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A review of carbon monoxide incident information for 1999/2000

Produced from the full investigation of incidents which had resulted from the use of piped natural gas and LPG within Great Britain

Prepared by
Advantica Technology
for the Health and Safety Executive

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Produced from the full investigation of incidents which had resulted from the use of piped natural gas and LPG within Great Britain

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This report has been written by Advantica Technology as a continuation of the work established during the Joint Industry Programme (JIP) Addressing Carbon Monoxide Issues, within the Incident Data project area. The aim of this work is to identify common causes of CO incidents related to appliance and system design, installation and maintenance. This information can then be used to further improve customer safety, to target expenditure on CO incident prevention and to identify further research work.

As part of the JIP project a national data collection scheme for piped natural gas and LPG Carbon Monoxide (CO) incidents, which occur within Great Britain, was established by Advantica Technology. This was with the support of the Health and Safety Executive (HSE) and the gas industry. This report provides information collectedvia this national data collection scheme.

This is the fourth report of a series that are being published, starting with the 1996/97 report. It covers the financial reporting period 1999/00. The incidents are only described by postcode to ensure anonymity. During this period the majority of the incidents reported were domestic incidents. There were four non-domestic incidents reported and seven LPG incidents.

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EXECUTIVE SUMMARY

This report has been written by Advantica Technology as a continuation of the work established during the Joint Industry Programme (JIP) Addressing Carbon Monoxide (CO) Issues, within the Incident Data project area. It covers the period 1999/00. The aim of this work is to identify common causes of CO incidents related to appliance and system design, installation and maintenance. This information can then be used to further improve customer safety, to target expenditure on CO incident prevention and to identify further research work.

As part of the JIP project a national data collection scheme for piped natural gas and LPG CO incidents, which occur within Great Britain, was established by Advantica Technology. This was with the support of the HSE and the gas industry. This report provides information collected via this national data collection scheme and analysed by Advantica Technology. Historical data has also been used within the report, from previously unpublished internal company reports, to show incident trends.

This is the fourth report of a series that are being published, starting with the 1996/97 report. It covers the financial reporting period of 1999/00. The incidents are only described by postcode to ensure anonymity. During this period the majority of the incidents reported were domestic incidents. There were four non-domestic incidents reported and seven LPG incidents.

The results of this report are summarised below: -

The number of domestic related CO poisoning deaths reported, at 24 during 1999/00, was in line with previous trends.

The majority of all CO incidents involved open flued appliances.

Central heating appliances were responsible for the majority of fatal and non-fatal casualties.

The over-all FPPY figure of 0.53×10^{-6} is within, what would normally be considered as, the "broadly accepted region" of HSE's criteria for the tolerability of risk. However societal concerns over gas safety override averaged numerical considerations.

The only appliance type that was above the HSE's criteria for the tolerability of risk was single-point water heaters (2.77×10^{-6}).

The most common room location for casualties was in the bedroom.

There was an above average risk of a CO incident in tenanted accommodation that was privately owned.

Flueing and ventilation faults were common in many domestic incidents.

Flue/terminal faults and a lack of servicing were the most common incident causes.

There were 7 LPG and 4 non-domestic incidents reported during 1999/00.

1 INTRODUCTION

This report covers accidental CO poisoning incidents resulting from the use of piped natural gas for the period April 1st 1999 to March 31st 2000. Data for incidents up to 1994/95 comes from Advantica's own incident recording system. Following the restructuring of British Gas insufficient information was collected to enable the statistics for 1995/96 to be calculated. From 1996/97 the information is obtained from incident reports and investigation forms completed on behalf of gas suppliers. If any additional reports should be received after publication of this report they will be included within updated annual statistical tables in future reports.

Domestic incidents are covered in the main part of the report with LPG incidents and non-domestic incidents reported in Appendix C and D respectively. Suspected intentional incidents have not been included in the analysis.

Information for this report comes via the Downstream Incident Data Report (DIDR) - Form 551/7. Tables and plots of actual fatalities and incidents and also plots relating to the risk associated when using gas appliances expressed in terms of fatalities per person per year (FPPY), as incidents per person per year (IPPY) and as casualties per person per year (CPPY) are given. The definitions and use of FPPY, IPPY and CPPY values are described in Appendix A. Fatality, casualty and incident trend data are presented within this report for incidents that occurred between 1992/93 and 1999/00.

Note: Some inconsistencies may appear in some parts of the report because all the required information may not have been completed on the DIDR forms e.g. in Table 1 the numbers of casualties, by classification code, differs from the total number of non-fatal casualties reported in the total for Table 1. Some information was completed as "unknown" or "other" and in some instances the tick box was not completed (field empty).

Appendix B gives details of each of the CO poisoning incidents for 1999/00.

The order used in this report follows the layout used in the DIDR - Form 551/7.

Note: Included on the DIDR form are 3 sections to complete related to the installation - to current standards, to standards current at time of installation, not to any appropriate standards or unsure/don't know, of the following:-

- the incident appliance
- the flue
- the permanent ventilation

For "the incident appliance" items that are standards related include the correct room/location, proximity to walls, fire resistance and electrical safety. Each of the three items are dealt with separately on the DIDR form and within this report.

2 ANALYSIS OF REPORTED DATA

2.1 INCIDENT DETAILS - ANALYSIS OF SECTION 1 OF DIDR

Transco issued 300 Incident Notification Forms during the reporting period. These gave details of CO Poisoning Reports under their companies internal reporting procedures.

There were 63 domestic incidents that met the requirements for reporting on the DIDR form. The majority of these being notified directly to Transco as part of the operation of the national gas emergency service and advised by Transco's internal procedures. In addition there were some incidents reported directly to gas suppliers by, for example, coroners or the police that did not get entered onto Transco's reporting system. All reports were fully analysed for this report and every effort was made to obtain as many completed DIDR forms, for this report, as possible. However due to the voluntary nature of the reporting scheme it is likely that a very small number of reports were not supplied. If any additional reports should be received after publication of this report they will be included within updated annual statistical tables in future reports. Each form is treated as a separate DIDR incident and will be referred to as an "incident" throughout the rest of this report. The incident risk data and trend data has been combined with the casualty details and is described within section 2.2.

The date of occurrence of each domestic incident has been plotted by month, in Figure 1, for the 12 month period April 1999 to March 2000.

