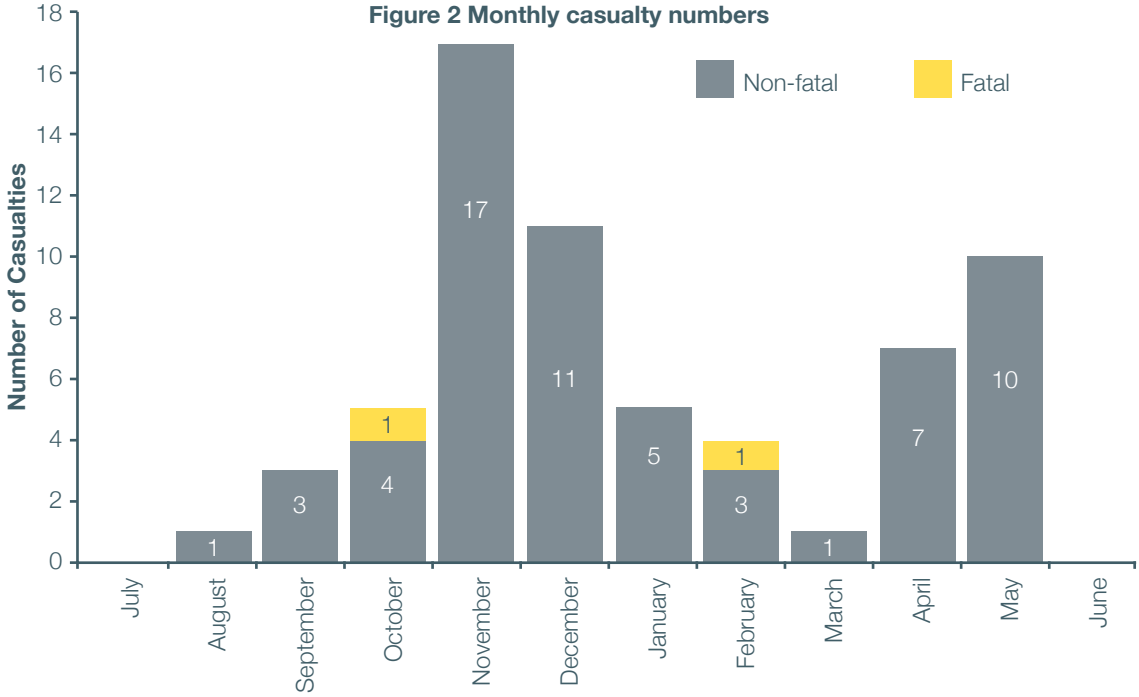


Figure 2 Monthly casualty numbers



For 2012/13 there were 29 separate CO incidents reported by investigators relating to piped natural gas. These affected 64 people, of whom two died[5].

The HSE website[6] lists nine individuals reported to have died from suspected CO during the reporting period. The details have been scrutinised and after discussion with HSE it was agreed only two cases should be confirmed accidental CO fatalities relating to the use of domestic mains natural gas or piped LPG.

5 There is one possible further incident that is still under investigation. Details will feature in a future annual report.

6 http://www.hse.gov.uk/foi/fatalities/2012-13.htm , HSE, Ref 1.

2.2.1 Geographic coverage

Of the 119 postal areas in Great Britain, 89 were incident free and 29 had a single incident. Therefore there is no evidence of geographical clusters this year.

2.3 Casualty details

2.3.1 Fatalities, non-fatal casualties and incident numbers

A breakdown of those persons (62) non-fatally injured during the reporting year 2012/13 is presented in Table 1 and in Figure 3, with the severity of the casualties classified into four groups.

Table 1 Classification of non-fatal casualties

Classification	N1	N2	N3	N4	Not stated	Total
Number of casualties	1	34	16	6	5	62

Table Notes:
The classifications N1 to N4, as used on the DIDR form, are:-

N1 - requiring immediate hospitalisation for more than 24 hours
N2 - requiring immediate hospitalisation for less than 24 hours, and/or hospital tests
N3 - requiring other medical treatment (e.g. GP or Paramedic)
N4 - receiving no medical treatment (e.g. treatment refused)

2.3.1.1 Discussion

This year, of the 57 casualties whose severity classification had been reported, 22 (39%) were classified as not requiring hospitalisation. This is in contrast to last year's figure of only 2.5% and those in 2008/9, 2009/10 and 2010/11 when the proportion had been close to 20% (see Figure 4).

The reported number of incidents in 2012/13 was up slightly to 29 from 24 in 2011/12 and the number of non-fatal casualties was up to 62 from 46. Part of the increase in the number of non-fatal casualties was due to one incident which unusually involved eight people.

Compared to the totals reported in 2008/9, 2009/10 and 2010/11, the 2012/13 total is lower, and in particular lower in the statistically significant sense, than the average number reported over the four years (2007/8 to 2010/11) which was 51 incidents and 95 non-fatal casualties. The normal spread expected in 19 out of 20 years is between 38 and 65 incidents and 77 and 115 casualties.

This indicates that both the number of non-fatal casualties reported and the number of incidents recorded in 2012/13, like 2011/12, remains significantly lower than previous years.

Figure 3 Reported incident and casualty numbers

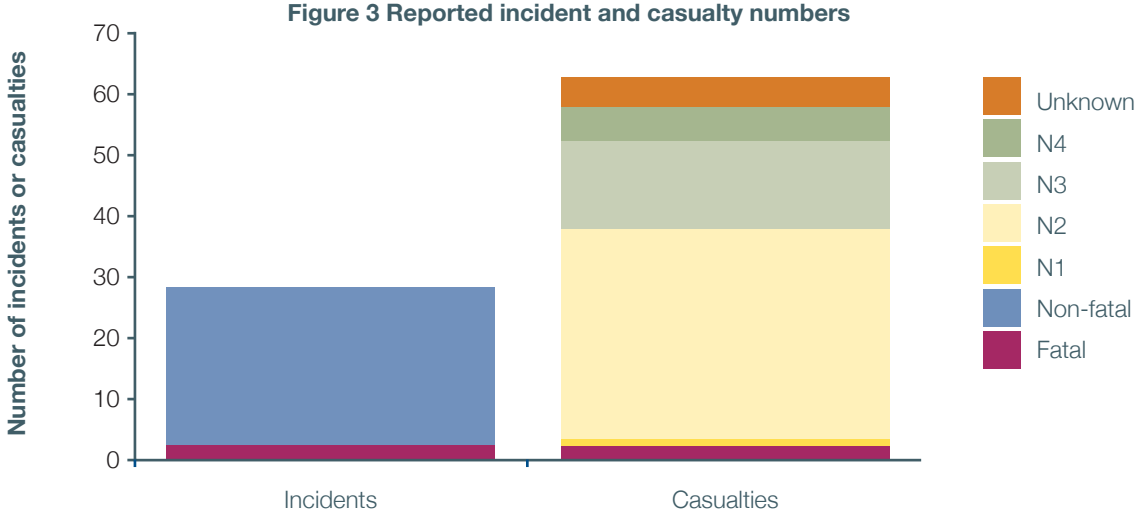
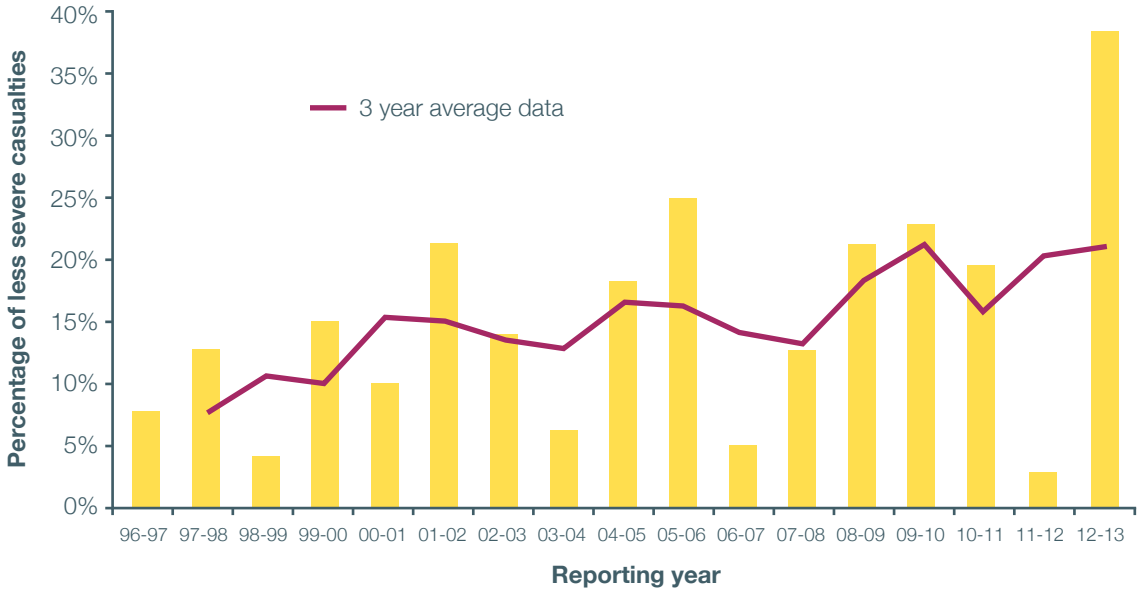


Figure 4 Percentage of casualties not requiring hospital treatment



The increase in the number of incidents where victims have been less severely affected by CO could be due to a number of reasons.

Firstly, it may be (in part) due to the increased use of non-invasive carboxyhaemoglobin pulse CO-oximeters[7] that can be used by paramedics at an incident site. Before their usage increased, testing for the levels of COHb in the blood required a hospital visit and hence the casualty was categorised as at least N2 (requiring hospitalisation for less 24 hours). Now that testing can be done on site the casualty with only low COHb levels would be categorised as less severely affected with classification N3.

Secondly it could be the result of an increase in the number of CO alarms alerting occupants before more severe symptoms develop.

A study of 1768 patients at four hospitals in England in 2010 with symptoms of CO poisoning found that 16% had CO alarms installed[8].

It should be noted that this is considerably lower than the 38% (11 in 29) of CO incidents where it was reported a CO alarm was already installed.

One possibility is that alarm activation may be increasing the likelihood of someone seeking medical treatment thereby increasing the proportion of incidents associated with CO alarms. In 2012/13 50% of incidents involving alarm activation had the lowest severity classification of N3 or N4. In homes with CO alarms that did not activate and for those homes without CO alarms, 30% had the lowest severity of N3 or N4.

CO alarms are supplied with user instructions. These generally advise users that, in the event of an alarm sounding, they should get medical help immediately for anyone suffering headache or nausea. In addition, when attending sites where alarms have activated, gas emergency service providers may also advise those feeling unwell to seek medical assistance. In this way, it is possible that an incident is reported under RIDDOR even though blood levels of COHb do not turn out to be particularly elevated and serious injury has not occurred.

2.3.2 Overall risk and trends

Table 2 shows the likelihood of someone being involved in a CO incident during 2012/13. The risk rates were calculated by dividing the number of incidents, casualties or fatalities by the number of people at risk per year. The exact number of people at risk is open to debate but in this report, it has been taken to be the number of people that live in homes with at least one gas appliance (i.e. the number of households with mains gas multiplied by the average number of people living in a household).

7 Masimo RAD-57 pulse CO-oximeter (Masimo Corporation, Irvine, California, USA).

8 Ref 3, page 6.

The calculated risk presented in Table 2 is based on the number at risk of 51.6 million people in 21.77 million gas households in GB at the end of 2012 with an average occupancy of 2.37[9]. The 21.77 million figure is derived from, but not the same as, the number of properties in GB that are classified as using less than 73,000 kWh pa[10] as published by UK's Department of Energy and Climate Change (see Ref 5). The published figure is higher because it relates to dwellings and not the 21.77 million related to households. There are fewer households than dwellings because some are empty properties, for example 4.4% of dwellings were empty in England in 2012 (Ref 6).

Table 2 CO incident numbers and risks for 2012/13

Total Incidents	Numbers of people affected		Incidents, fatalities or casualties per million people at risk per year		
	Fatal	Non-fatal	Incident	Fatality	Non-fatal
29	2	62	0.56	0.04	1.20

The risk rates calculated for previous years are given in Table 3. Yearly trends recorded for fatality and incident rates are also shown in Figure 5 and Figure 6 respectively. The trend is defined as a moving average over three years centred on the middle year. It should be noted that for the 2012/13 year the trend is represented as the average of 2011/12 and 2012/13 only.

Table 3 Yearly data (July 1st to June 30th)

Reporting year	Number per year			Overall rate per million people per year		
	Incidents	Fatalities	Casualties	Incidents	Fatalities	Casualties
96/97	70	21	142	1.64	0.49	3.33
97/98	94	24	206	2.21	0.56	4.83
98/99	107	24	241	2.49	0.56	5.61
99/00	70	23	150	1.68	0.55	3.60
00/01	85	16	206	2.01	0.38	4.86
01/02	52	11	107	1.19	0.25	2.44
02/03	36	11	66	0.79	0.24	1.44
03/04	38	8	85	0.84	0.18	1.89
04/05	25	5	48	0.55	0.11	1.05
05/06	19	11	20	0.39	0.22	0.41
06/07	27	8	40	0.54	0.16	0.80
07/08	42	12	67	0.84	0.24	1.34
08/09	57	17	97	1.13	0.34	1.93
09/10	56	4	115	1.10	0.08	2.27
10/11	51	10	101	1.00	0.20	1.98
11/12	24	1	46	0.47	0.02	0.90
12/13	29	2	62	0.56	0.04	1.20

Note incident rates may have changed slightly from those reported last year for 2005 onwards because better household statistics have recently been published for these years.

9 Table 5: Households by size United Kingdom, 1996-2013, Ref 4.

10 This is the traditional boundary between domestic and non-domestic used by the gas industry. Some of these domestic properties will include small business properties that consume less. However, the number of such properties is much smaller than the number of residential properties.

Figure 5 Fatality data

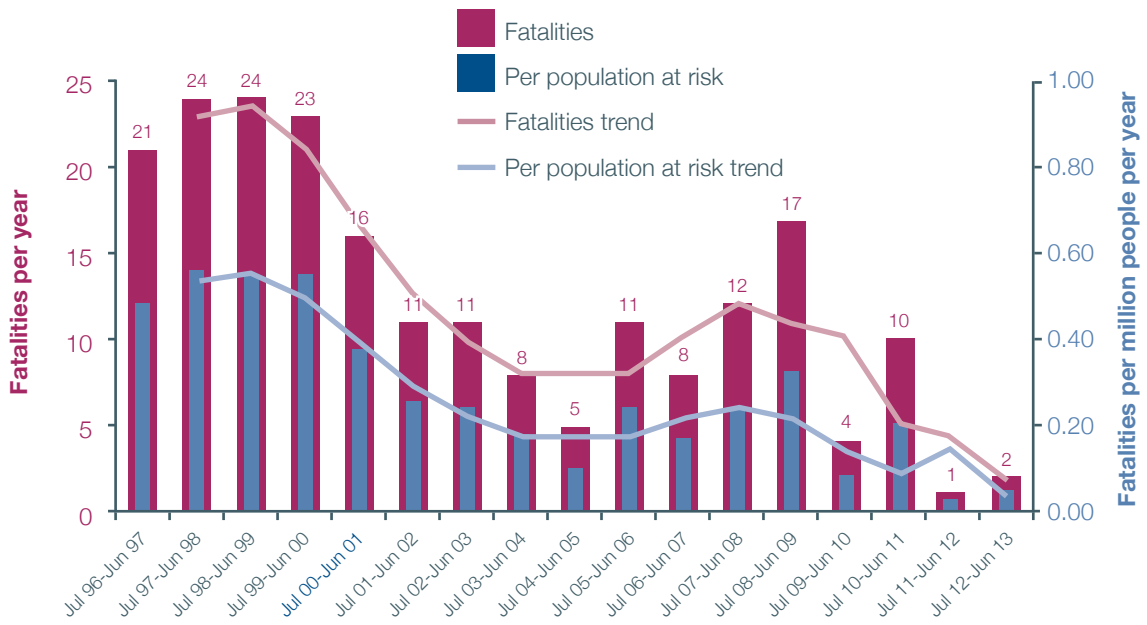
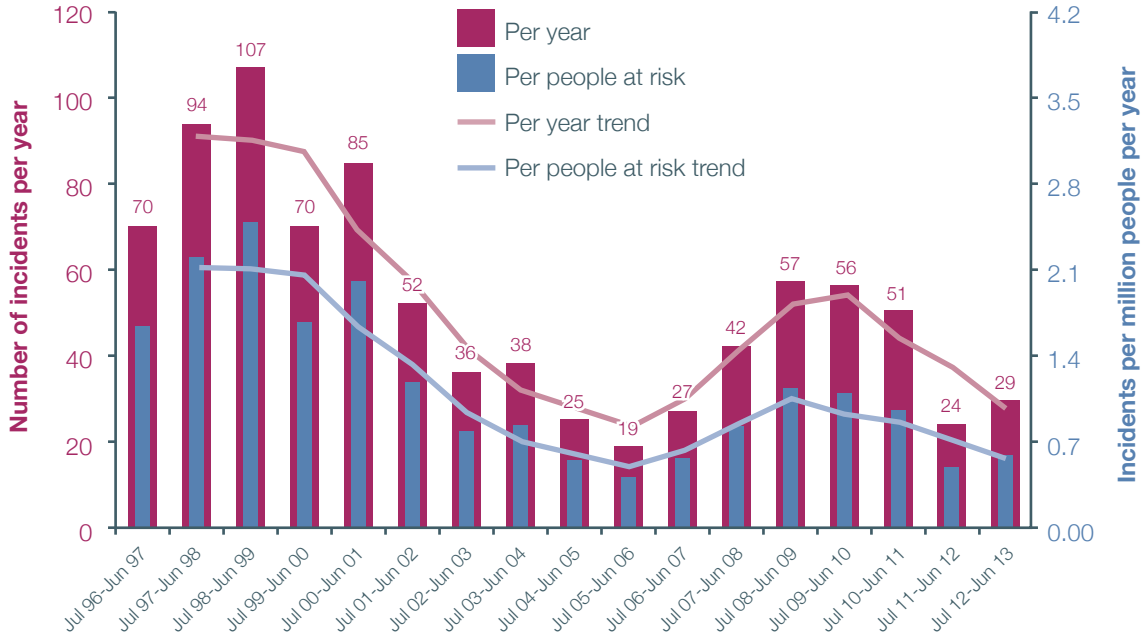


Figure 6 Incident data



2.3.2.1 Discussion

The number of fatalities reported annually has reduced since the incident database was established in 1996 from a peak in the late nineteen nineties of 24 to an average of eight per year over the past four years (2008/9 to 2011/12). This year's reported number of two reflects the downward trend evident in 2011/12 and 2012/3.