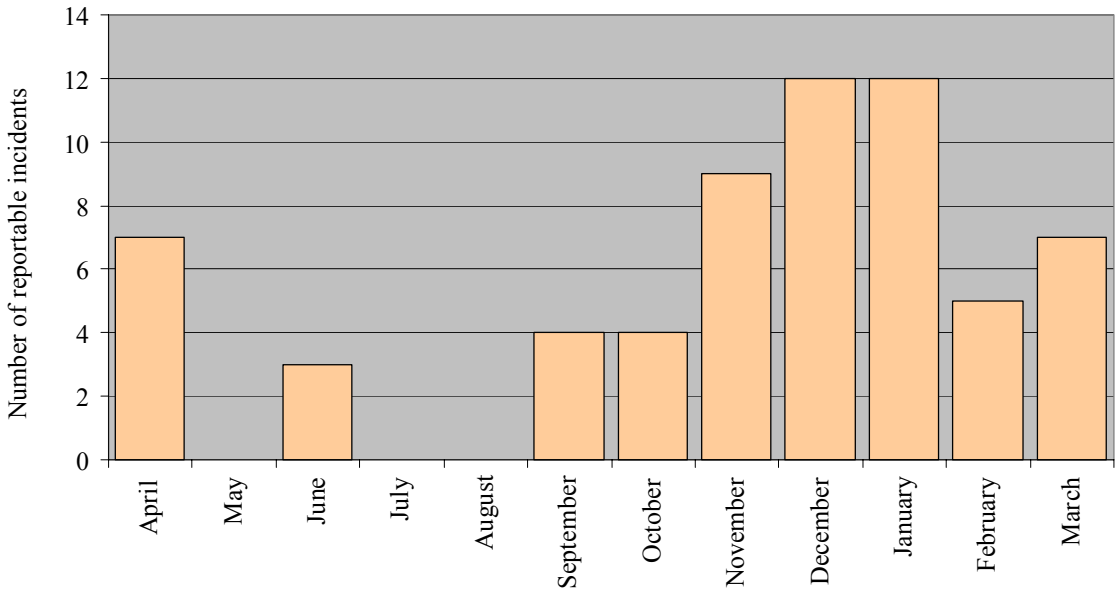

Figure 1 - Profile of incident occurrences over the year

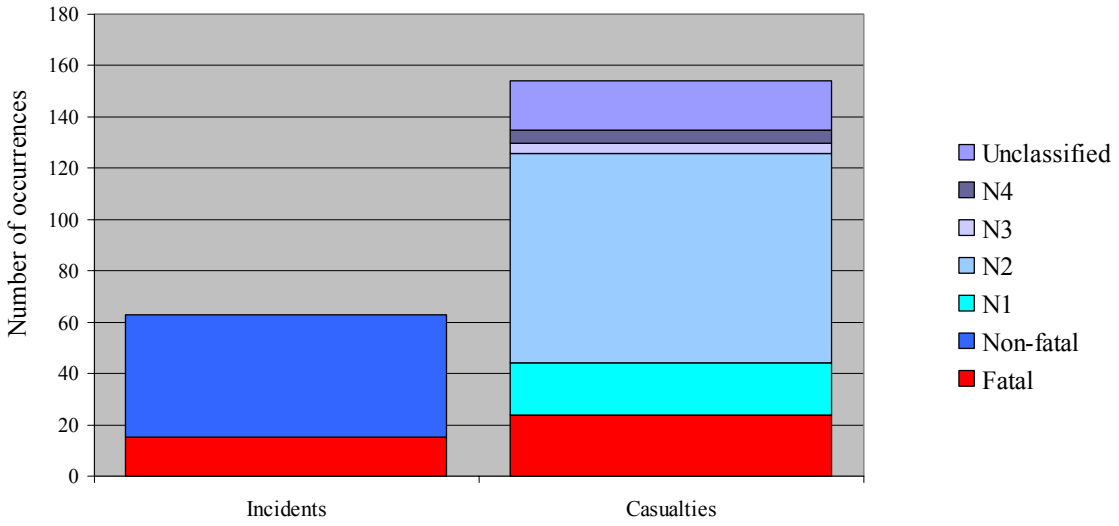

Figure 2 - Incident analysis

Figure 2 gives the number of reported domestic occurrences of CO incidents and CO casualties that took place during the year 1999/00. Further information on casualty groups are given in section 2.2 of this report.

Details of the LPG incidents that occurred during the year are given in Appendix C and details of non-domestic incidents are given in Appendix D.

2.2 CASUALTY DETAILS - ANALYSIS OF SECTION 2 OF DIDR

The total number of people reported by the DIDR system to have been injured in domestic CO poisoning incidents, by piped natural gas and within the reporting period for 1999/00, is presented below in Table 1.

Table 1 - Classification of non-fatal casualties

Classification	*N1*	*N2*	*N3*	*N4*	*Total*
Number of casualties	20	82	4	5	130

Table 1 indicates the breakdown of the non-fatal casualties by casualty classification N1 to N4, as used on the DIDR form. The four classifications 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 Paramedics)
N4 - receiving no medical treatment (e.g. treatment refused)

Note: There were some non-fatal casualties that were unclassified.

Figure 2, in section 2.1, gives the number of occurrences of incidents and casualties that took place during the year.

Using this data a corresponding risk data analysis has been carried out. The results from this are given in Table 2. The table also includes details of the number of fatalities and the number of incidents reported on the DIDR form.

Table 2 - The number of CO incidents and casualties, used for the risk analysis, with the corresponding risk values

Total number of incidents	*Total number of fatal casualties*	*Total number of non-fatal casualties*	*Over-all IPPY ($x10^{-6}$)*	*Over-all FPPY ($x10^{-6}$)*	*Over-all CPPY ($x10^{-6}$)*
63	24	130	1.39	0.53	2.88

In the calculation of FPPY, CPPY and IPPY the following statistics were used for this report.

a) The number of domestic customers i.e. the number of households using piped natural gas for 1999/00 - 20.00 million - see report section 7, reference 7.1.3.

b) The average number of people per household in Great Britain for 1999/00 = 2.26 - see report section 7, reference 7.1.4.

Note: In the calculation of FPPY, CPPY and IPPY [a x b] replaces [Number of people at risk x Appliance Population]. Definitions are given in Appendix A.

Overall trends are given in Table 3 and plotted in Figures 3 and 4.

Table 3 - Trend data

Year	*92/93*	*93/94*	*94/95*	*95/96*
"A"	38	29	31	-
"B"	0.9	0.65	0.69	-
"C"	174	167	189	-
"D"	4.1	4.4	4.2	-
"E"	87	86	102	-
"F"	2	1.9	2.3	-

YEAR	*96/97*	*97/98*	*98/99*	*99/00*
"A"	25	22	23	24
"B"	0.54	0.48	0.49	0.53
"C"	121	224	231	130
"D"	2.63	4.92	4.9	2.88
"E"	67	97	107	63
"F"	1.46	2.13	2.3	1.39

Notes to Table 3:
A = Total number of deaths due to CO poisoning in each financial year
B = FPPY (Average fatalities per person per year are $x10^{-6}$). The FPPY was calculated by the same method as that used for Table 2.
C = Total number of non-fatal casualties due to CO poisoning in each financial year.
D = CPPY (Average non-fatal casualties per person per year are $x10^{-6}$). The CPPY was calculated by the same method as that used for Table 2.
E = Total number of incidents due to CO poisoning in each financial year.
F = IPPY (Average incidents per person per year are $x10^{-6}$). The IPPY was calculated by the same method as that used for Table 2.
Following the restructuring of British Gas insufficient information was collected to enable the statistics for 1995/96 to be calculated.

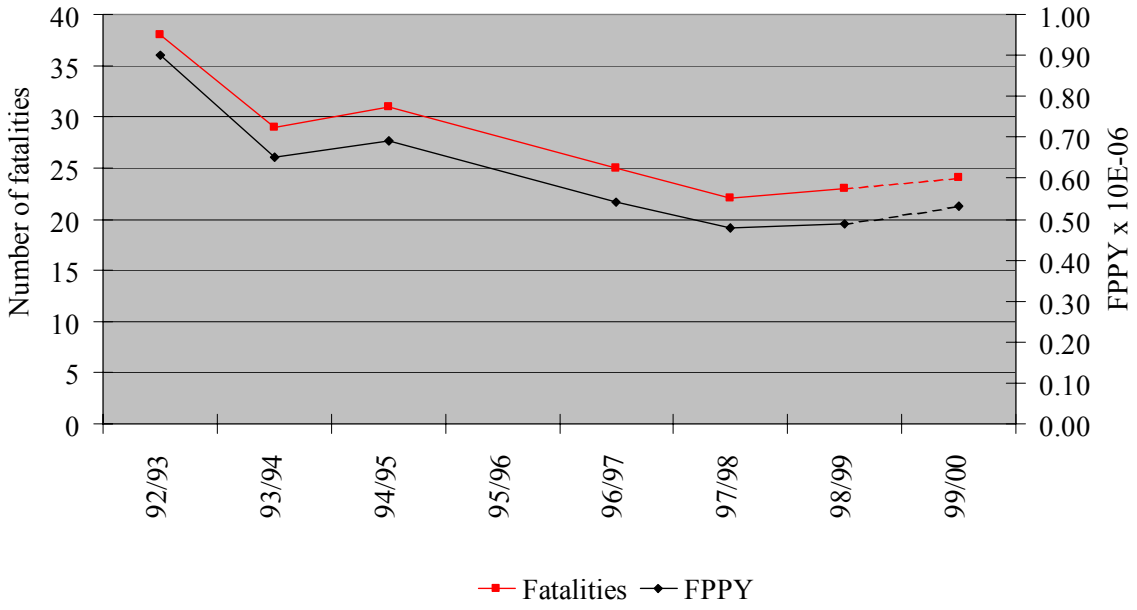

Figure 3 - Graph of fatality trends

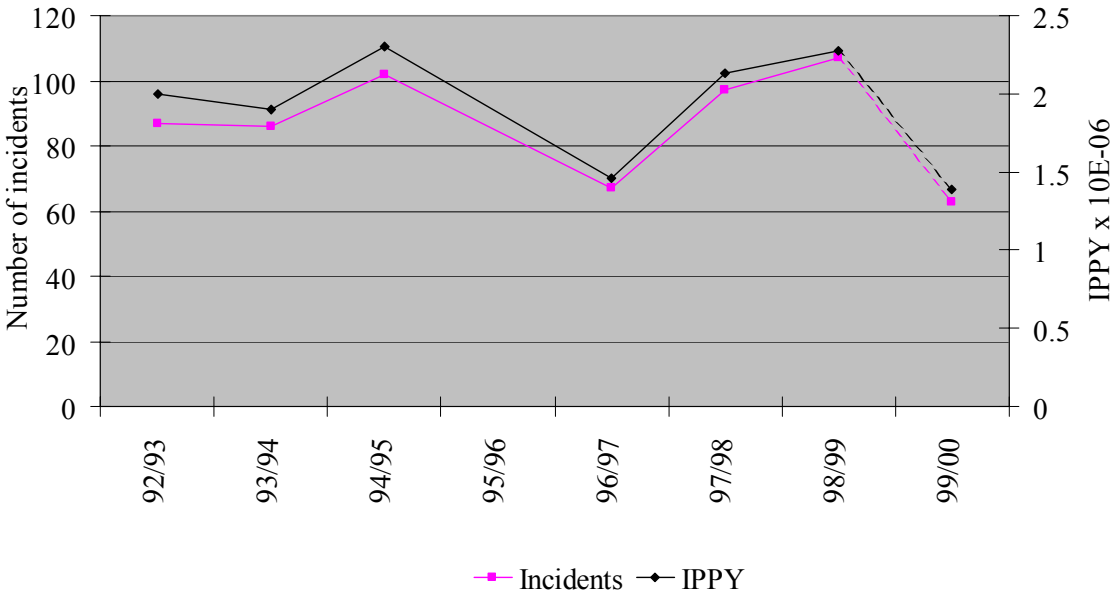

Figure 4 - Graph of incident trends

The age and numbers of the combined totals of the fatal and all non-fatal casualties are given in Figure 5.

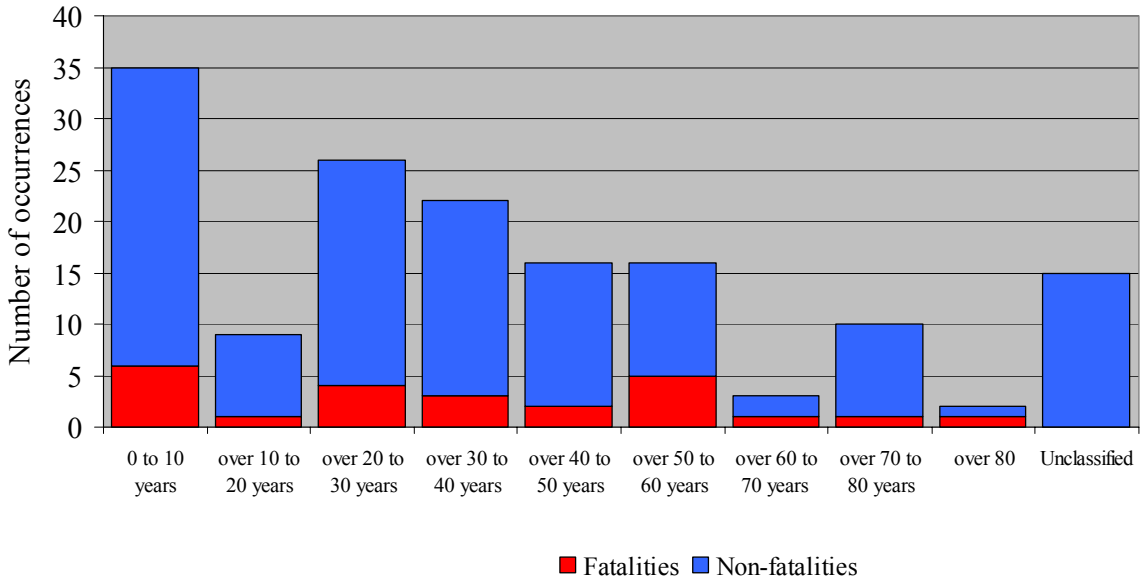

Figure 5 - Casualty age profile

2.3 INCIDENT LOCATION DETAILS - ANALYSIS OF SECTION 3 OF DIDR

Figure 6 gives the occupancy types of the properties shown on the DIDR forms. The percentage owner occupied was 68% and 32% were tenanted. There were no empty fields or unrecognised values. Of the 32% (20) of tenanted properties 27% (17) were single occupancy and 5% (3) were multiple occupancy. The proportion of the tenanted properties that were council owned was 17.6% (11) and 14.4% (9) were privately owned. There were none that were owned by housing associations.