The number of fatal and non-fatal incidents reported annually has reduced since the incident database was established in 1996 from a peak of just over 100 in the late 1990s to an average of 47 per year over the four year period 2008/9 to 2011/12. During 2012/13 the 29 incidents reported, although slightly up from last year's figure of 24, means that the average for the four years (2008/9 to 2012/13) has reduced further to 40 incidents per year. Statistically, if the average were 47 incidents per year in GB, the chance of 29 or fewer incidents in a year is less than 1% and well within the level of statistical significance.

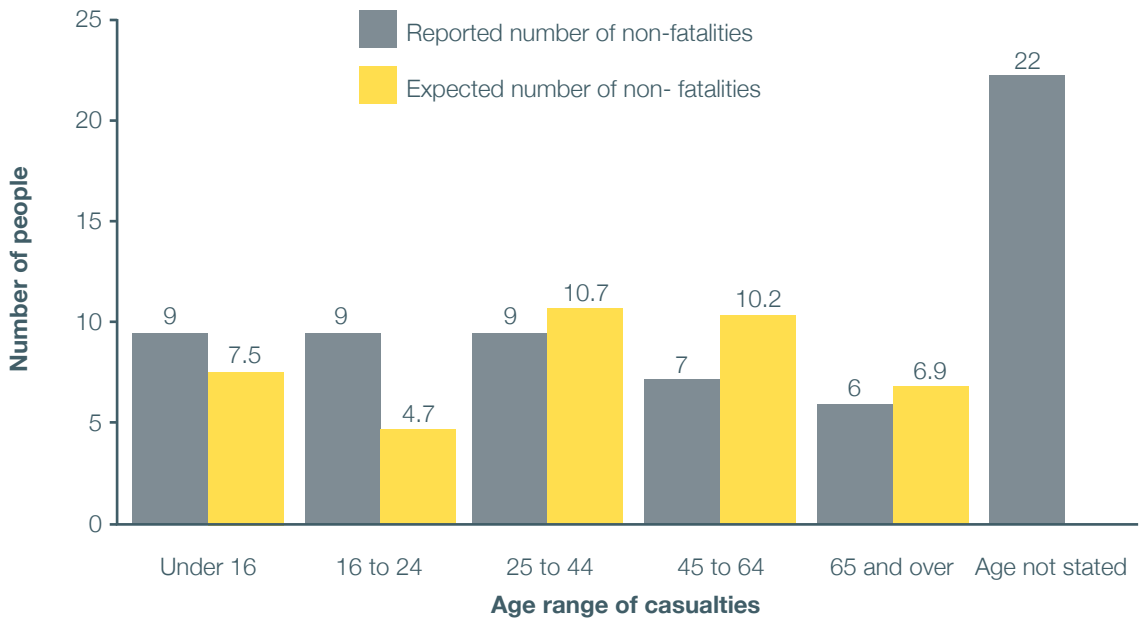
2.3.3 Casualty ages

The two fatalities reported this year were women in their 60s and 80s.

The age ranges of non-fatal casualties are presented in Figure 7. The percentage of people in each age group in GB is estimated to be: 18.7% for those under 16, 11.7% from 16 to 24, 26.8% from 25 to 44, 25.5% from 45 to 64 and 17.3% for 65 or over[11].

These ranges have been deliberately chosen to represent age groups with perceived differing vulnerabilities and potential for exposure to CO. The expected numbers of incidents by age range is also shown in Figure 7. The expected number is the percentage of those within each age range resident in GB in 2012/2013 multiplied by the total number of casualties with an age recorded. In effect, the expected number is the average number that would occur if all ages were equally susceptible to CO poisoning and exposed to the same level of risk.

Figure 7 Casualty age profile



2.3.3.1 Discussion

From Figure 7 it is evident that there are only minor differences between the age profiles of non-fatal casualties. Indeed, a statistical Chi-squared test shows that the reported distribution is not significantly different to that which would be expected by chance alone from the age distribution of the general population assuming all are equally at risk. However, this conclusion must be viewed with caution as slightly over a third of the casualties did not have their age reported.

2.4 Incident location details

This section examines whether the relative risk of an incident varies with occupancy type, dwelling type, year of construction, double glazing and floor construction.

2.4.1 Housing sector

A breakdown of English dwellings with a main gas supply by housing sector[12] is shown in Table 4. This is considered to be a reasonable measure of the breakdown of homes supplied with mains gas in GB because a) England accounts for 85% of the homes in GB, b) the percentage of homes with a gas supply in Wales and Scotland is similar to England.

11 Average of mid-2012 and mid-2013 projections, Ref 7.

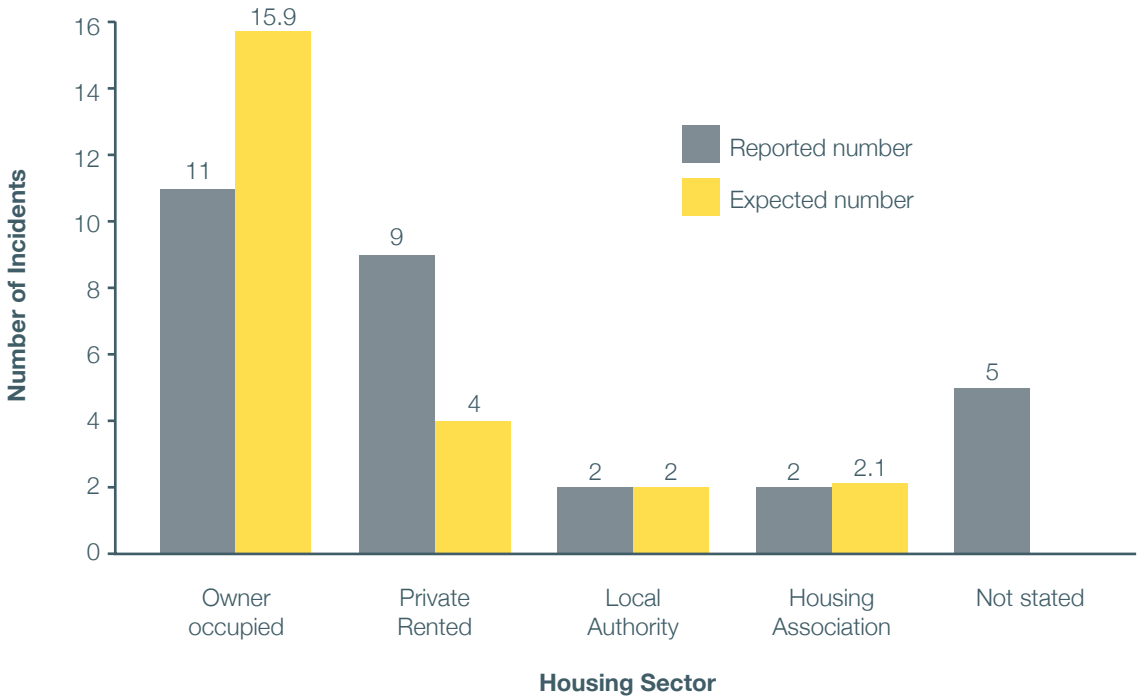
12 In previous reports the term occupancy type was used. Housing sector is now the preferred term as this is more widely used in demographic publications.

Table 4 Distribution of gas dwellings by housing sector in England 2012[13]

Housing sector	Distribution of homes with a gas supply, %
Owner occupied	66.3
Rented privately	16.5
Rented from council	8.5
Registered Social Landlords (RSL)	8.7
ALL	100

Figure 8 shows the number of reported and expected incidents by housing sector. The expected number is the national proportion by housing sector (Table 4) multiplied by the total number of reported incidents of known housing sector and represents the number expected assuming all housing sectors pose equal risk.

Figure 8 Incidents by housing sector



2.4.1.1 Discussion

Risk

Incidents in privately rented properties occurred more frequently than would be expected given the demographic of housing sectors nationwide and this increased frequency was confirmed to be statistically significant. The risk of an incident in the privately rented sector is expected to be between 1.3 and 6.7 times the risk of an incident in the other sectors[14]. The most likely value is 3.0 times[15].

If the incidents classified as 'not stated' occurred outside the privately rented sector, the risk reduces to between 1.3 and six times but is still statistically greater than one.

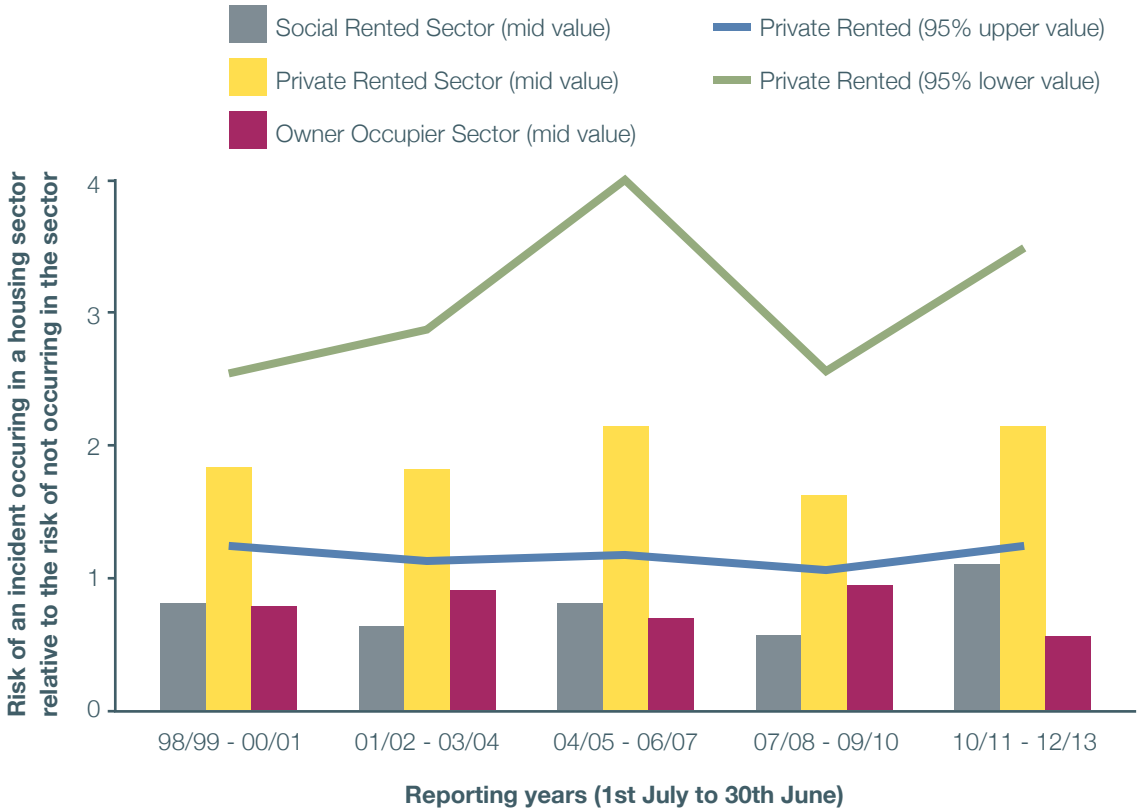
Figure 9 shows the risk associated with private rented sectors over the last 15 years, averaged three-yearly to prevent year-to-year fluctuations obscuring the overall trend and shows the risk has remained fairly constant at around twice the risk of an incident occurring in a different housing sector.

13 Projected forward using 2009 to 2011 data sourced from Table DA2201, Ref 8.

14 This assumes the conventional statistically accepted criteria of "95% confidence", which means if the analysis were to be repeated using new samples that 95% of samples would have an average risk in this range.

15 The relative risk is (A x D) /(C x B) where A and B are the reported and expected number of incidents in privately rented properties respectively and C and D are the reported and expected number in other occupancy types respectively.

Figure 9 Historical risk of an incident by housing sector



CO alarms

Table 5 shows the breakdown of incidents by housing sector for homes where CO alarms were installed and those where none were found. The breakdown by housing sector for homes without alarms is similar to the national picture indicating equal risk across sectors. This appears to be at odds with Figure 9 which indicates the risk associated with the private rented sector is twice that of other sectors. Bearing in mind that this enhanced risk has occurred since the records began in 1996 when the number of incidents with CO alarms and presumably the population with alarms was very much smaller than in 2012/13 (see Figure 23), confidence in the enhanced risk illustrated remains high.

As this is the first year that this apparent contradiction has been observed it will be investigated next year, if it still remains, when more incidents with CO alarms are likely to be available for analysis.

Table 5 Housing sector incidents and CO alarms

Housing sector	All incidents	Incidents with CO alarms	Incidents without CO alarms	National proportion of housing sector
Owner/occupied	11(46%)	2 (20%)	9 (64%)	66.3%
Social rented	4 (16%)	1 (10%)	3 (21%)	17.2%
Private rented	9 (38%)	7 (70%)	2 (14%)	16.5%
Totals of known sectors	24 (100%)	10 (100%)	14(100%)	100%
Unknown sector	5	1	4	n/a

In addition, domestic CO alarms are now required in GB when a new or replacement appliance burning solid fuel is installed and in Scotland and Northern Ireland, this extends to all newly installed (i.e. new and replacement) appliances irrespective of the fossil fuel.

The Energy Act received Royal Assent on 18 December 2013 and includes provision to enable the Secretary of State to require private landlords to provide smoke and/or CO alarms.

Any move, therefore, which requires private landlords to have CO detection in their properties as the second line of defence against CO exposure could further afford protection to gas users and, in particular, would not be restricted to new or replacement appliances. Incident data collated across all housing sectors since 1996 shows that it is older appliance installations which tend to figure most often.

With issues such as the long-term reliability of sensors now being addressed by alarm manufacturers for incorporation into the European Standard thereby ensuring adequate 'end of life' alerts exist for the protection of users, it is envisaged that the use of CO alarms as a secondary line of defence against CO in the home will develop significantly in the near future.

The main risk factors reported in the private rented sector this year were older appliances combined with a lack of servicing or unsatisfactory installation of the flue system connected to a newer appliance.

The following table explores the reasons why the private rented sector is more at risk by examining the two potential risk factors (flue type and appliance age).

Table 6 Breakdown of the nine incidents in the private rented sector

Flue type (all central unless stated)	Year of installation	CO alarm
Open flue (2)	2011, 2012, 2007, 1988, 1980, 1975, and 1972.	Installed (7)
Room sealed with fan flue (4)		None (2)
Room sealed natural draught (1)		
Cooker (1)	Age unknown (2)*	
Unknown type (1)		

** One of which was a cooker*

Appliance age

The average life expectancy of a boiler is probably around 15 years. So it is noteworthy that four of the seven incidents involved central heating boilers that were considerably older. Reports from three of the older installations stated a lack of servicing to have been a contributory factor. The fourth stated a cracked burner was a contributory factor.

The two incidents involving new central heating appliances (i.e. installed in 2011 or 2012) were caused by installation faults. Both involved flues that were not installed to standard due to badly sited terminals. One was sited in a covered passageway and caused CO exposure in adjacent properties. The investigators were unable to obtain information on the installers, so it not known if they were registered operatives or not. The incident involving the boiler installed in 2007 was caused by incorrect positioning of a flue sealing gasket. It is worthy of note that out of this year's total of 29 incidents, two incidents involved newly installed boilers and that both of these were in the private rented sector.