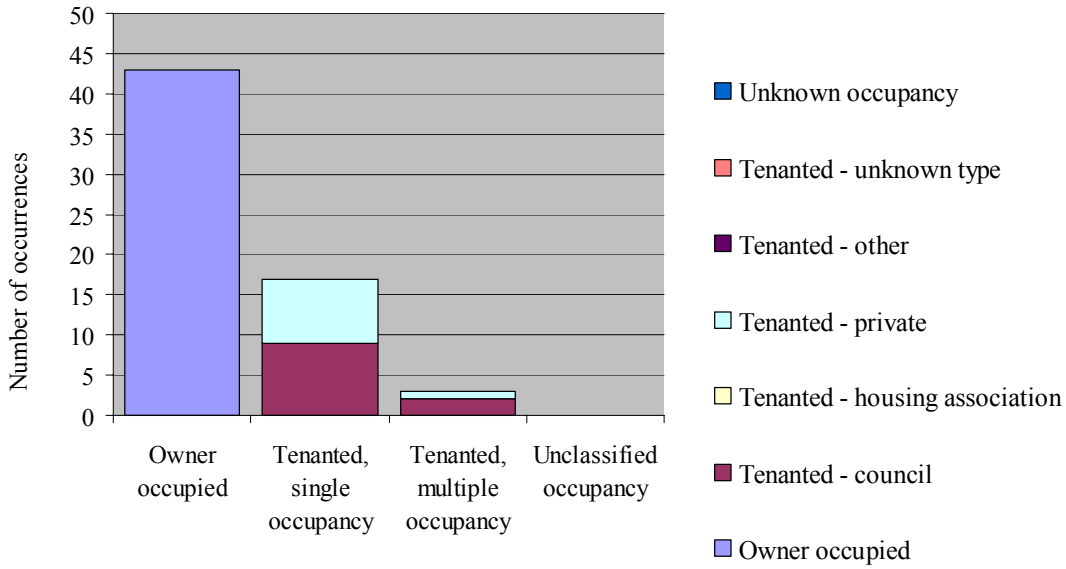

Figure 6 - Occupancy type

The 1999/00 survey of English Housing from the Department of the Environment, Transport and the Regions gives the owner occupied tenure group as 69% and the tenanted sector as 31%. This covers renting from the local authority at 15%, privately at 10% and from a housing association at 6%.

Figure 7 is shown below. It indicates that the highest proportion of incidents occurred in houses (73%), followed by flats (17%).

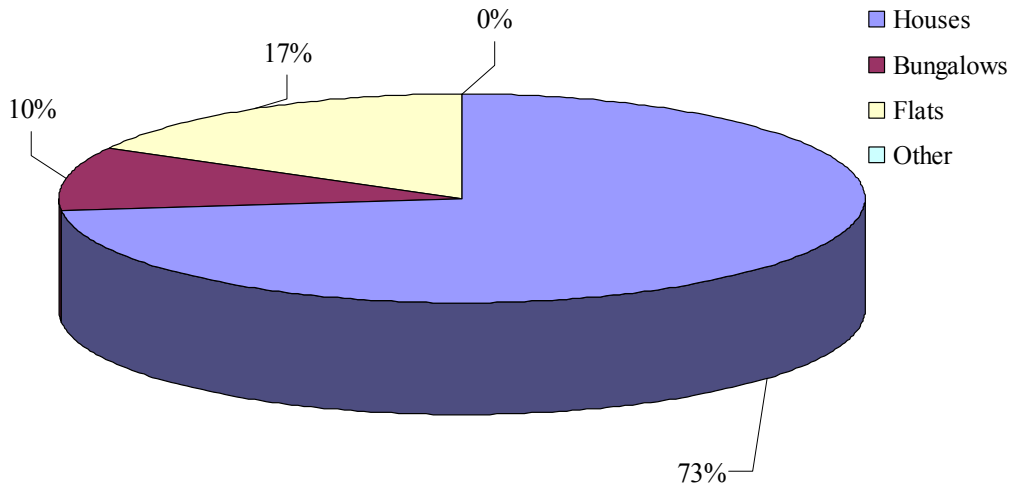

Figure 7 - Property types

Table 4 shows the number of and percentage of each style of property, within each property type, in which incidents took place during the year. There were no incident properties categorised as "other". The table indicates that the highest proportion of incidents occurred in terraced houses (33%), followed by detached houses (13%).

Table 4 - Breakdown of incident sites by property style

Bungalow	*Nos*	*Flat*	*Nos (%)*	*House*	*Nos (%)*
Detached	5 (7.9)	Bed sit	0 (0)	Detached	13 (20.6)
Semi-	0 (0)	Conversion	2 (3.2)	Semi-detached	11 (17.4)
Terraced	1 (1.6)	Maisonette	3 (4.8)	Terraced	21 (33.3)
		PBB (4 storeys or less)	3 (4.8)	Townhouse	1 (1.6)
		PBB (5 storeys or more)	3 (4.8)		

The 1999/00 survey of English Housing from the Department of the Environment, Transport and the Regions gives a breakdown of types of accommodation in England. The analysis is given below where it is compared to the incident statistics.

Table 5 - Comparison of DIDR incident stats with accommodation stats

Property style	*Accommodation Stats for England (%)*	*Incident Stats (%)*
Detached house/bungalow	21	29
Semi-det house/bungalow	34	17
Terraced house/bungalow	27	35
Purpose built flat or maisonette	13	13
Converted flat or maisonette/rooms	5	6

The age bands of the properties in which incidents took place are shown on Figure 8.

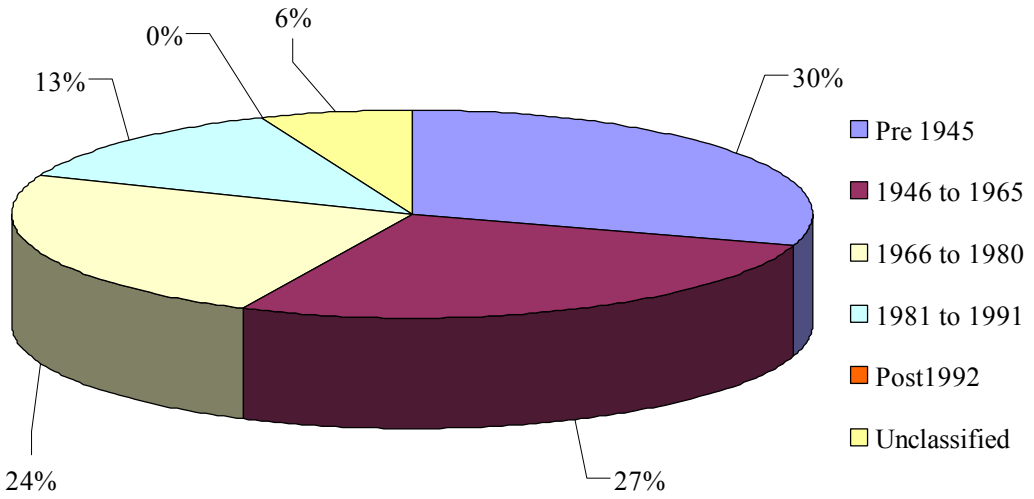

Figure 8 - Property construction period

The two largest sectors are properties built after 1965 at 37% and those built before 1945 at 30%. The age was unspecified for 6% of the incidents. Where the age was specified (59 properties) the post 1965 group is the majority at 39%. The next largest group was 32% for those built pre 1945. The remainder, built between 1946 and 1965, totalled 39%. The 1999/00 survey of English Housing from the Department of the Environment, Transport and the Regions states that for England 40% of all dwellings were built before 1945, 22% were built in the period 1945 to 1964 and 38% were built during or after 1965.

Table 6 shows the analysis of the glazing and ground floor details for the incident sites. These are also described graphically in Figures 9 and 10.

Table 6 - Construction details of the incident property

Glazing details	*%*	*Ground floor details*	*%*
Single	33	Solid	52
Double	48	Suspended	33
Partial double	16	Partial solid	5
Unclassified	3	Unclassified	10

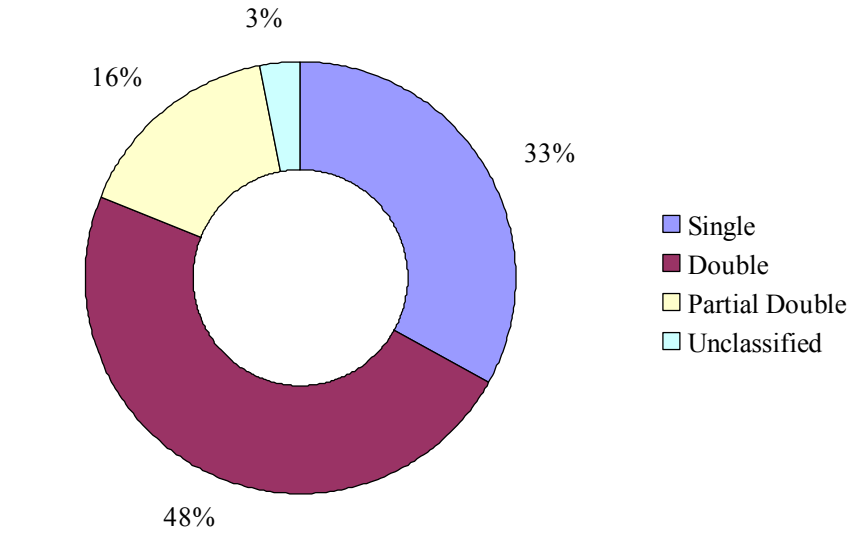

Figure 9 - Glazing details

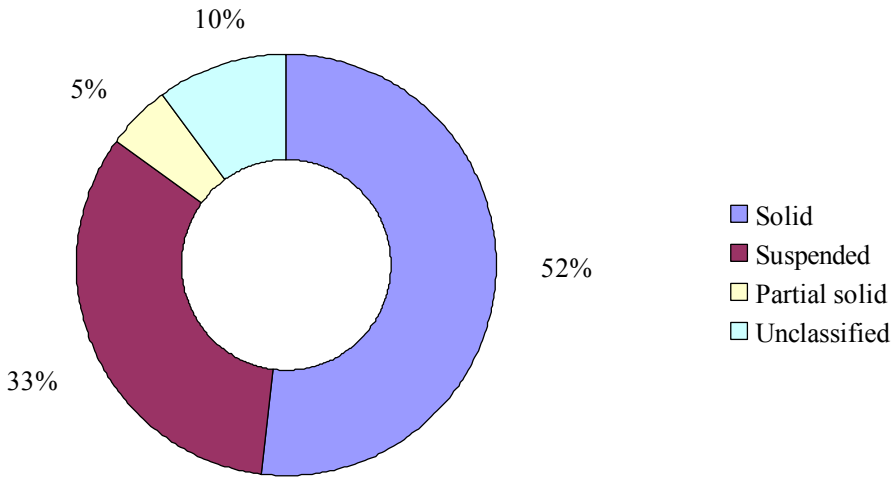

Figure 10 - Ground floor construction

2.4 CASUALTY & APPLIANCE LOCATION - ANALYSIS OF SECTION 4 OF DIDR

The location of the incident appliance and the casualties are given below in Table 7.

Table 7 - Appliance and casualty locations

Location	*Number of appliances at each location*	*Number of casualties at each location*	*Number of casualties reported in the same room as the appliance*
Attic	0	0	0
Bathroom	1	13	1
Bedroom	4	51	2
Bedsit	0	0	0
Cellar	0	0	0
Dining Room	1	5	0
Utility	4	0	0
Garage	0	0	0
Hall	7	8	2
Kitchen	37	27	21
Landing	1	0	0
Living room/lounge	4	39	6
Shower-room	0	0	0
Other	2	1	0
Unclassified	2	10	-

The “Other” appliance locations indicated in Table 7 were a corridor and a bar and for the casualty it was a granny flat. Of the 63 incident sites the majority of incident appliances were located in rooms (60%), 32% were described as being located in compartments and the remainder were not coded. This is shown on Figure 11.

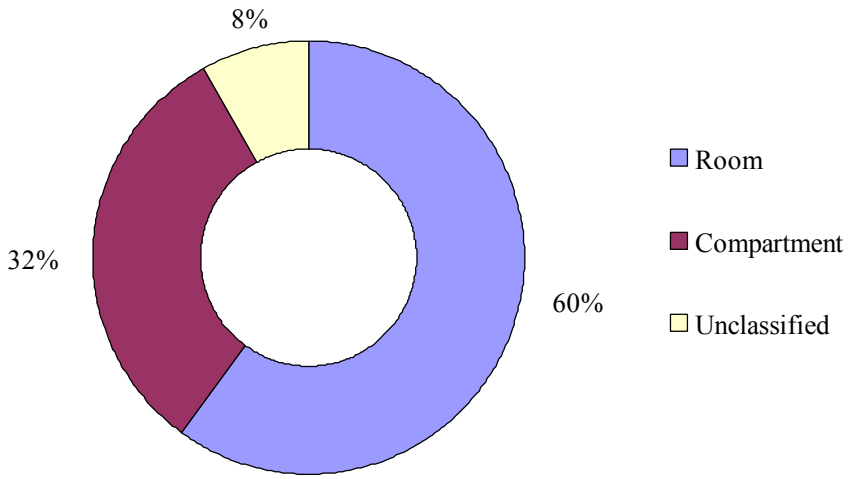

Figure 11 - Appliance location

There were 3 incident sites where the incident appliance was located in an extension to the original building. There were 4 incident sites where additional appliances were found to be producing CO into the property. At three of these sites there was 1 additional appliance and at the forth site there were 2 additional appliances. There were also 7 incident sites where additional appliances were found to have "substandard" faults. There was 1 appliance at each site. Details of incident appliance locations, by floor, are given below in Table 8.