Lack of servicing

Of the 14 incidents in dwellings where a lack of servicing was reported to have been a contributory factor, six occurred in the privately rented sector and eight outside the sector. The corresponding risk of an incident involving a lack of servicing in the privately rented sector lies between 1.2 and 11 times that in other sectors with a most likely value of 3.8 times (see footnote 14 notes on methodology). As the range in the estimated risk for the private rented sector is greater than the risk in other sectors, it is justifiable to say that a lack of servicing contributed to the higher risk associated with the private rented sector.

Whilst there is a specific requirement in the GSIUR (Regulation 36) for a landlord to ensure gas fittings and flues are maintained in safe condition, by no means all organise regular servicing as would be recommended by appliance manufacturers. Furthermore, the risk data presented in Figure 9 tends to suggest that landlords in the social sector keep appliances in safer condition than private landlords. This may be a consequence of social landlords tending to have a larger number of properties than private landlords.

For this reason, mandatory servicing (proactive maintenance) of appliances in properties with private landlords is worthy of consideration and offers the first line of defence against CO.

2.4.2 Dwelling type

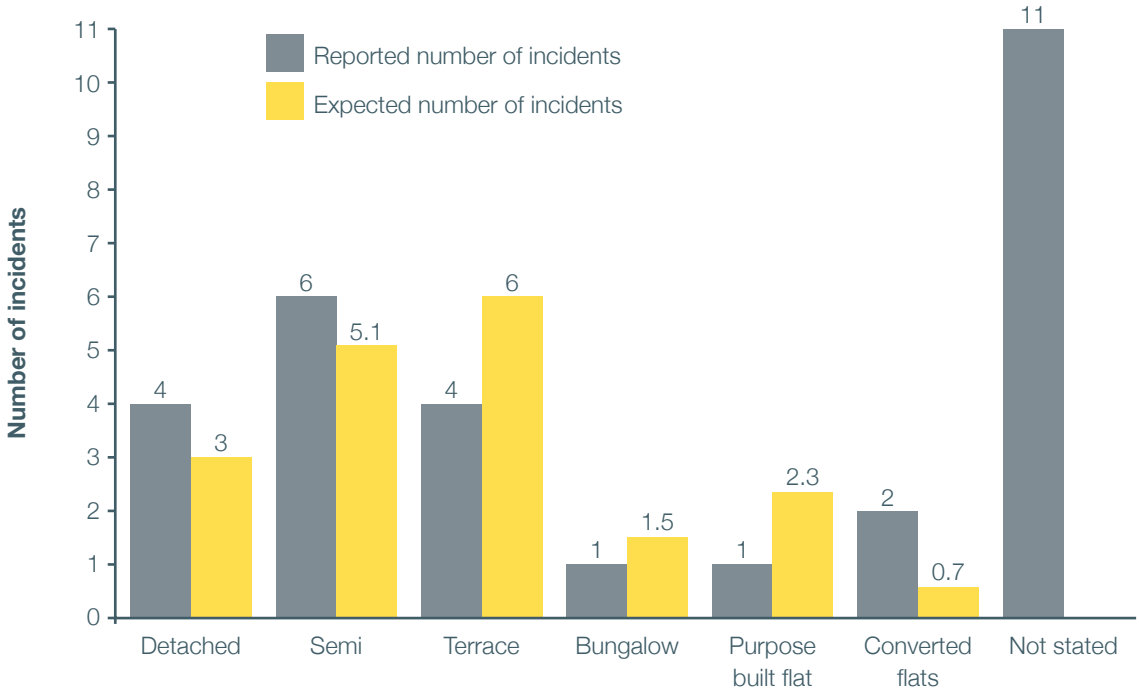
Table 7 shows the distribution of dwelling types in England with a mains gas supply.

Figure 10 provides a breakdown of incidents reported this year by dwelling type and compares the expected number based on the national profile, were an incident in one type of dwelling to be equally as likely as in another type. The reported numbers of incidents by dwelling type were similar to the proportion of properties supplied with gas for terraced houses, flats and bungalows but not for semi-detached houses, where more were reported than would have been expected. However, no deviations from expected incident numbers compared with those reported were sufficiently different to constitute statistical significance for any dwelling type.

Table 7 Distribution of dwelling types with a mains gas supply in England in 2011[16]

Dwelling type	Proportion of dwelling types, %
Detached house	16.5
Semidetached house	28.1
Terraced housed	30.9
Bungalow	8.1
Flats purpose built	12.6
Flats converted	3.8
Total	100

Figure 10 Incidents by dwelling type



16 Ref 8, Table DA 2201.

2.4.2.1 Discussion

Figure 10 shows the expected number of incidents assuming all property types pose an equal risk. There is little evidence to suggest different properties types pose different risks.

It was noted that the number of incidents in purpose built flats was proportionally higher than expected in 2011/12 suggesting that purpose built flats may pose a higher risk than other property types[17]. This was the first year such a rise had been observed and as the raised risk was not observed in 2012/2013 it is concluded that in 2011/12 it was something of an anomaly.

11 of the incidents occurred in unknown dwelling types. These are unlikely to be biased towards any particular dwelling type because the reasons for not fully investigating are unrelated to dwelling type.

2.4.3 Property construction period

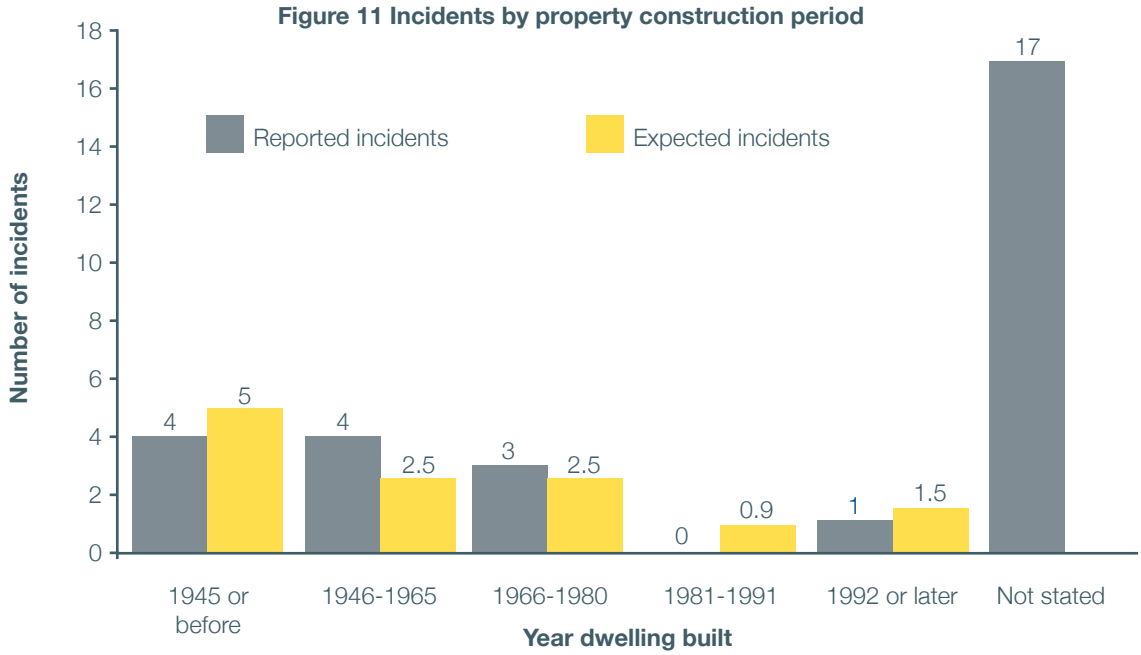
Table 8 gives the national breakdown of properties built in each of five periods for those property types listed on the DIDR form.

Figure 11 shows how the reported number of incidents compared with those expected assuming properties within all construction periods pose an equal risk of being involved in an incident by property age based on the data presented in Table 9.

Table 8 Percentage of dwelling in England 2011 with a mains gas supply by property era[18]

Built period	Distribution of gas properties by built era in England 2010, %
Pre 1945	20.2
1945 to 1965	18.1
1966 to 1980	20.9
1981 to 1990	20.8
Post 1991	20.0[19]
Total	**100**

Figure 11 Incidents by property construction period



17 The relative risk is (A x D) /(C x B) where A and B are the reported and expected number of incidents in purpose built flats and C and D are the reported and expected number in other dwelling respectively.
18 Table DA2203, Ref 8.
19 In the 2011/12 report a 7.7% figure was incorrectly stated. The correct figure should have been 19.9%. The corrected figure was used to calculate the data in Figure 11

2.4.3.1 Discussion

Older properties, particularly those built in 1945 or before, generally have higher levels of background ventilation which may help to reduce the chance of a dangerous build-up of CO.

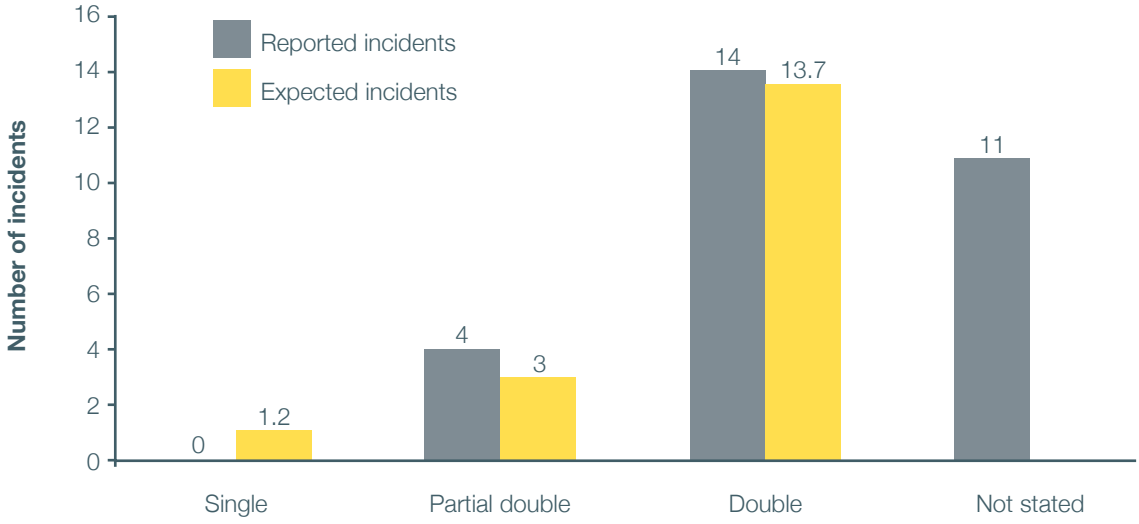
There is no evidence to suggest that CO exposure is related to property age.

2.4.4 Glazing type

The percentage breakdown of homes by glazing type in the latest English Housing Survey was 6.9% single glazed only, 16.8% mixed single-glazed and double-glazed and 76.3% fully double-glazed in 2011[20]. There was a slight increase in the percentage of properties with double glazing in 2011.

Figure 12 compares the number of reported incidents with those expected from the national figures for glazing categories assuming each category is equally at risk. In 2012/13, there were a similar number of reported incidents to those that would be expected if each category posed an equal risk.

Figure 12 Incidents by glazing details



2.4.4.1 Discussion

The number of incidents in properties with double glazing was in line with those expected indicating that properties with double glazing are not at an increased risk compared with those having single glazing. This has now been the theme for six years and is contrary to the suggestion that double glazed properties are more at risk because they tend to have lower background ventilation rates.

2.4.5 Floor construction

Table 9 shows a breakdown of CO incidents reported by ground floor construction.

Table 9 Incidents by floor construction

Ground floor construction	Reported number of incidents
Solid	6
Suspended	7
Partial solid	4
Not stated	12
Total	**29**

20 Table D6203, Ref 8.

2.4.5.1 Discussion

National statistics on floor construction are not readily available. However, an estimate in England based on property age is that 70.7% have solid floor construction[21]. A similar estimate made assuming all properties with cavity walls have solid floors also produces a very similar result of 69% with solid floors[22]. If 70% was taken as the figure for properties with solid floors and each floor type posed a similar risk of an incident, the expected number of incidents in properties with a suspended floor construction would be four and for solid floor would be 10. In fact, there were six and seven reported respectively and like previous years these are not significantly different. As a consequence, the type of floor construction is not considered to have a bearing on the likelihood of a CO incident occurring.

2.5 Appliance and casualty locations

This section covers the reported location (eg room or compartment) for both the incident appliance and those injured. No reports implicated more than one appliance. Details of the incident appliance locations, by floor level, are given in Table 10.

Table 10 Incident appliance location by floor level

Floor on which the appliance was situated	Number of incident appliances
Roof space	0
Second or higher	0
First	0
Ground	16
Below ground	1
Not stated	12

Table 11 lists where the incident appliances were reported to have been located together with the numbers of casualties at each location. The most common location for an incident appliance was the kitchen and living rooms.

Table 11 Appliance and casualty locations

	Number of appliances at each location	Number of casualties at each location	Number affected when the occupants were in the same room as the appliance	
			Fatal	Non-fatal
Hall/landing	2	1	0	0
Kitchen	11	0	0	0
Living rooms	6	18	1	2
Bathroom	0	0	0	0
Utility	3	0	1	0
Bedroom	0	4	0	0
Other	1	0	0	0
Not stated	7	39	0	0

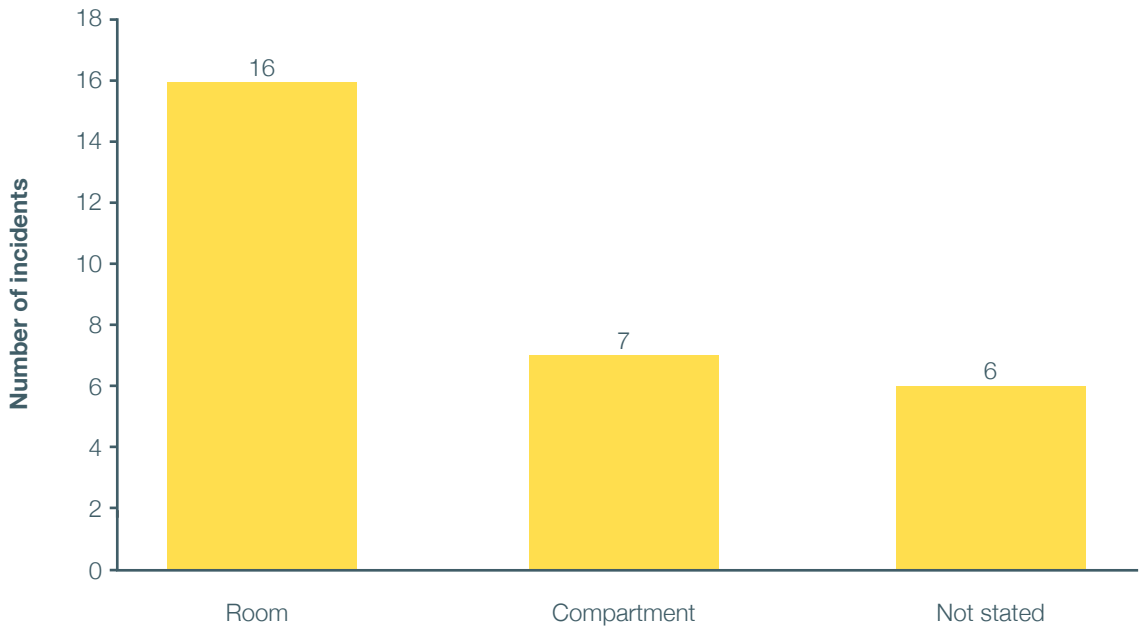
21 The relative risk is (A x D) /(C x B) where A and B are the reported and expected number of incidents in purpose built flats and C and D are the reported and This assumes dwellings built before 1919 and half of those built during 1920-1945 were of suspended floor construction and those built after 1945 were of solid floor construction, which is reasonable for England and Wales. Scotland has different historic construction practices.

22 DA6201, Ref 8.

The most common location for casualties was a living room. Fewer casualties in the bedroom were reported this year compared with 2011/12 (four as opposed to nine). Only one injured person was located in the hall/landing compared with four last year.

A further analysis was carried out on the number of incident appliances fitted in compartments. There were eight incidents that involved appliances in compartments out of a total of 24 where the relevant details were reported. This is presented in Figure 13 and shows that this year, in common with 2011/12, a similar proportion of incident appliances were installed in a room compared to a compartment (around a third).

Figure 13 Incident appliances installed in compartments



Of the 19 reports that provided a response to the question "was the casualty and incident appliance located in the same or an adjacent property?" all but two specified that they were located within the same property as the incident appliance. There were two reports of casualties being located in adjacent properties, both terraced houses. One incident was caused by a badly sited flue terminal in a covered passageway. It is unclear how the CO migrated in the other incident.

2.5.1 Discussion

Without data on the nationwide breakdown of appliance installations by room, it is not possible to judge the significance, if any, of the incident appliance location. The location of casualties reported during the year was not surprising given people tend to spend most time in the bedroom and living room and indeed may go to bed if they feel unwell (as may be the case when suffering symptoms of CO poisoning). One fatal incident involved a victim dying in the living room after inhaling CO from a gas fire caused by a problem with the flue in the loft. The other fatality resulted in the victim dying in the utility room after CO was discharged from a poorly installed and serviced central heating boiler.

Without the knowledge of how many appliances are installed in compartments nationwide, it is not possible to gauge the significance or otherwise of whether compartment installations are more at risk of being involved in an incident. Over the last four years a similar proportion of the detailed incident reports involved appliances installed in compartments. Installing appliances in compartments can in some circumstances exacerbate the rate at which CO is produced and spreads around a property following appliance/installation malfunction as carbon dioxide can build up within a compartment more rapidly and hence can adversely affect combustion more quickly. One fatality this year involved a boiler fitted within a cupboard/compartment.

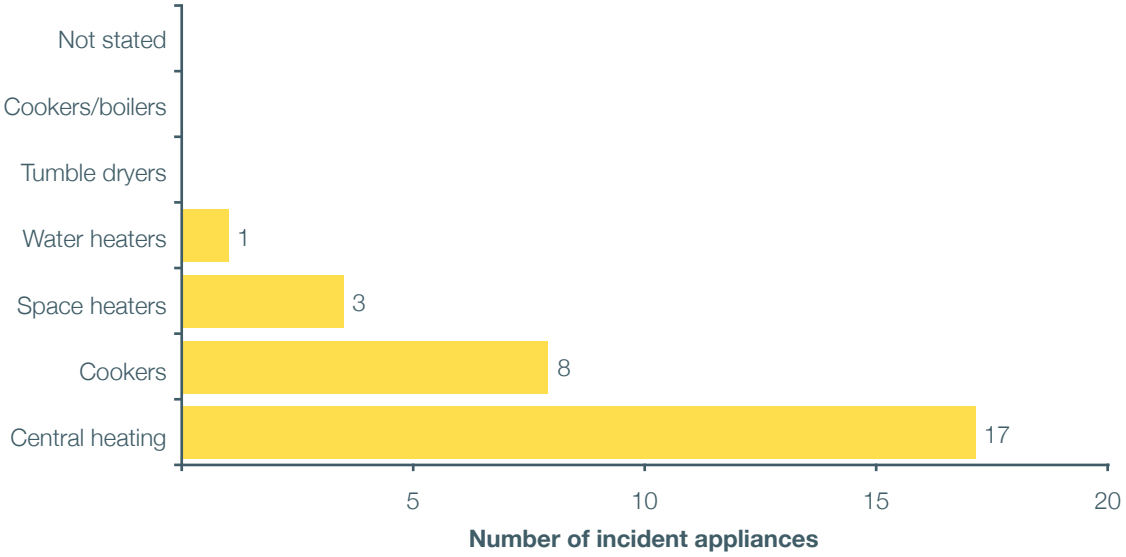
2.6 Incident appliance details

This section examines incident appliance details to see if there are any factors that could help influence future installation and maintenance guidance.

2.6.1 Appliance type

The numbers of incidents reported by the appliance type are given in Figure 14.

Figure 14 Incidents by appliance type



Most incidents involved central heating appliances (17), one of which involved a warm air heater (there were zero, four and two incidents involving a warm air heater in 2011/12, 2010/11 and 2009/10 respectively). Central heating appliances would be expected to figure prominently given their prevalence, their larger heat input compared to other domestic appliances and the fact that they tend to be in operation for substantial periods of time.

There were eight incidents reported this year involving cookers and three involving space heaters. For the second successive year there was one incident involving a circulator water heater.

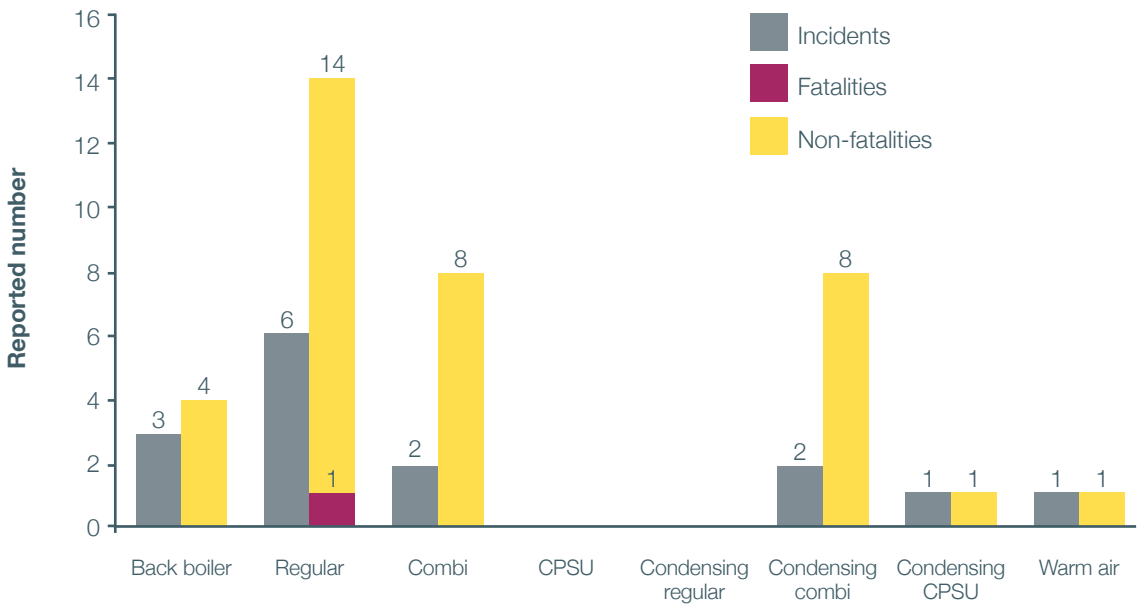
2.6.2 Central heating and boiler type

The incident numbers involving central heating appliances are sub-divided further in Figure 15. For only the second time since records began in 1996 an incident involved a combined primary storage unit (CPSU)[23]. The first incident was reported in November 2000. These central heating appliances are uncommon.

There was one fatality involving an old central heating appliance which was of the floor-standing regular boiler type. (Note a regular boiler is not a combination boiler or CPSU).

23 CPSU are combination boilers that heat and store water to feed the central heating circuit and a plate heater to provide domestic hot water. They were also called thermal storage systems when the boiler and storage water were in separate appliances.

Figure 15 Incidents by central heating type



In order to establish the relative risk presented by each boiler type, the boiler population by boiler type is required. Given the latest English Housing Survey is typically 18 months behind the current reporting period, the last published boiler population was projected forwarded 18 months using a best fit quadratic equation to the years 2007 to 2011.

Table 12 shows the resultant percentage breakdown for England which has been assumed to apply to GB as a whole. Figure 16 illustrates the projected proportions of each boiler type.

Table 12 Boiler populations by boiler type for England

Boiler type	Boiler population at end of March (%)[24]				Projection at end of 2012
	2008	2009	2010	2011	
Regular	36.3	32.7	29.2	26.1	20.3
Back-boiler	7.6	6.6	5.7	5.1	4.3
Combi-boiler	27.3	24.6	21.6	19.4	12.0
Condensing regular boiler	4.3	6.0	7.9	9.6	14.0
Condensing combi-boiler	12.5	18.2	23.7	28.3	38.7
No boiler	12.0	11.9	11.8	11.5	10.7

Note the population of CPSUs is assumed to be much smaller than the least numerous category in Table 12.

24 Source 2008 to 2011, DA6101 Ref 8.

Figure 16 Boiler population and projected figures

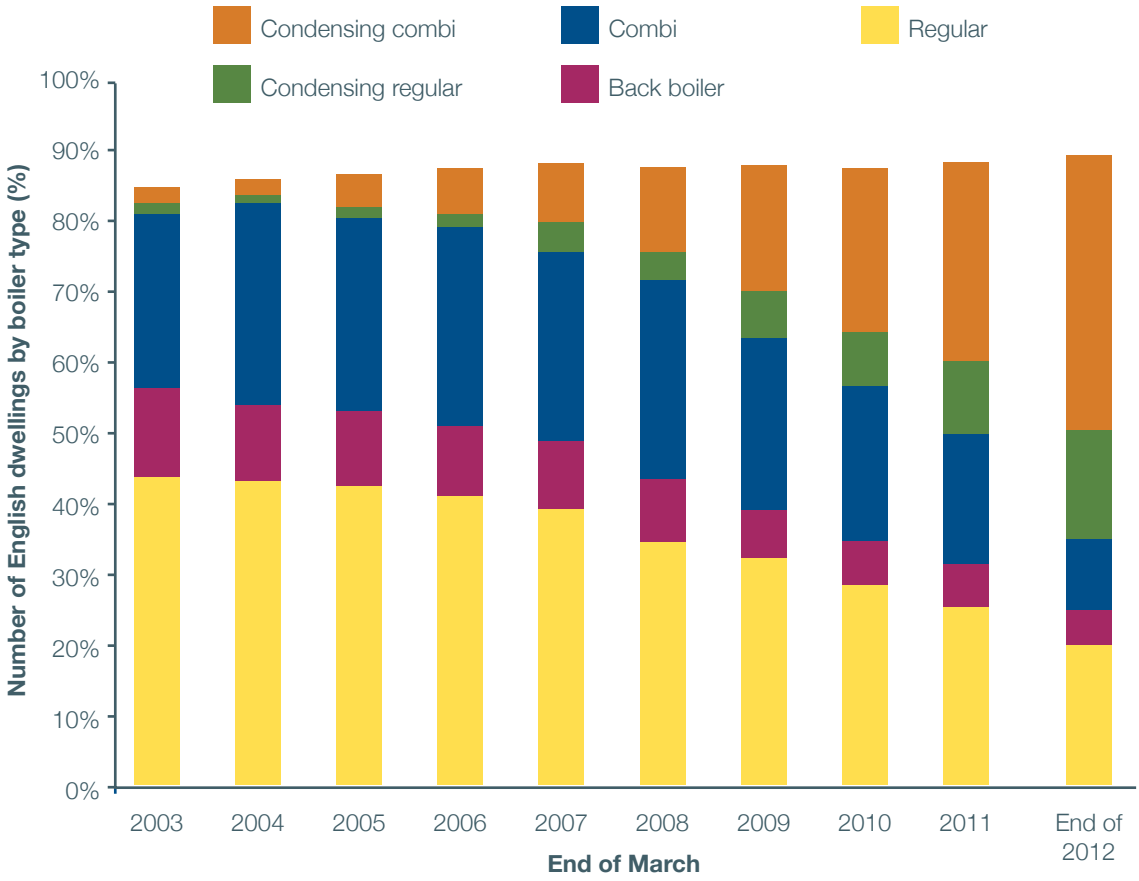


Figure 17 Incident numbers by boiler type

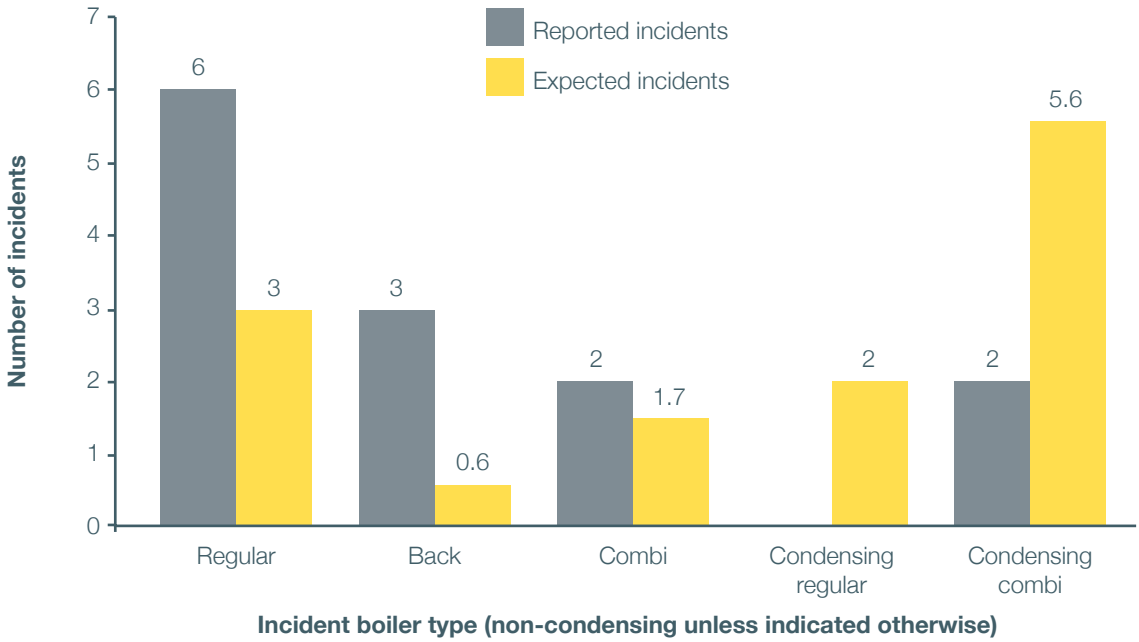


Figure 17 compares the 14 CO incidents reported with a known boiler type with those expected given the prevalence of each boiler type in the general population and assuming each poses an equal risk[25]. There are higher than expected numbers of incidents involving regular and back-boilers and lower than expected numbers of incidents involving condensing boilers. However, the numbers are too low this year to draw any firm statistical conclusions.

25 The expected number is the total number of incidents reported with a known boiler type multiplied by the percentage breakdown of boiler types in the general population.

2.6.2.1 Discussion

Figure 18 shows the calculated risk relative to the safest boiler type (all condensing boilers) for the years 2009/10 to 2012/13. The associated upper and lower estimates of relative risk are shown in Table 13.

Figure 18 Relative risk of incident by boiler type for recent years

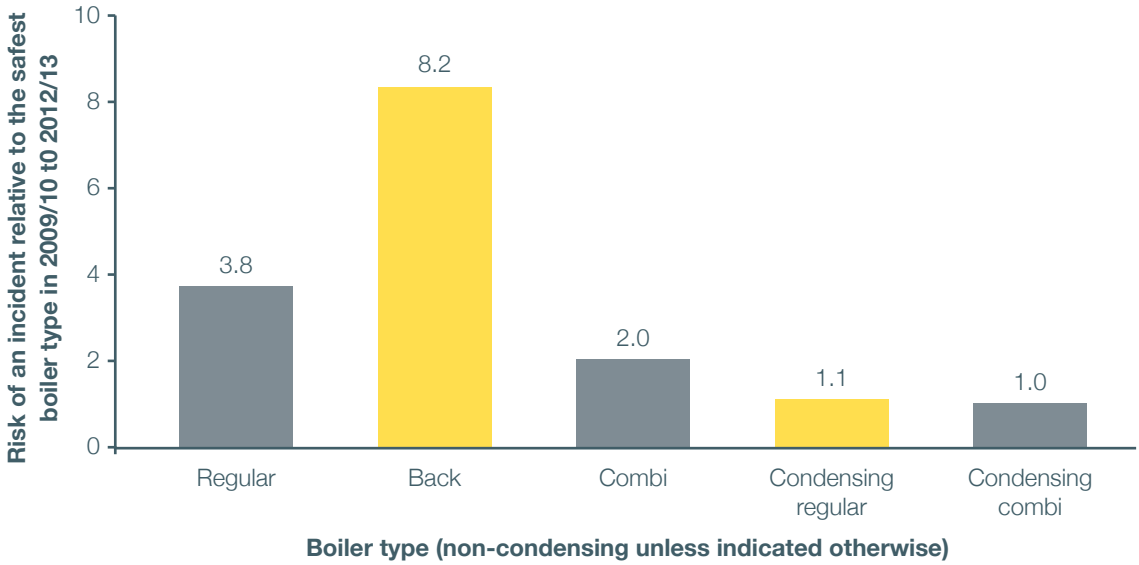


Table 13 Estimate of risk relative to safest boilers (2009/10 to 2012/13[26])

Boiler type	Lower estimate of risk	Mostly likely value of risk	Higher estimate of risk
Regular	3.5	3.8	4.1
Back-boiler	7.6	8.2	9.0
Combi-boiler	1.9	2.0	2.2
Condensing regular	0.9	1.1	1.3
Condensing combi-boilers	0.9	1.0	1.1

There is no statistically significant difference between the risks associated with condensing models.

Back boilers posed the highest risk of being involved in a reportable CO incident in the past four years as a whole with this risk calculated to have been 8.2 times that associated with condensing boilers. The factors contributing towards this high risk are likely to have been: -

- the tendency towards them being older appliances
- they have an open flued design
- they are very near the floor which means their burners can become linted without regular servicing and
- the fact they are two appliances in one (i.e. a gas fire in front of a boiler) offering more chance of malfunction compared with a single appliance, especially when regular servicing is not carried out.