Table 8 – Location of the incident appliances

Floor on which the appliance was situated	*Number of incident appliances*
Second	1
First	4
Ground	42
Below ground	0
Unclassified	16

At 61 (97%) incidents the casualties were in the same property as the incident appliance and in 2 incidents the details were not coded. During this reporting period there were no incidents due to appliances located in adjacent properties. This information is shown on Figure 12.

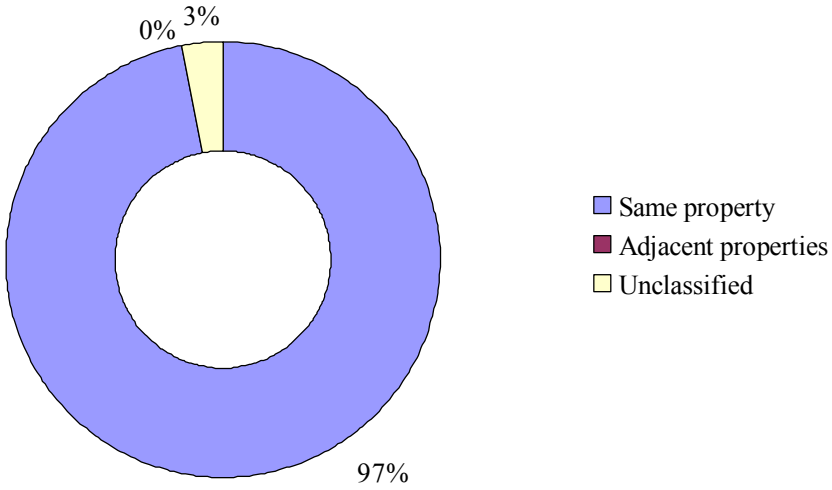

Figure 12 - Casualty/Appliance location

2.5 INCIDENT APPLIANCE DETAILS - ANALYSIS OF SECTION 5 OF DIDR

2.5.1 Incidents during 1999/00

Details of the CO poisoning incidents for 1999/00, by appliance type, are given in Table 9 and in Figure 13.

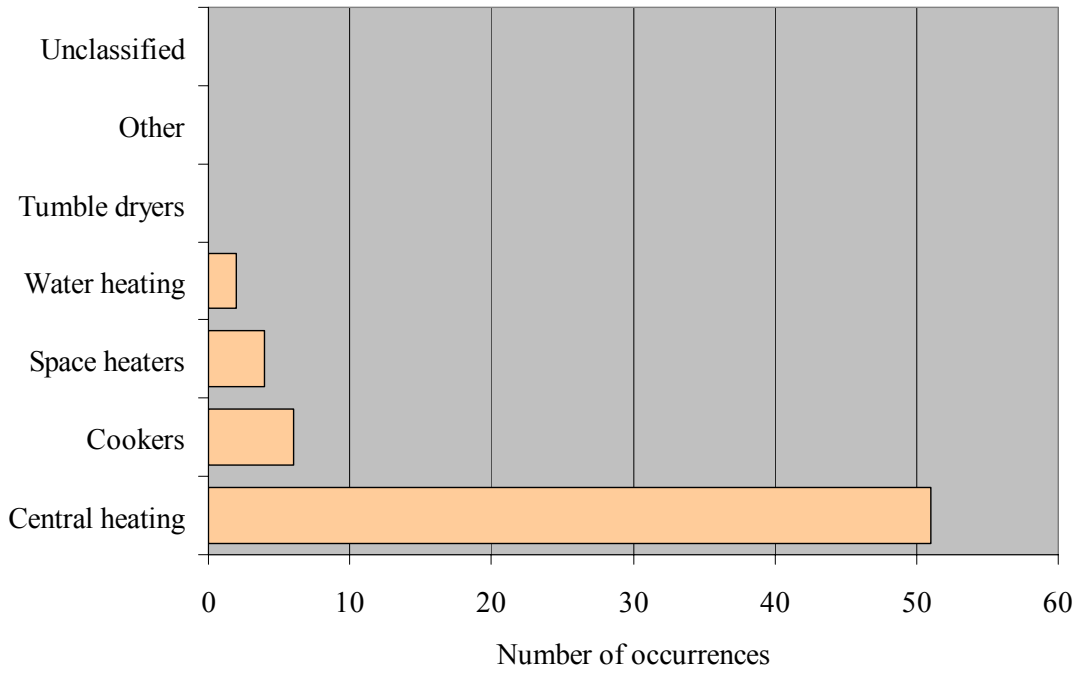

Figure 13 - Incidents by appliance type

TABLE 9 - Incidents by appliance types

Appliance	*Incidents (All) - Total*	*Incidents - Fatal*	*Casualties – Non-fatal*	*Casualties - Fatal*
Central Heating				
Back boiler unit	0	0	0	0
Floor standing	8	1	22	1
Floor standing combi	0	0	0	0
Thermal storage unit	0	0	0	0
Wall mounted	23	7	50	9
Wall mounted combi	15	1	34	7
Warm air unit	5	0	12	0
Total	**51**	**9**	**118**	**17**
Cookers				
Free standing	6	5	1	6
Built-in oven	0	0	0	0
Built-in hob	0	0	0	0
Total	**6**	**5**	**1**	**6**
Space Heaters				
Balanced flue g .f.	0	0	0	0
Cabinet heater	0	0	0	0
Decorative g .f.	0	0	0	0
Flueless heater	0	0	0	0
Inset live fuel effect g .f.	0	0	0	0
Rad. & rad. con. g .f.	4	0	10	0
Wall heater	0	0	0	0
Total	**4**	**0**	**10**	**0**
Tumble Dryers				
Tumble Dryers (total)	**0**	**0**	**0**	**0**
Water Heaters				
Bulk storage	0	0	0	0
Circulator	1	0	1	0
Multi-point	0	0	0	0
Single-point	1	1	0	1
Total	**2**	**1**	**1**	**1**
Other	**0**	**0**	**0**	**0**
Column total	**63**	**15**	**130**	**24**

Notes: Appendix B gives details, by appliance type, for each incident. In the above table and following tables g .f. has been used as an abbreviation for gas fire.

There were no reports of any condensing appliances having been involved in any incidents during this reporting period.

The breakdown of the types of central heating boiler units involved in incidents are given in Figure 14.