In the past four years non-condensing regular boilers pose the next highest risk with a risk 3.8 times greater than condensing boilers. They tend to be older appliances and are a mixture of open flued and room sealed appliances.

Non-condensing combi-boilers pose a risk twice that of condensing boilers. These combi-boilers were developed later than regular boilers and so are generally newer and more likely to be room sealed boilers than non-condensing regular boilers. Hence they pose less of risk than non-condensing regular boilers.

26 This table illustrates the range in the expected value of the risk using the conventional criteria of 95% confidence, which means if the analysis were to be repeated on further samples, 95% of the samples would have a risk in this range.

2.6.3 Appliance age

Table 14 lists the numbers of incidents reported this year by appliance type and age.

Boilers of indeterminate age tend towards being older boilers. It is frequently the case that older boilers are more difficult to assess for age than those installed more recently. For example, older boilers are more likely to have been installed in properties where the occupancy has changed and hence installation date information is less likely to be known.

More appliances were reported this year of unknown age than those of known age making any detailed risk analysis by appliance age unreliable. Therefore no firm conclusions about appliance age and associated risk can be deduced. However, Table 15 suggests there seems to have been a disproportionate number of incidents involving appliances more than 12 years old.

Table 14 Incident numbers by appliance age

	Appliance age (years)			
	Under 3	3 – 12	Over 12	Unknown
Central Heating	2	1	8	6
Cooker	0	0	1	7
Space Heater	1	0	0	2
Water Heater	0	0	0	1
Total	3	1	9	16

2.6.4 Trends in incident appliance rates

Figure 19 and Table 15 show the annual numbers of fatalities involving different appliance types since July 1996. The two fatalities this year were associated with a space heater and a central heating boiler.

Figure 19 Fatalities by appliance type since 1996

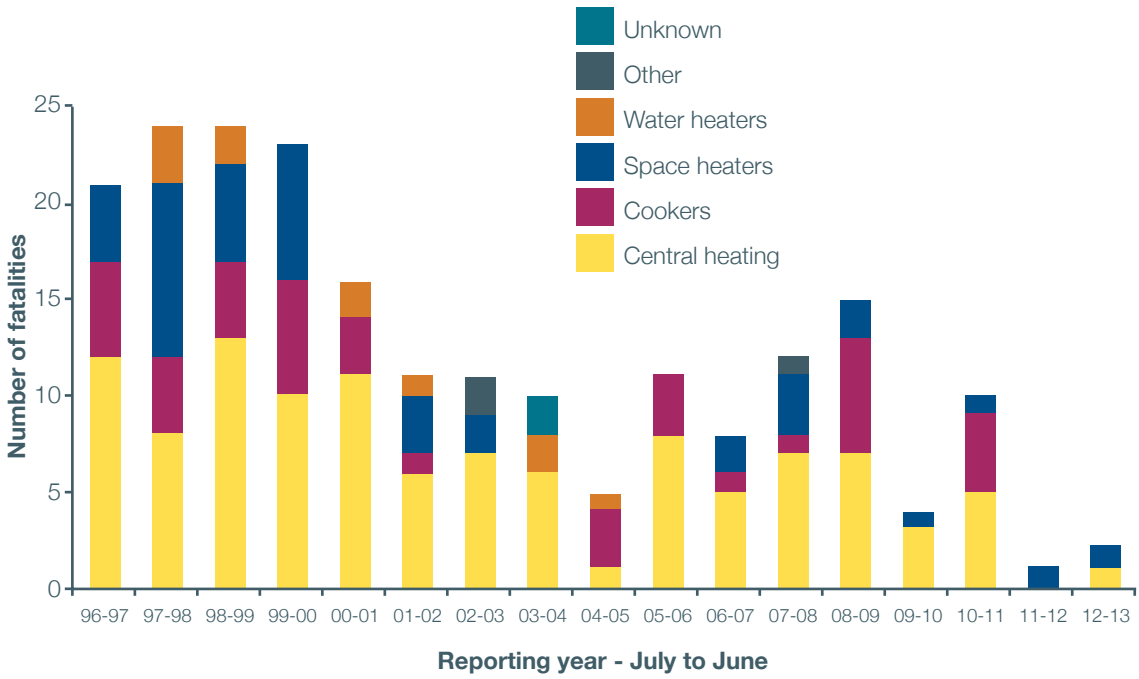


Table 15 Fatalities per year by appliance type since 1996

Year (July to June)	Not known	Cookers	Water heaters	Space heaters	Central heating	Other	Total
96/97	0	5	0	4	12	0	21
97/98	0	4	3	9	8	0	24
98/99	0	4	2	5	13	0	24
99/00	0	6	0	7	10	0	23
00/01	0	0	2	3	11	0	16
01/02	0	1	1	3	6	0	11
02/03	0	0	0	2	7	2	11
03/04	0	0	2	0	6	0	8
04/05	0	1	1	0	3	0	5
05/06	0	3	0	0	8	0	11
06/07	0	1	0	2	5	0	8
07/08	0	1	0	3	7	1	12
08/09	2	6	0	2	7	0	17
09/10	0	0	0	1	3	0	4
10/11	0	4	0	1	5	0	10
11/12	0	0	0	1	0	0	1
12/13	0	0	0	1	1	0	2
Average 96/97 to 00/01		3.8	1.4	5.6	10.8		21.6
Average 03/04 to 12/13		1.6	0.3	1.1	4.5		7.8
Average 09/10 to 12/13		1.0	0.0	1.0	2.3		3.4

2.6.5 Absolute risk of a CO incident by appliance type

This section quantifies the overall risk associated with different appliance types and determines whether it falls within generally accepted safety guidelines. It requires a reliable estimate of the appliance population nationwide. Such reliable appliance population estimates are only available for boilers and cookers.

2.6.5.1 Absolute risk of a CO incident involving boilers

For 2012/13, the number of people estimated to live in properties with gas central heating boilers in GB was 51.2 million[27] and this figure is used to estimate the absolute incident rate related to gas boilers (see Table 16).

27 26.4 million UK households at the end of 2012 (Ref 2) x (97.3% of dwellings in the UK are in GB (Ref 9 and 10) x 84.1% of dwellings gas boilers (Ref 8) x 2.37 occupants per household in 2012 (Ref 4).

Table 16 Incident data for gas boilers

	July 1st 2012 to June 30th 2013		
	Incidents	Fatalities	Non-fatal casualties
CO incidents	16	1	38
	Incident rate	Fatality rate	Non-fatality rate
Per million people per year	0.31	0.020	0.74

The risk of a fatality associated with gas boilers in GB occurring during the reporting year 2012/13 was considerably less than the commonly accepted health and safety criterion of one fatality per million people at risk per year. More particularly it is 0.02 fatalities per million people at risk per year (or two per 100 million people per year).

The risk of becoming a non-fatal casualty is also less than one per million people per year at 0.74 per million people at risk per year (or less than eight per 10 million people per year).

2.6.5.2 Absolute risk of a CO incident involving cookers

The estimated gas hob and gas oven populations for GB are shown in Table 17.

Table 17 UK cooking appliance population estimates

	Source data DUKES[28]			Inferred populations		
	Electric ovens millions	Electric hobs millions	Households millions	Gas hob & oven millions	Electric hob and oven millions	Gas hob and electric oven millions
UK households	16.6	12	26.6	10.0	12.0	4.6
GB population			61.9[29]	23.3	27.9	10.7

Table 18 assumes:

1) Homes without an electric oven have a gas hob and gas oven (i.e 26.6 – 16.6 = 10.0 million).

2) Very few homes have an electric hob and gas oven which means homes with an electric hob will have an electric oven (i.e. 12 million). This leaves 26.6 - 10 - 12 = 4.6 million with a gas hob and electric oven.

3) Percentage ownership of cooking appliances is the same in the UK as in Great Britain.

The risk of an incident, fatality or non-fatality involving a cooker is shown in Table 18.

Table 18 Incident data for cooking appliances

	July 1st 2012 to June 30th 2013		
Free standing gas cooker or separate gas hob	Incidents	Fatalities	Non-fatal casualties
CO related incidents[30]	7	0	13
Free standing gas cooker or separate gas hob population base	Risk of an Incident	Risk of a fatality	Risk of a non-fatal casualty
Per million people per year	0.21	<0.03	0.38
Free standing gas cooker population base	Risk of an Incident	Risk of a fatality	Risk of a non-fatal casualty
Per million people per year	0.30	<0.04	0.56

28 Table 3.11, Ref 11.

29 GB population mid-2012, Ref 7.

30 There were eight incidents involving cooking appliances one of which was inbuilt gas oven. Population data for inbuilt gas oven is unknown and hence the inbuilt oven incident is excluded from this table.

The number of fatal casualties associated with cooking appliances in GB over the reporting year 2012/13 was zero. The risk of a fatality, can never be zero as there will be a small risk of a fatality even if a fatality does not occur during the year (risk is about potential). All that can be usefully said about the risk in this case is that the risk is less than one fatality per reporting period expressed in fatalities per people at risk per year.

2.6.5.3 Discussion

The total number of fatalities due to accidental CO poisoning associated with domestic natural gas use has declined from an average of 22 during 1996/7 to 2000/1 to an average of four per year over the last four years, the turning point being around the start of the millennium. The average number of fatalities associated with central heating appliances has declined to two, space heaters to one and for cookers to one (see Table 16) over the four years ending in 2012/13.

No reliable conclusions about appliance age and associated risk can be deduced due to the number of incidents reported with indeterminate age.

Risk rates for fatalities involving cookers or boilers in 2012/13 were well below one tenth of the generally accepted risk criteria of one fatality per million people at risk per year. Rates for non-fatal casualties were about half the generally accepted risk criteria.

No reliable population estimates of gas fires are known hence information about absolute risks cannot be stated.

2.7 Individual appliance types and models

Detailed information about the incident appliances is presented below as it was stated on the DIDR form. This included the manufacturer's name and model which has been provided for the record. No significance can be attributed to models or manufacturers without relating this to the numbers of such appliances installed nationwide. For example, the most frequently occurring manufacturer's name featured in the incident reports may be there simply because it is the most common manufacturer in the general population or, alternatively, that the incident may have had nothing to do with the design or performance of the appliance, but as a consequence of poor installation, maintenance or servicing practice.

2.7.1 Fatal incidents

2.7.1.1 Central heating appliances

A single fatality involved an Ideal Mexico Super floor-mounted central heating boiler. The causes specified were appliance fault, flue/terminal fault, sub-standard compartment, lack of servicing and sub-standard servicing.

2.7.1.2 Space heaters

A single incident with one fatal and one non-fatal injury involved a gas fire (make unknown) connected to a chimney. It happened shortly after work had been carried out in the loft by insulation contractors.

2.7.1.3 Cooking appliances

No fatal incidents involving natural gas cooking appliances were reported. The details of a triple fatality associated with a LPG cooker are presented in Appendix A.

2.7.1.4 Water heating appliances

No fatal incidents involving water heating appliances were reported.

2.7.2 Non-fatal incidents

The following sub-sections describe those appliances involved in incidents with non-fatal casualties that were fully investigated.

2.7.2.1 Central heating appliances

These were involved in 17 incidents. Two of these incidents did not have the central heating appliance details specified.

- **Back boiler units (BBU)**
  Three incidents – makes and models unknown
- **Condensing regular boilers**
  None
- **Condensing combi-boilers**
  Ravenheat CSI 150NT
  Sabre HE 25
- **Condensing combined primary storage unit**
  Ideal istor HW325
- **Combi-boilers (non-condensing)**
  Worcester Greenstar
  Glow-worm, Fuelsaver MKII 50B
- **Regular boilers (non-condensing)**
  Wall mounted:
  Glow worm, Fuel Saver Mk2 30C
  Glow worm, Fuel saver MK2 40

  Floor standing:
  Potterton, Kingfisher, CF 100
  Ideal Standard, E Type, RS 50
  Ideal Mexico Super
  Potterton, Kingfisher 2
- **Warm air heaters**
  Johnson and Starley, JB40/50 with Janus 3 Water Circulator

2.7.2.2 Space heaters

Two incidents involved space heaters:

Wonderfire decorative fire
Valor, Bauhaus Inset live fuel effect fire

2.7.2.3 Cooker/boilers

None

2.7.2.4 Cooking appliances

Seven incidents involved free standing cookers or separate gas hobs and one incident involved a built-in oven. Details supplied for two of the free standing cookers are:

Leisure, Victoriana EL
Laureat deluxe

2.7.2.5 Water heating appliances

One incident involved a Johnson and Starley, Janus 3 with a warm air heater

2.8 Appliance installation details

Table 19 provides information relating to the person reported to have installed the appliance involved in an incident and whether the appliance installation was to standard.

Table 19 Appliance installation details

Installer details	To current standards	To standards current at time of installation	Not to any appropriate standards	Unsure/don't know	Total
Registered	0	0	2	0	2
Non-registered	0	0	0	0	0
DIY	0	0	0	0	0
Unknown	2	3	7	15	27
Total	2	3	9	15	29

The vast majority of appliances had unknown installers (27 out 29) so an analysis of those carrying out the appliance installation is not possible.

Two registered operatives each carried out an installation that was not to standard. The first installed a circulator water heater and the fault stated was "Ventilation undersized and compartment not sealed to allow natural migration route into lounge". The date of the installation was unknown. The second installed a Combined Primary Storage Unit in 2007 with the safety discharge 1m above ground level onto a public walkway.

2.9 Flue details

A breakdown of the 20 incidents where flue type details were reported is shown in Figure 20.

Most of these incidents involved open flues with four incidents associated with room-sealed flues, nine with open flues and seven with flueless appliances (which were all either cookers or hobs). One of the fatal incidents involved an open flued appliance. The flue status in the incident involving the other fatality is not known.

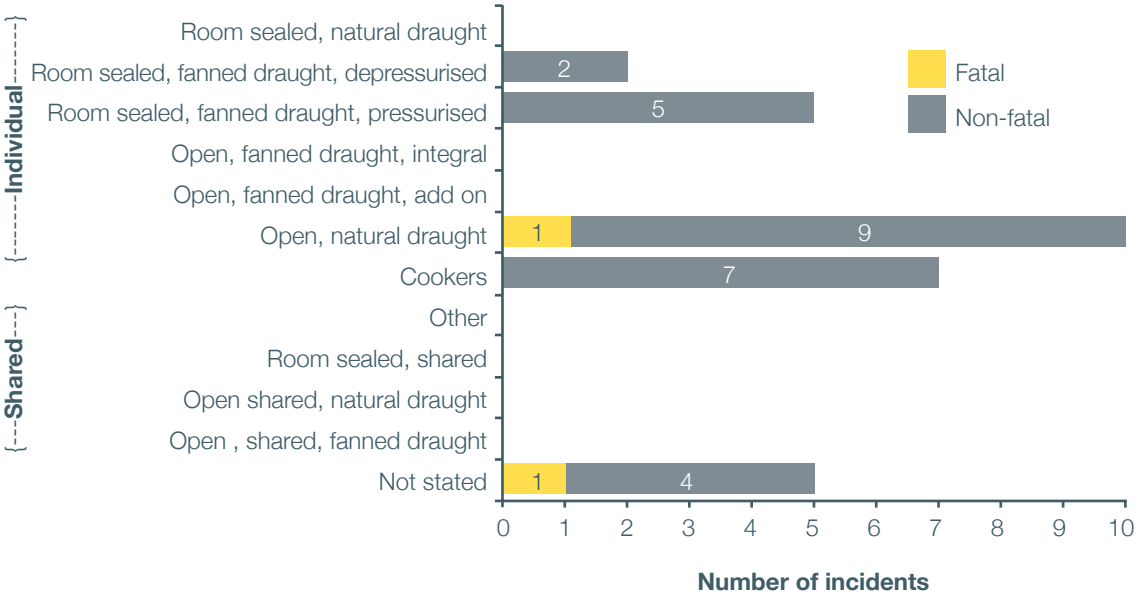
There were only five incidents with a known flue installation standard status of which none were installed to current standards as shown in Figure 21. This is too few to draw any conclusions.

One of the two fatalities reported this year involved an open flue system not installed to standards that were current at the time of installation.

2.9.1 Discussion

The proportion of incidents involving appliances with open flues increased from 55% in 2009/10 to 63% in 2010/11 and 64%[31] in 2011/12. In 2012/13 it was 59%. Whilst the proportion of open flues existing and operational with gas appliances nationwide will have decreased over the same period of time, they continue to feature disproportionately highly in incidents.

Figure 20 Incidents by flue type



In previous annual reports, population data on open flued and room-sealed boilers has referred to a survey published in 2005. In May 2005[32] 19% of boilers had open flues. Since then the number of boilers with open flues has gradually declined as they have been replaced by newer room-sealed appliances. The figures published in 2005 therefore represent an upper estimate of the population of room-sealed boilers during 2012/13 and hence this represents a lower estimate for the relative risk associated with open flued boilers compared to room-sealed boilers.

Table 20 shows the numbers of central heating incidents reported this year where the flue type was specified (14) and the expected number based upon the estimated boiler population in May 2005, based on equal risk by flue type.