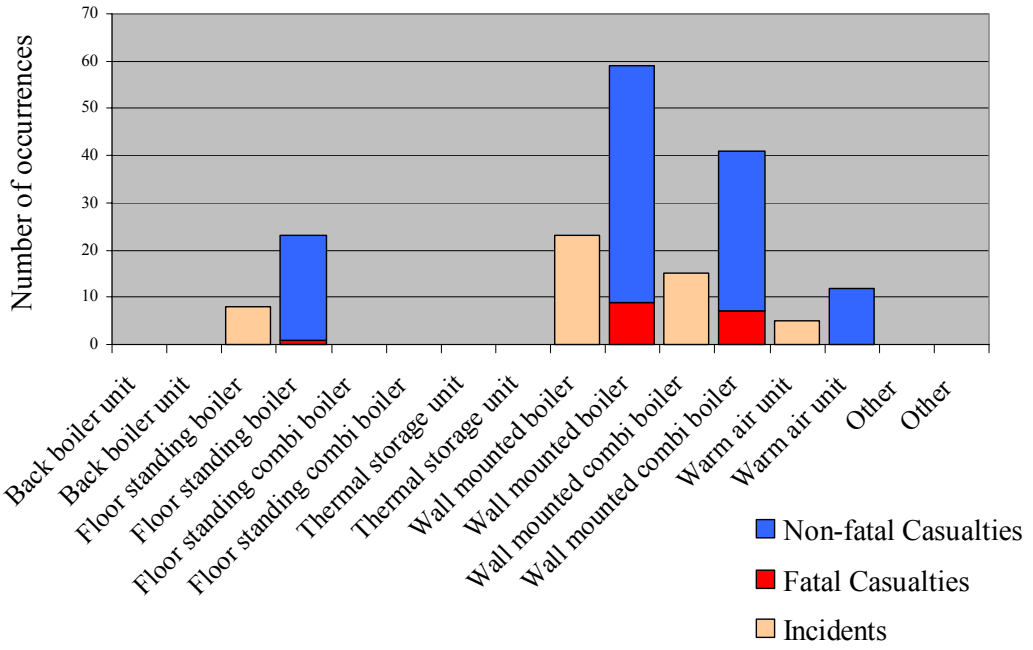

Figure 14 - Central heating boilers

Figure 15 shows the fatality trends associated with appliance type since 1992/93. It should be noted that it is likely that there have been changes to the profile of gas appliances in use, within Britain, between 1992/93 and 1999/00. The FPPY risk values shown in Table 13 take account of these changes.

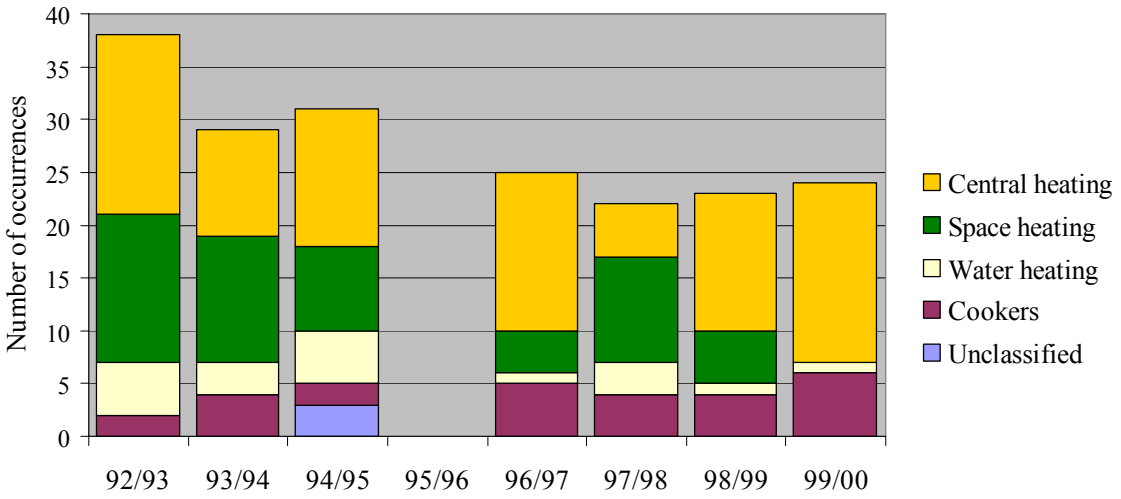

Figure 15 - Fatalities by appliance type

The age of the appliances involved in incidents during the reporting period has been given under the main appliance groups in Table 10. It is also described in Figure 16.

Table 10 - Age of incident appliances

Appliance Type	*Age (years)*					
	0 –5	*6 - 10*	*11 - 15*	*16 - 20*	*Over 20*	*Unknown*
Central heating	2	7	7	2	2	31
Cookers	0	0	0	0	0	6
Space heaters	0	0	0	0	0	4
Tumble dryers	0	0	0	0	0	0
Water heaters	0	0	0	0	1	1
Column total	**2**	**7**	**7**	**2**	**3**	**42**

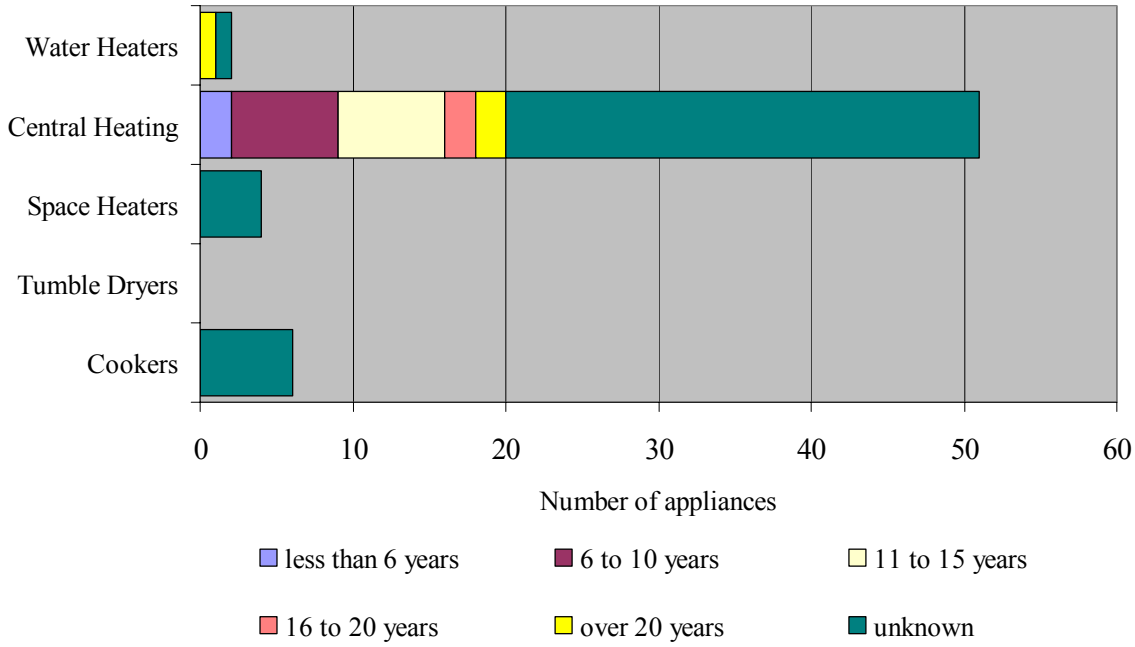

Figure 16 - Appliance age distribution

2.5.2 Notes relating to individual appliance types and models

The following information is extracted from the incident details given in Table 9 and Appendix B:

2.5.2.1 Central Heating

Central heating appliances featured in 51 incidents, which is approximately four-fifths of all CO poisoning incidents reported during the year. The number of fatalities reported at 17 was nearly three quarters (71%) of the total recorded, with the number of non-fatal casualties being 118 (91%).