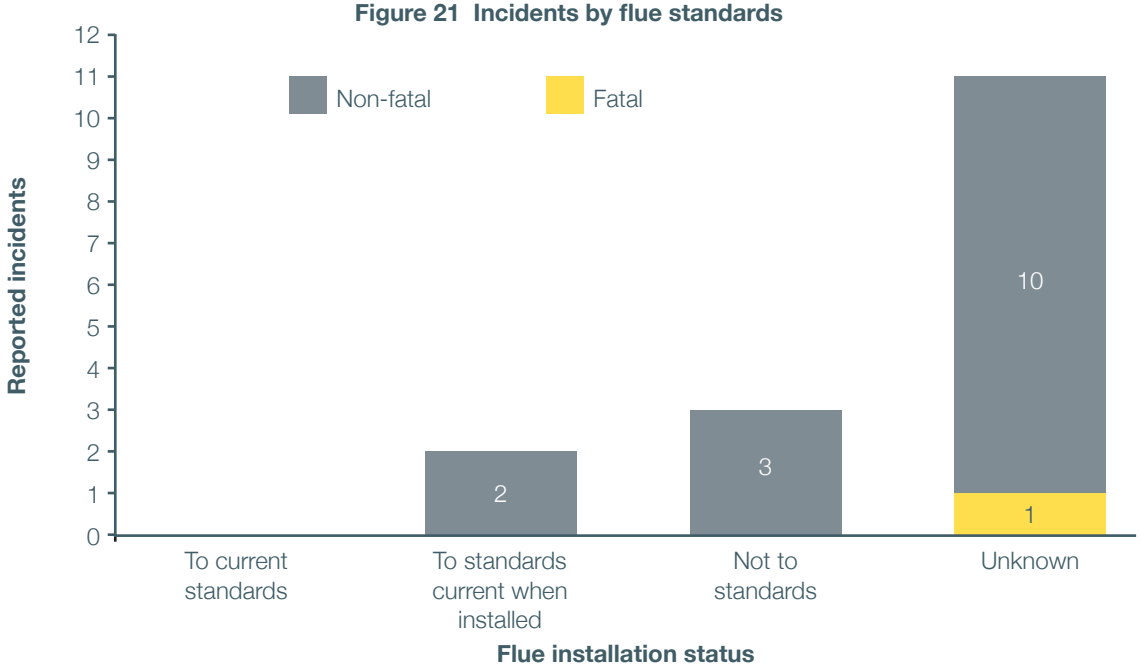
Table 20 Reported and expected incident numbers for boilers by flue type

Boiler flue	Reported number	Expected number
Open flue	7	3
Room-sealed	7	11

Assuming open flued and room-sealed boilers are equally likely to be involved in an incident, the probability of seven or more incidents occurring by chance is very small (less than 2%). It is therefore concluded that boilers with open flues expose occupants to a higher risk of a CO incident, either fatal or non-fatal, and this is at least 4.2 times that associated with room-sealed appliances. In 2011/12, the risk was six times that associated with room-sealed appliances and in 2010/11, it was 3.4 times greater.

31 69% was stated in error in the 2011/12 report, Ref 2.
32 Ref 11.

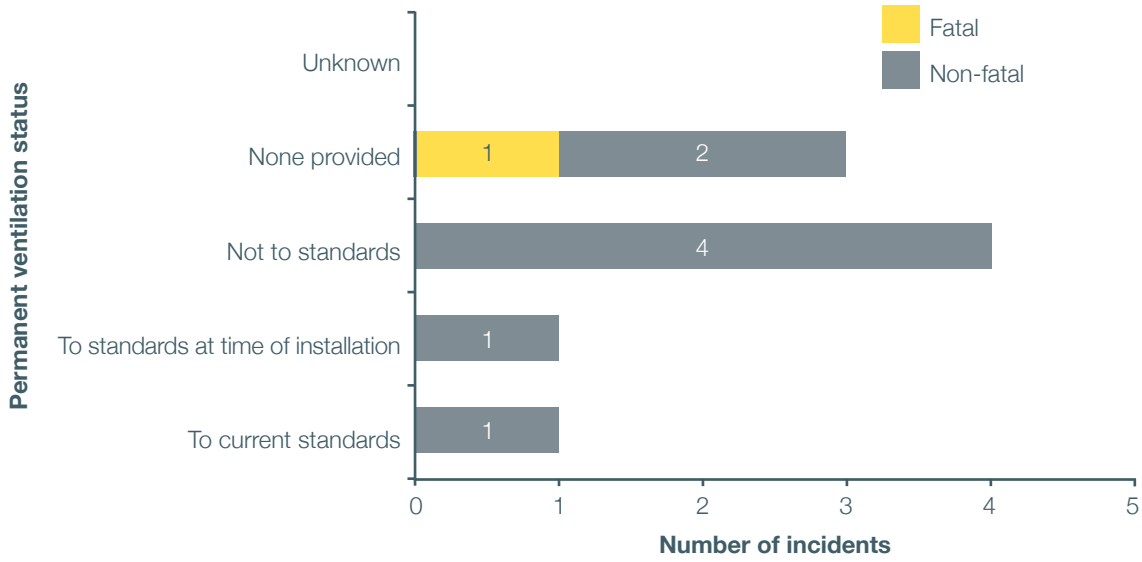
Figure 21 Incidents by flue standards



2.10 Permanent ventilation

For nine incidents, investigators reported that permanent room ventilation was inadequate and Figure 22 shows a summary of the ventilation provision reported. In seven of the nine reports, the ventilation was described as 'not to standard' either at the time of inspection or appliance installation (or was not specified at all).

Figure 22 Incidents by reported ventilation condition



Where ventilation was provided, there were five incident sites at which this was found to be either fully or partially obstructed. A breakdown of those incident sites where totally obstructed vents were reported is given in Table 21.

Table 21 Incidents reported with obstructed ventilation

Number of incidents with:	
Vents intentionally obstructed	1
Vents unintentionally obstructed	3

2.11 Safety devices

The categories of safety device specified on DIDR forms are CO detectors (chemical spot or battery/mains powered alarm type), downdraught sensors and anti-vitiation devices. Safety devices were reported at 11 incident sites this year.

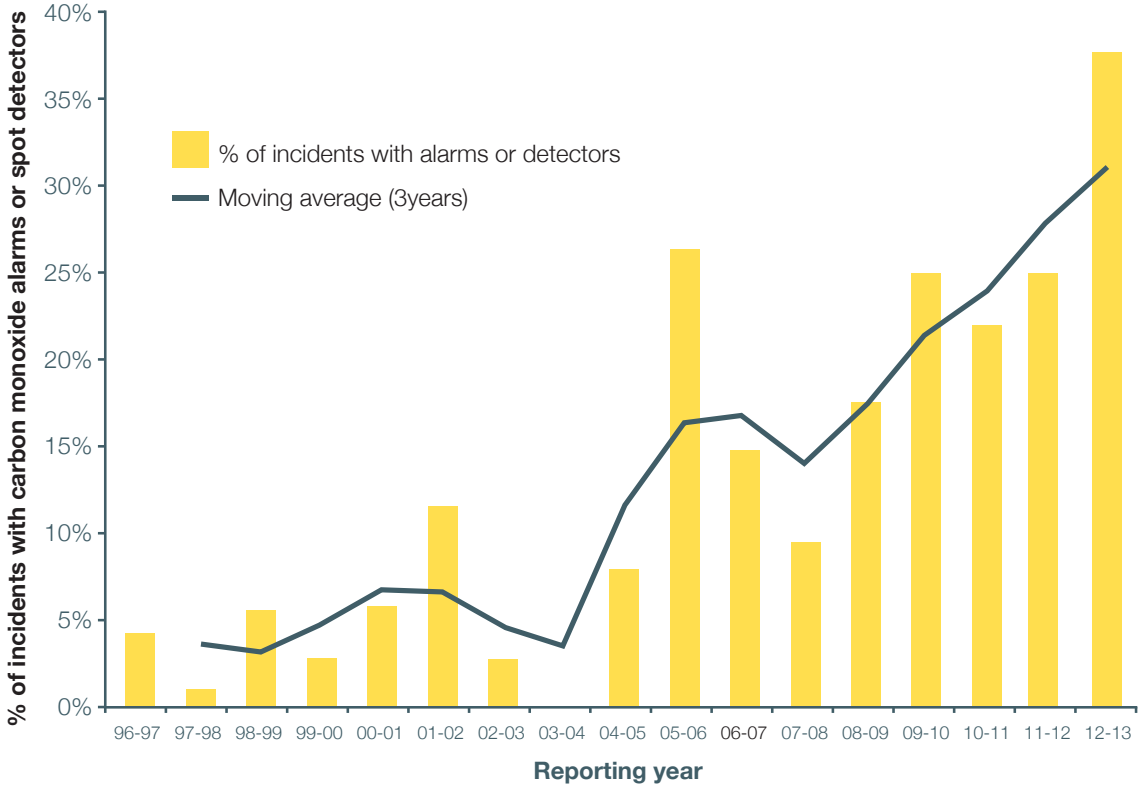
CO electrical alarms were installed at 11 of the incident sites with eight reported to have sounded during the incident. Of the two fatal incidents reported, one did not have a CO electrical alarm installed and at the other, insufficient information was reported.

Figure 23 shows the percentage of incidents where a CO alarm or chemical spot detector was reported to have been installed for the years since 1996. Prior to 2004/5, the average proportion of incidents where alarms or detectors were installed was around 5% and this had risen to over 20% by 2010/11. The graph shows a three-year moving average centred on the middle year. The moving average for 2012/13 is the average of 2011/12 and 2012/13.

CO alarms (not chemical spot detectors) were found by investigators at 38% of incident sites this year and this is the highest on record.

Investigators at eight of the 11 sites with CO alarms reported that activation occurred during the incident. Of the other sites, two alarms did not sound (apparently due to inappropriate siting) and it is unknown if the remaining alarm activated; all three were reported to be operational by investigators.

Figure 23 Percentage of incidents with CO alarms or detectors



2.11.1 Discussion

The rise in the proportion of incidents where CO alarms had been installed (see Figure 23) is probably a reflection of a rise in their popularity. An estimated 16%[33] of homes have CO alarms nationwide, whereas in 2012/13, 38% of reported incidents involved homes with CO alarms.

33 CO alarms, page 6, Ref 3.

If sited and fitted properly, alarms are intended to sound before any CO in the property reaches levels that are dangerous to health. In particular, they are intended to prevent someone's blood carboxyhaemoglobin (COHb) level reaching more than 2.5% v/v saturation.

Of the eight incidents where the alarm sounded, half had at least one person immediately hospitalised and half had no one immediately hospitalised. All were confirmed to have involved CO leakage within or into the property. It is not possible to tell whether hospitalisation resulted in only precautionary tests or a longer stay to recover from the effects of CO poisoning (i.e. admitted for more than a day).

On the strict definition of a RIDDOR reportable incident (i.e. a death or major injury) CO alarms would be expected to have alerted occupants to danger and prevented serious injury.

From the outset of the work to collate and report on CO incidents involving mains natural gas and piped LPG using DIDR in 1996, incidents only qualified if someone required treatment (even if treatment was refused). These may not all be RIDDOR reportable incidents in the strictest sense (i.e death or a major injury) but as an investigation has to be conducted in order to identify a source of CO, it would be unwise to ignore the information obtained given it can contribute to a body of knowledge for use in assessing safety into the future.

When COHb levels are recorded, this can give an indication of how much the victim has been exposed but can be misleading both because of an individual's smoking habits and also the time delay between exposure and COHb measurement.

Of the two cases reported this year when the alarm did not activate: -

- In the first case, a combined CO and smoke alarm was installed 2m above floor level in the hallway. The incident appliance was in the kitchen and three occupants were in the living room or bedsit at the time of the incident. Immediate hospitalisation was sought. It is recommended by Which?[34], alarm manufacturers and industry standards that alarms are installed at around head height in the same room as the appliance.
- In the second incident, the alarm was located in the living room on a 600mm high shelf. The occupants affected were in this room. The appliance, a back boiler unit, was installed in the same room. In this case, immediate hospitalisation was not sought.

These cases serve to emphasise the importance of fitting CO alarms in compliance with manufacturer's instructions or industry standards.

There is concern that the activation of a CO alarm may be leading to an increase in the number of RIDDOR incidents reported because if someone feels unwell after the device triggers, they are likely to get checked out medically even though their exposure to CO may have been minimal.

This is further exacerbated when: -

i) user instructions advise the user to obtain medical help if an activation occurs and/or

ii) gas emergency service providers recommend to someone feeling unwell at the site that they should obtain a medical check-up to be on the safe side.

Investigators confirmed that CO had been released during all of the incidents reported this year where alarms were installed, (i.e. no alarm activation proved to be a false or nuisance alarm). The number of incidents where CO alarms had been installed was disproportionately higher in the private rented sector and this is discussed in section 2.4.1.1.

34 Carbon monoxide alarm review, Which? Ref 13.

There is other evidence that CO alarms may be helping to reduce the number of incidents reportable under RIDDOR. Three instances were identified by British Gas investigators during 2012/13 in which the alarm sounded and alerted the occupants before they were harmed. Subsequent investigations confirmed the installations involved were discharging excessive amounts of CO into the properties. Between 2009/10 and 2011/12, 15 similar situations were brought to our attention by British Gas from their incident register.

It should be emphasised that only the details of the incidents confirmed to have been caused by CO are entered onto the national CO incident database.

In principle, it could be argued that alarms which have triggered might motivate those who may have been exposed and are feeling unwell to seek medical attention and this could lead to a reportable incident when none should have been recorded.

As alarms are becoming more prevalent, and this might be leading to more reportable incidents which do not involve fatal or major injury, then consideration may need to be given towards creating a sub-category of incident 'triggered by CO alarm' in order to help identify trends in those specific incidents where death and/or serious injury do occur.

2.12 On-site checks

The on-site investigation of an incident involves the investigator making a number of fundamental observations and carrying out specific checks and measurements. The results are broken down by category in Figure 24 and Table 22. A wide range of faults were identified but it should be remembered that these did not necessarily contribute to the incident.

The specific faults which were considered to have contributed to each incident are discussed in Section 2.14.

Figure 24 Reported faults by type

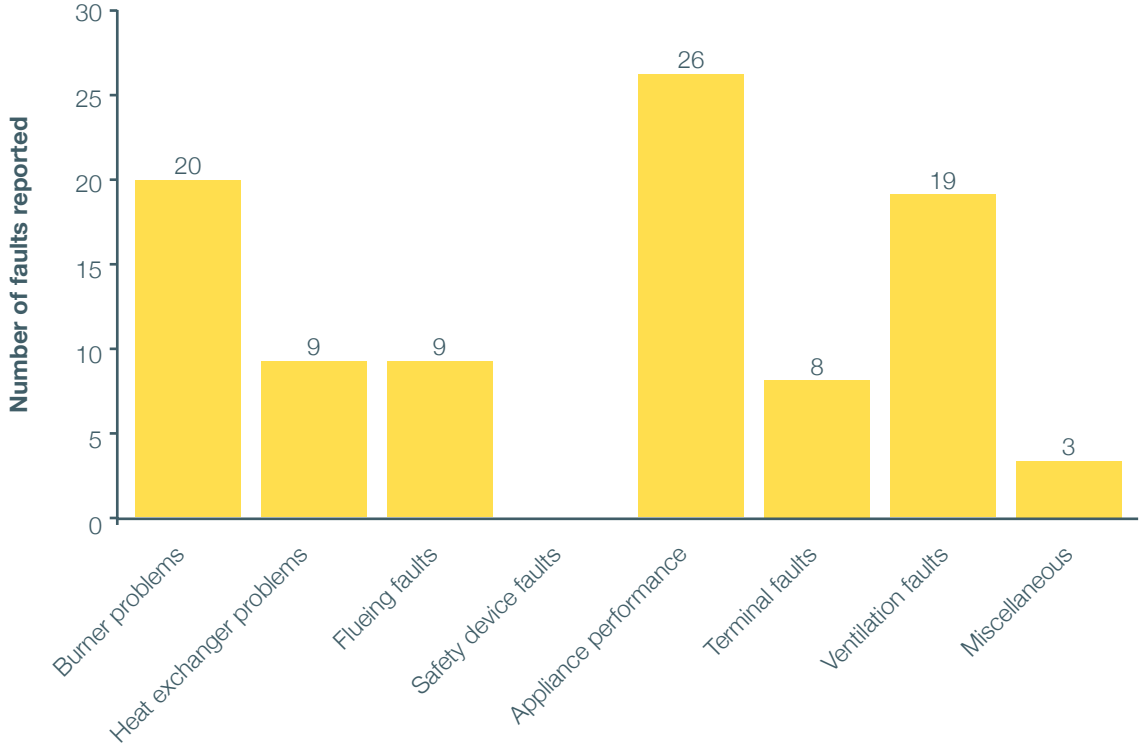


Table 22 Incident appliance/installation faults

Fault group	Number of faults
Burner	
Corrosion	0
Defective flame picture	8
Linting	6
Over-pressure	3
Under-pressure	0
Other	3
Flue	
Blockage	0
Corrosion	1
Flue not to any standard	0
Installation fault	8
Other	0
Heat exchanger	
Blockage - shale	2
Blockage - soot	4
Cracked	1
Other	2
Safety device	
CO inoperable alarm	0
Failed down draught	0
Failed vitiation device	0

Fault group	Number of faults
Appliance performance	
High CO/CO2 ratio	8
Failed spillage test	4
Overrated	3
Underrated	1
Signs of spillage – inside or outside	10
Terminal	
Down draught	2
Bad siting	4
Unapproved design	0
Other	2
Ventilation	
Air vent/vents ineffective	6
Air vents obstructed - intentionally	1
Air vents obstructed - unintentionally	4
Compartment not to any standards	0
No permanent ventilation provided	3
Ventilation was not to any standard	5
Miscellaneous	
Local topography	0
Weather	3

Note to Table 20

The number of faults (not incidents with a fault) and it is evident that there is likely to be more than 1 fault existing per appliance.

The greatest numbers of faults reported were related to appliance performance. From Table 22 it can be seen that there were eight instances of a high CO/CO2 combustion ratio and 10 instances where signs of spillage were observed by investigators. The 10 instances where signs of spillage were reported were associated with six separate installations. Defective flame pictures were also reported at eight sites.

Although not necessarily contributing to the incident concerned, a high proportion (28%) reported flue installation faults compared to 8% in 2010/11 and 16% in 2011/12.

2.13 Incident appliance history

Service history information was reported for 19 incidents and details are given in Table 23.

Table 23 Details of service history

Service history status	Number of incidents	Number of fatalities	Number of Non-fatal casualties
On a regular service contract	4	0	12
Not on a regular service contract	8	0	19
Unknown whether or not on a regular service contract	17	2	31
Total reported incidents	29	2	62

The registration status of the gas operative who attended the installation prior to an incident is given in Table 24. Unlike previous reports, where a working visit was defined as one other than the original installation, a working visit may include the original installation if this was the last visit made prior to the incident.

Table 24 Status of operative attending at last working visit

Number reported	Number of fatalities	Number of non-fatal casualties	Number of Non-fatal casualties
Non-registered operative	0	0	0
Registered operative	8	0	26
Unknown	21	2	36
Total for all incidents	29	2	62

Table 25 details when the last working visit occurred and shows 10 of the 19 incidents with an appliance history had a last working visit during the 12 months prior to the incident. Five of these 10 visits were by registered operatives; the rest were reported as unknown.

Of the ten working visits that were within 12 months of the incident, two had been for a service, two had been to attend to a breakdown or report of fumes, two had been for a Landlord's Safety Check and four to install the appliance.

A concern is that four new appliance installations were involved in incidents within 12 months. The status of the operatives was reported as unknown and the installation faults/causes were describe as:

- Incorrect installation of fire, fire surround, alterations of fireplace opening and flue system, fire flue restrictor fitted.
- Flue terminated into a covered passageway
- Badly sited flue terminal and flue installation fault
- Second hand cooker fitted without service history or documentation of safety checks carried out prior to purchase. No flame failure devices (FSDs) fitted on all burners in multi occupancy dwelling (since June 2008, newly installed flueless cooking appliances in multi-occupancy dwellings should have FSD protection on the hotplate burners). Cooker hotplate burners positioned lower than the surrounding worktop. No stability device fitted to cooker. Defective grill flame picture.

The two visits following a report of fumes or a breakdown and the two service visits were attended by registered operatives. The faults/causes described were:

Service visits:

- Sub-standard service of warm air unit (heat exchanger not fully cleaned out during service), undersized ventilation. An 'at risk' warning notice for undersized ventilation had been left prior to the incident. The air vent was unintentionally partially blocked.
- Ventilation undersized and compartment not sealed allowing a natural migration route for combustion products into the lounge. Evidence of a lack of servicing was poor burner condition and unsatisfactory pilot flame picture associated with the circulator water heater of a warm air unit. The air vent was unintentionally partially blocked.

Breakdown visit:

- A lack of servicing combined with flue installation issues was reported as a contributory factor. A flue/configuration issue was reported not to have been to standard at the time of installation due to its proximity to an air vent. The air vent was partially blocked. It is unknown when the last service visit occurred.

Report of fumes visit:

- A second hand cooker was installed to current standards. A contributory factor was stated as a lack of servicing although the specific cause has not yet been established.

Warning notices classify a situation as immediately dangerous (ID), at risk (AR) and not to current standards (NCS)[35]. Two sites had AR warning notices left prior to an incident.

One AR notice was attached to a boiler. The investigator stated the flue was inadequately supported. The last working visit had been between one and two years before. The landlord had failed to respond to requests to carry out a service and organise a safety check visit.

The other AR notice (attached to a warm air unit after a service visit) is mentioned above in the details of the first service visit.

In 2012/13, none of the most recent visits made to incident properties were confirmed to have been made by unregistered operatives.

Table 25 Interval between the last working visit and the incident

Time between the last working visit and the incident	Number of reported visits	Number of reported fatalities	Number of reported non-fatal casualties
Less than 6 months	7	0	20
6 months to 1 year	3	0	9
1 year to 2 years	2	0	4
More than 2 years	2	0	2
Unknown	15	2	27
Total of all incidents	29	2	62

35 The Gas Industry Unsafe Situations Procedure, Ref 14.

2.13.1 Discussion

The number of operatives visiting to carry out gas work in the period up to 12 months prior to an incident (10) was slightly higher than the numbers in 2010/11 (7) and in 2011/12 (8). Two service visits were conducted between six and 12 months prior to an incident.

Before leaving an appliance in operation, the operative must always carry out the safety checks required by Regulation 26(9) of the GSIURs which are intended to ensure that an appliance is safe for continued use.

However, as there is no requirement to carry out a combustion check on leaving an appliance following a breakdown or Landlord's Safety Check, it is by no means certain that combustion will remain satisfactory for the next 12 months.

During a service visit, either the appliance should be fully stripped and cleaned or serviced in accordance with BS 7967. Following this, the combustion is expected to remain satisfactory for the subsequent 12 months.

Two incidents in 2012/13 had a service visit between six and 12 months prior to the incident and sub-standard servicing was reported as the cause. This was evidenced by inadequate cleaning of the heat exchanger, poor flame picture and poor pilot light flame picture. In both cases, these service visits were carried out by registered operatives and both involved warm air heaters, one with a circulator water heater.

Two sites had AR warning notices left. It is a cause for concern that an owner/occupier and a private landlord did not seem to have taken these notices seriously.

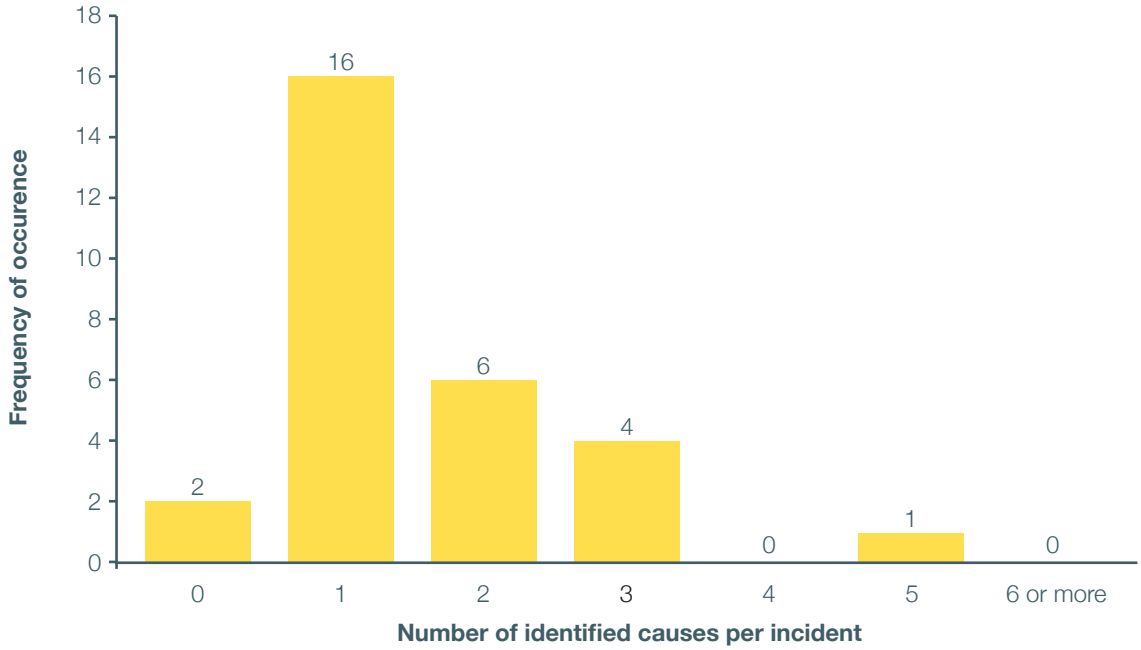
2.14 Incident causes

Details of the causes of reported incidents are summarised in Figures 25 and 26. It should be noted that these causes are different from the general faults discussed in Section 2.12.

Figure 24 shows the distribution by the number of causes reported per incident. For example, a single cause was recorded for 16 incidents whilst a further six had two causes specified. "Zero causes" means no cause was identified.

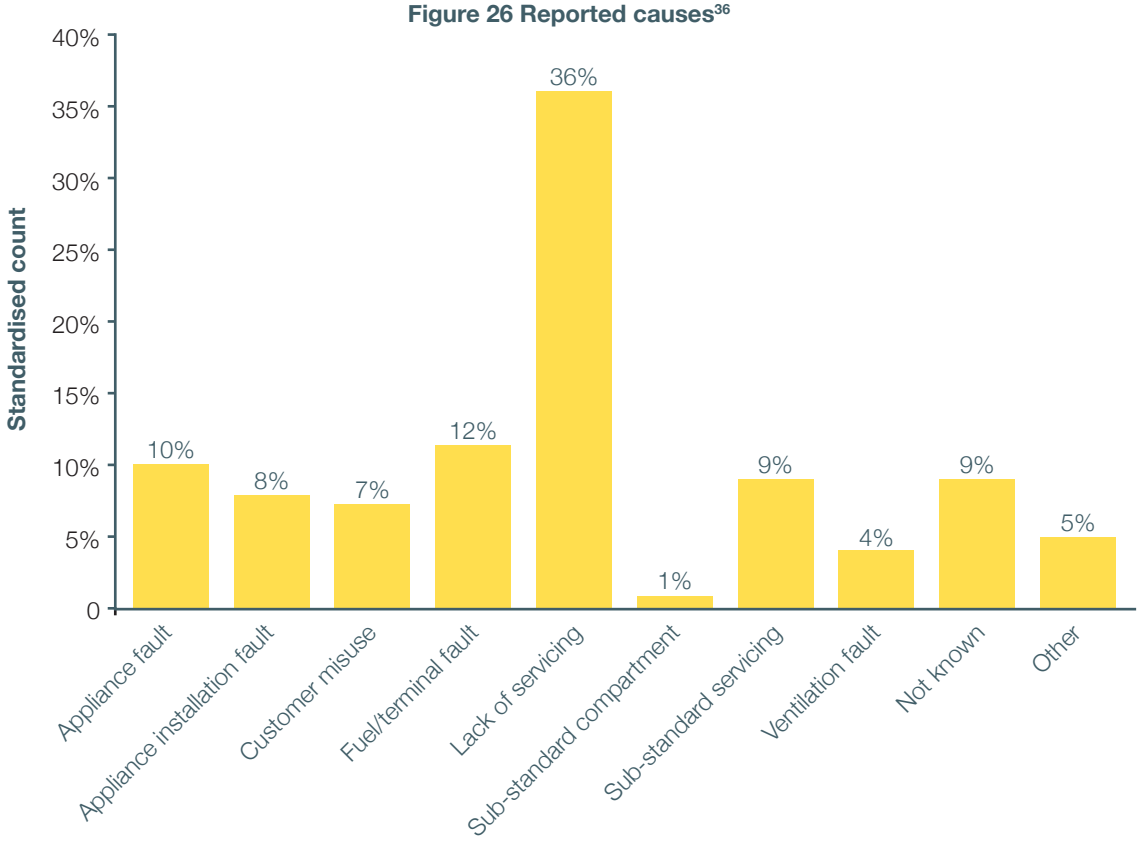
Experience has tended to suggest that incidents occur when a number of events occur simultaneously resulting in the production of CO and leading to its discharge into the property. This year, like last year, a sizeable number of incidents were reported as having a single cause (16 out of 29 compared to 13 out of 24 in 2011/12). Lack of servicing was the most frequently reported fault. Half of the cases that reported a single cause stated lack of servicing as the cause. As just over half of the incidents reported a single cause, and half of these stated lack of servicing as the cause, the implication is that regularly and proper servicing might reduce that number of incidents by just over a quarter.

Figure 25 Distribution of the number of stated causes



In Figure 26 the counts (the number of times a specific fault was reported) have been standardised by dividing these by the number of established causes per incident and are expressed as a percentage of the total count (24). For example, if there were three causes reported for one incident, each of the three causes would represent a third of a count.

Figure 26 Reported causes[36]



As there were 10 reported causes if all the causes were equally likely, the contribution score for each of the causes detailed in Figure 26 would be 10%, so groups with a contribution score above 10% constitute a higher contribution than average.

36 Figures add up to 101% and not 100% due to rounding errors.

Lack of servicing was the most common cause specified by investigators with a standardised count of over a third of incidents (36%) the same as last year, followed by flue terminal fault (12%) and appliance fault (10%). The other remaining causes were less frequently specified.

These are the same top three as 2010/11 and 2011/12 but the order differs.

Reports of customer misuse of an appliance (7%) as the cause of an incident all related to cookers and were similar to 2011/12 (8%), 2010/11 (9%) and 2009/10 (7%). Customer misuse in 2012/13 was usually the practice of placing unsuitable objects on the burners.

A sub-standard compartment contributed to one fatal incident in 2012/13. The investigator also reported sub-standard servicing, a lack of servicing, an appliance fault and a flue/terminal fault. Sub-standard installations in compartments can cause a more rapid generation and spread of CO around a property compared to those not installed in a compartment. From the report received, it was unclear whether a sub-standard compartment was the major contributor or just one of the many factors including lack of service or poor standard of servicing leading to a build-up of dust and lint around primary intake to the burner, incorrectly installed baffles or bad siting of the flue terminal.

3 Conclusions and recommendations

1. The risk of someone in the private rented sector being involved in a reportable CO incident where mains natural gas was the fuel remains greater than in any other housing sector. The two main risk factors recorded were an older appliance (four of the seven incidents with full reports involved appliances installed in 1988 or before) and a lack of appliance servicing. Measures that could be considered in order to address the elevated risk of a CO incident in the private rented sector include; requiring an operative to make a combustion performance measurement on open flued boilers and warm air units when carrying out a Landlord's Safety Check; requiring CO alarms to be installed with a record made of details on the Landlord's Safety Check form; promoting or even requiring regular servicing of appliances.

2. This year the second lowest number of fatalities was recorded since detailed records began in 1996 within the mains natural gas and piped LPG sectors and there is a continuing trend towards fewer fatalities. Figures for the number of CO incidents have been repeatedly quoted in the media and tend either to be grossly inflated or ill-defined in terms of the fuel/energy sector to which they refer. There is no doubt that to focus upon specific fuel sectors would offer the greatest opportunity to improve CO safety. It is positive that HSE are now quoting the average numbers of gas related fatalities over the last five years rather than an inflated number that relates to the situation more than 15 years ago.

3. Incidents involving open flued boilers have again figured disproportionately in the number of CO incidents reported. This year, using an open flued boiler presented at least 4.2 times the risk of being involved in a RIDDOR reportable incident than one with a room-sealed boiler. Bearing in mind that such a trend has persisted since the collation of detailed CO incident data began and that both fatalities involved an open flued appliance, this serves to emphasise the importance of regularly servicing open flued appliances.

4. Lack of servicing or sub-standard servicing was the most frequently reported preventable contributory factor in a gas related CO incident. Owner occupiers and private landlords in particular should be aware of the importance of regular servicing in accordance with British Standards and the appliance manufacturer's instructions.

5. Since information on gas related CO incidents started to be collated in the DIDR format in 1996, incidents have been recorded only if a victim required some form of medical treatment (even if treatment was refused) or diagnostic tests.

   There is a trend that those victims of gas related CO incidents are showing less signs of serious injury. Whilst this is welcome, it should be noted that the use of CO alarms may well be contributing to the early identification of a problem. Both alarm manufacturer's instructions and gas emergency service providers will tend to advise someone who thinks they are feeling unwell at the scene to seek medical attention. This in turn tends to result in hospital attendance for a blood test and, very often, a modest elevation in blood carboxyhaemoglobin (COHb) level is identified as a consequence. Categorisation, therefore, of a RIDDOR reportable incident caused by a CO alarm activation, does not necessarily mean serious injury has been suffered and therefore, it may be helpful in future to classify such events as a 'CO alarm activation'.

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Appendix A: LPG incident information received via DIDR forms

One LPG incident was reported to Downstream Gas during the 2012/13 reporting period.

The incident occurred in Camborne, Cornwall (TR14) on the 23rd February 2013. A 90 year-old man, 86 year-old woman and 46 year-old woman were fatally poisoned by CO produced by a Flavel Aspen cooker in a static mobile home. The appliance was fuelled by bottled LPG.

The investigator found that a high level of CO built up when the cooker was operated with the grill door shut. The grill door seal was identified as the cause of the incident.

Appendix B: DIDR non-domestic incidents

No non-domestic incidents were reported.

Appendix C: Past incidents previously unreported

No records were received in 2012/13 of previously unreported incidents.

Appendix D: Carbon monoxide incidents related to the use of solid fuel and oil in the home

Since 1996, the focus for gathering CO incident information from those who investigate has been on the gas industry in GB. Mains natural gas and piped LPG represent the domestic energy supply for more than 20 million homes in GB and legislation has ensured the responsibility for investigating such an incident resides with the gas supplier.

Whilst the gas industry has made significant inroads towards improving the situation for domestic gas users, and recognises there is still work to do, moves have been made since 1st July 2010 towards agreeing a similar reporting system for the oil and solid fuel industries which represent the other major domestic energy sectors in GB.

Regulation

The Gas Safety (Management) Regulations confer a responsibility upon the gas supplier to investigate a gas related CO incident. The RIDDOR regulations define what constitutes an incident in terms of the severity of a victim's injuries and appropriate treatment. These together mean the gas industry has significant regulation which essentially stems from the potential for gas to cause both fire and explosion damage.

Regulation in the oil and solid fuel sectors is not as great as in the gas industry even though it is recognised that CO incidents associated with using these fuels in the home have occurred regularly for many years.

It was therefore agreed by the Gas Safety Trust and Downstream Gas that a reporting system be proposed for the oil and solid fuel energy sectors.

This was done for the solid fuel sector with the specific agreement and assistance of HETAS, the solid fuel advisory service and competence assessor for operatives that install, commission, service and maintain appliances.

The counterpart of HETAS for the domestic oil energy sector is OFTEC, whose help was volunteered in identifying and co-ordinating a reporting system for CO incidents involving oil.

Both HETAS and OFTEC have specialist investigators who were initially consulted on the way the format of the DIDR form used for reporting gas related CO incidents should be modified for their energy sectors.

Implementation

Meetings were held between Downstream Gas and investigators at both OFTEC and HETAS in order to ensure the detailed assessments of CO incidents were undertaken in such a way as to optimise data quality.

It was recognised from the outset when the reporting year 1st July 2010 to 30th June 2011 began that it would be challenging to expect the extent of information obtained from oil and solid fuel related incidents to be as wide as that gathered from gas related incidents. This would be a consequence both of the way investigators became acclimatised to completing their reporting forms but also, and more importantly, it would be a result of there being relatively minimal legislative drivers compelling proper investigations to be carried out and for them to be the responsibility of a particular individual or organisation.

As the year went on, this latter factor became crucially important and HETAS were sometimes in the situation where no-one would pay for an investigation to be carried out. In order for there to be sufficient data to be obtained from such investigations one of the following needs to happen:

Either

A fund is set up that investigators can draw upon as and when a 'reportable' incident occurs which can be assessed at the year end to determine whether its magnitude is affordable by one or more stakeholders

Or

Regulations are introduced that confer responsibility upon the solid fuel and oil sectors to investigate 'reportable' CO incidents in the way the Gas Safety (Management) Regulations do for the gas industry.

Nothing is understood to have taken place since last year which would be expected to resolve this issue.

Solid fuel incidents

No CO reports were received from HETAS investigators.

Reporting forms completed by OFTEC

One CO report was received from an OFTEC investigator via a Health and Safety Inspector. It involved the death of a 30 year old woman on 5th December 2012 in the IP postcode area. High levels of CO were produced from a thirty year old warm air appliance fired by class C2 kerosene, reportedly caused by lack of or sub-servicing and a flue/terminal fault (poor joints along horizontal flue). No CO alarms were installed. Burner lockout was installed and operational. The installation was visited by a non-OFTEC operative for breakdown within six months prior to the incident. It was last serviced between six and 12 months prior to the incident.

It should be remembered that the GSMR do not apply in NI and hence no gas related incidents in the Province form part of this report. However, OFTEC has offices in NI and for the purposes of this report details of any oil related CO incident submitted by OFTEC investigators have been included. No report of any incident in NI during 2012/13 was received.

Downstream Gas and the Gas Safety Trust are presently working with representatives of HSENI (the health and safety regulator in NI) with a view to establishing a reporting process for CO incidents for the three major domestic energy sectors. HSENI has advised Downstream Gas that it intends to gather incident data in-house on CO related incidents using the forms currently being used by investigators in GB. The domestic customer split in NI is approximately 70% oil, 10% solid fuel and 20% gas.

The CO incident data forms completed by HETAS and OFTEC investigators have provided the details presented below in Table D1. The figures for oil and solid fuel should be viewed as minimum numbers given the lack of regulation that exists to drive the reporting and full investigation of such incidents.

Table D1 Oil and solid fuel Incident numbers

	GB households at risk, in 1000s	GB population at risk, millions	Fatalities, per year	Non-fatal casualties, per year	Incidents, per year
Oil	946	2.24	1	0	1
Gas	21772	51.6	2	62	29
Solid fuel	180	0.43	none reported	none reported	none reported

Table D2 Risk of an injury from a CO incident in GB

	Risk of a CO incident per million people per year		
	Fatalities	Non-fatal casualties	Incidents
Oil	0.45	< 0.45[37]	0.45
Gas	0.04	1.20	0.56
Solid fuel	No information	No information	No information

The risk of a fatality as a result of a CO incident occurring in GB associated with operating a domestic oil-fired installation is lower than half the generally accepted societal accepted risk.

Dedicated databases for detailed CO incident information gathered since 1st July 2010 by incident investigators and submitted to Downstream Gas on the reporting forms developed with HETAS and OFTEC continue to be maintained.

37 When there are no incidents or no causalities in a given year the potential risk is not zero, there is always a potential risk. All that can be deduced in these cases is that the potential risk is less than the value based on 1 per year.

Appendix E: Carbon monoxide incident data from 2012/13 compared with information from previous years

The information presented in this section allows a pictorial comparison to be made between this year and recent years (2009/10, 2010/11, 2011/12).

Figure E1 Incidents reported in 2012/13 compared with those reported since 2009/10

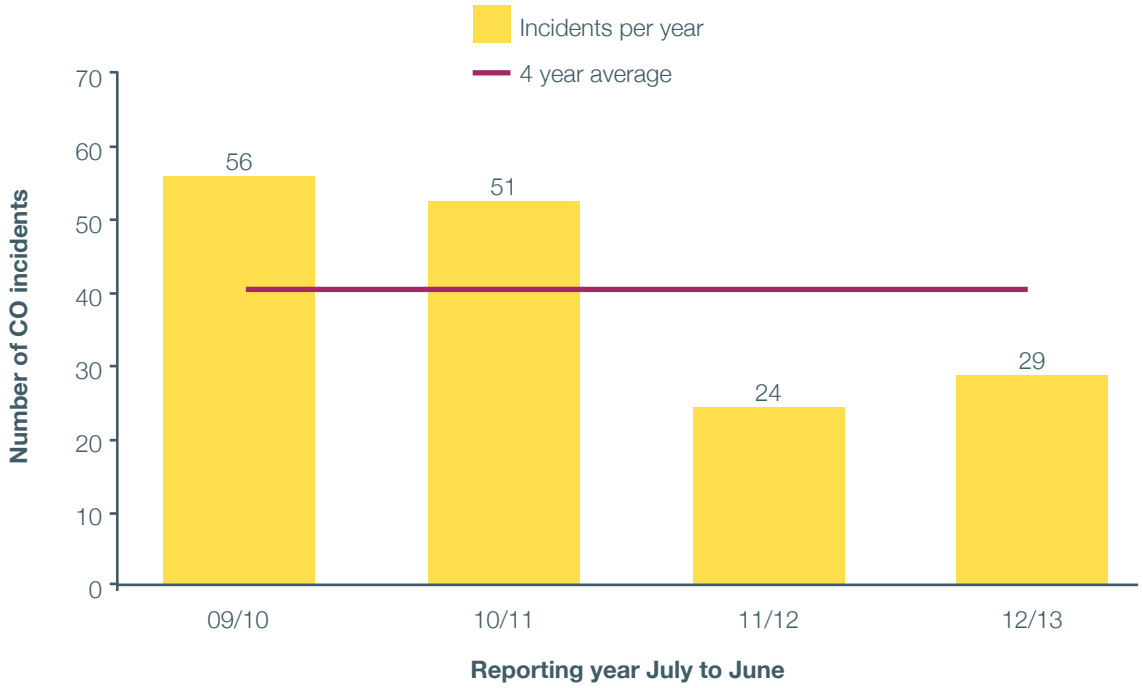


Figure E2 Injuries reported in 2012/13 compared with those reported since 2009/10

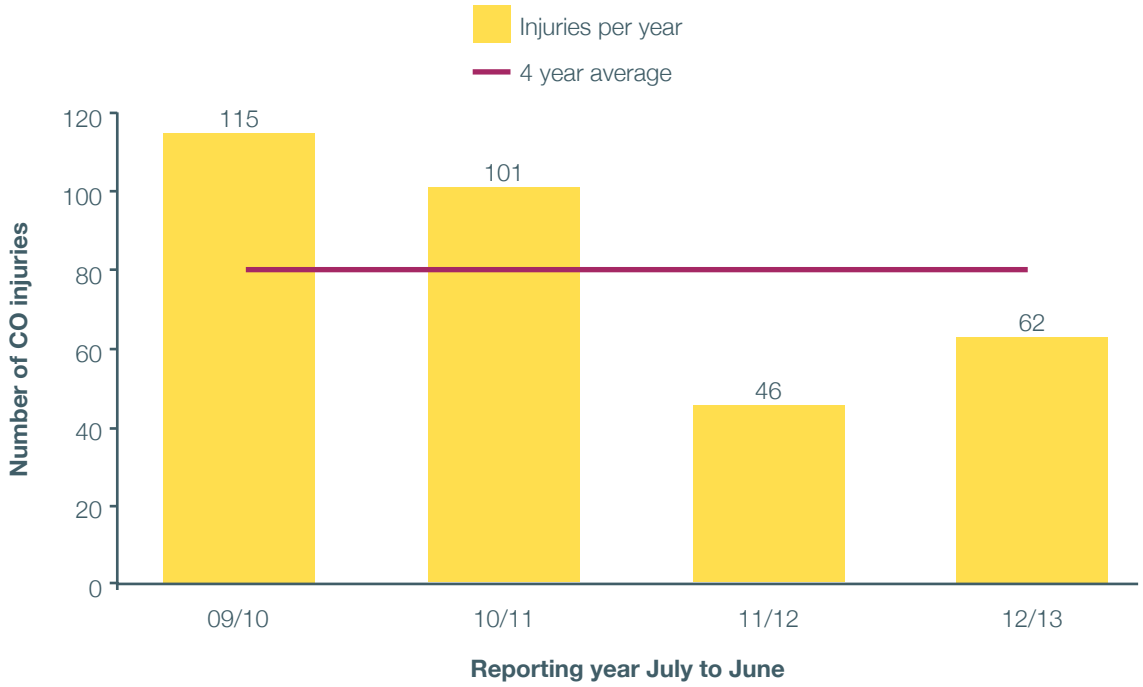


Figure E3 Fatalities reported in 2012/13 compared with those reported since 2009/10

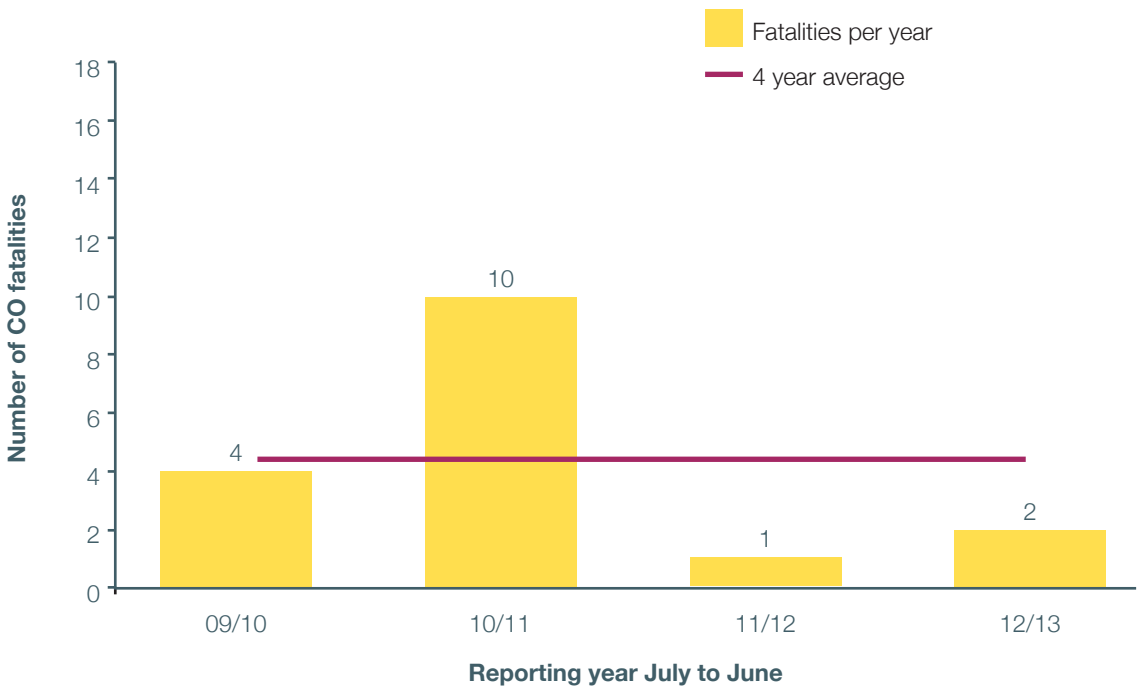
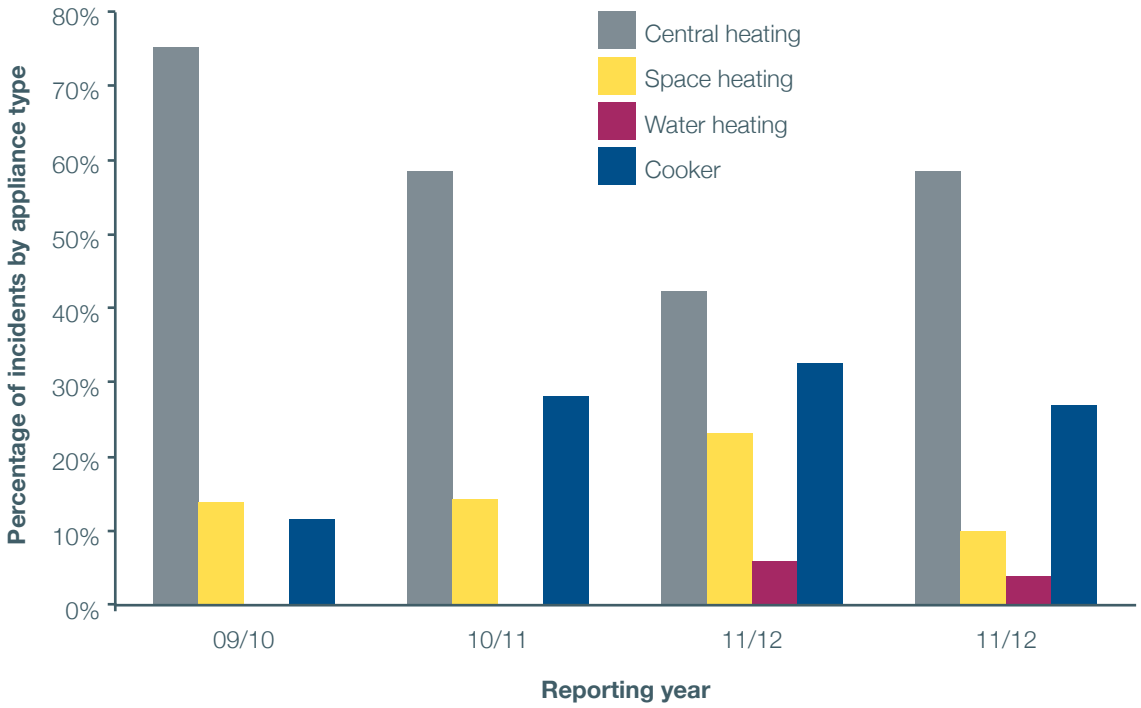


Figure E4 Incidents by appliance type for 2012/13 compared with those reported since 2009/10



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