Wall mounted boilers were involved in 45% of the central heating incidents, with wall mounted combi boilers and floor standing boilers being the next highest groups at 29% and 16% respectively. Wall mounted boilers were also responsible for the majority of fatalities, at 9, with wall mounted combi boilers being responsible for 7 fatalities and floor standing boilers being responsible for 1 fatality. For 2 incidents the investigator did not establish the cause of the incident or it was not known. This resulted in a reduction in the detail entered on the DIDR form in areas such as the on-site checks.

Note: Some appliance models may appear under several different manufacturers' names within Appendix B. For example Apollo boilers have been entered onto the database under Thorn, Myson and Potterton Myson.

Back boiler units

There were no recorded incidents involving these appliances.

Floor standing boilers

Floor standing boiler incidents totalled 8, with 1 fatality and 22 non-fatal casualties. A room sealed natural draught boiler was installed at one location, with the remainder being open flued natural draught appliances. Four of the appliances were Potterton Kingfisher models and 2 were Glow-Worm Hideaway models.

In 6 installations the ventilation was not to standard. In 5 cases the flue was not to standard, with the terminal siting being poor in 3 instances. In 4 incidents the flame picture was defective and in 3 incidents linting had taken place. Weather was thought to have contributed to the poor performance of the appliance in 6 of the incidents. In five cases the appliance was in need of servicing or had been serviced inadequately. For one incident the investigator did not establish the cause of the incident or it was not known. This resulted in a reduction in the detail entered on the DIDR form in areas such as the on-site checks.

Floor standing combi boilers

There were no recorded incidents involving these appliances.

Thermal storage units

There were no recorded incidents involving these appliances.

Wall mounted boilers

Wall mounted boilers were involved in 23 incidents, with 9 fatalities and 50 non-fatal casualties. Fifteen of the appliances were open flued, natural draught and 4 were room sealed natural draught. The remaining four were room sealed, fanned flue appliances with 3 having a pressurised case and 1 having a depressurised case.

8 Glow Worm Fuelsaver models and 4 Potterton Flamingo models featured in 12 of the incidents. A section of missing case seal, a damaged terminal, a DIY flue extension and an incorrectly located casing featured in the incidents related to the room sealed, fanned flue appliance installations with a pressurised case. These were all Potterton Netaheat models.

In 15 installations the flue was not to standard and in 10 cases the ventilation was not to standard. In 10 cases the appliance was installed in a compartment and in every case the compartment was not to standard. In one instance an open flued boiler was installed in a bedroom. The terminal siting was poor in 7 instances. In 12 incidents linting had taken place. Weather was thought to have contributed to the poor performance of the appliance in 6 of the incidents.

For one incident involving the room sealed, fanned flue appliance, with a depressurised case, the investigator did not establish the cause of the incident or it was not known. This resulted in a reduction in the detail entered on the DIDR form in areas such as the on-site checks.

Wall mounted combi boilers

Combi boilers were involved in 15 incidents. One of which was a fatal incident resulting in 7 fatalities. There were a total of 34 non-fatal casualties. Fourteen appliances were open flued, natural draught models and one was an open, fanned draught, integral model. One was fitted in a bathroom and another one was fitted in a bedroom. In 5 cases the appliance was installed in a compartment and in only one case was the compartment to standard. Vaillant models featured 8 times with the T3 model 4 times and the GB model 4 times.

Flues were not to standard in 13 cases and there were 10 flueing installation faults. The terminal was said to be poorly sited in 9 incidents. Ventilation was not to standard in 12 cases. The weather also featured in 11 incidents.

Warm air units

There were 5 incidents involving warm air units and they were all open flued, natural draught models. Johnson & Starley manufactured four of the incident appliances. Of the 5 incidents there were no fatalities, but there was a total of 12 non-fatal casualties.

Three appliances had faults with the return air ductwork system. At 3 sites the flue was not to standard and in 2 cases the ventilation was not to standard.

2.5.2.2 Cookers

There were 6 incidents, with 6 fatalities and 1 non-fatal casualty, involving free standing cookers. Of the 6 incidents 5 were fatal incidents. The appliance model was different in each incident. At 4 incidents the cooker had burner problems and in 4 incidents the cause included customer misuse of the appliance.

2.5.2.3 Space Heaters

The only space heaters which featured in incidents were radiant and radiant convector gas fires. There were 4 incidents, with no fatal incidents reported. There were 10 non-fatal casualties. The appliance model was different in each incident and they were all open flued, natural draught models.

In 3 incidents there were signs of spillage and in 2 cases linting had taken place. In 3 incidents the cause was identified as a lack of servicing.

2.5.2.4 Tumble Dryers

There were no recorded incidents involving these appliances.

2.5.2.5 Water Heaters

Water heating appliances featured in 2 incidents of which 1 involved a single point water heaters and the other a circulator. The single point water heater incident was a fatal incident with 1 fatality. The other incidents led to 1 non-fatal casualty.

The single point water heater was a flueless model. The ventilation was not to standard, the heat exchanger was dirty, linting had taken place to the burner and the flame picture was defective. This led to high levels of CO being produced by the appliance. Causes of the incident were given as a lack of servicing and customer misuse of the appliance as it was understood that the appliance had been in continuous use for about eight hours. The circulator was open flued and was installed in a bedroom. It had been made in 1969 and was flued into the roof void. The ventilation was not to standard, there was a flue/terminal fault and the fins of the heat exchanger had been slightly distorted. It was thought to have been subjected to intermittent spillage.

2.5.3 Appliance risk values

Details relating to the risk values by appliance type are shown below in Table 11. In terms of the risk of a fatal incident (FPPY) only the single point water heaters have a risk value greater then the recommended level of 1×10^{-6}.

The appliances, in descending order of risk, are as follows: Single-point water heaters (2.77×10^{-6}) and wall mounted combi boilers (0.84×10^{-6}).

Table 11 - Risk values by appliance type

Appliance	*Population ($x10^6$)*	*FPPY ($x10^{-6}$)*	*CPPY ($x10^{-6}$)*	*IPPY ($x10^{-6}$)*
Central Heating				
Back boiler unit	-	-	-	-
Floor standing	2.53	0.17	3.85	1.40
Floor standing combi	-	-	-	-
Thermal storage unit	-	-	-	-
Wall mounted	6.31	0.63	3.51	1.61
Wall mounted combi	3.70	0.84	4.07	1.79
Warm air unit	1.29	-	4.11	1.71
Cookers				
Free standing	9.08	0.29	0.05	0.29
Built-in oven	-	-	-	-
Built-in hob	-	-	-	-
Space Heaters				
Balanced flue g .f.	-	-	-	-
Cabinet heater	-	-	-	-
Decorative g .f.	-	-	-	-
Flueless heater	-	-	-	-
Inset live fuel effect g .f.	-	-	-	-
Rad. & rad. Con. g .f.	7.25	-	0.61	0.24
Wall heater	-	-	-	-
Tumble Dryers				
Tumble dryers	-	-	-	-
Water Heaters				
Bulk storage	-	-	-	-
Circulator	-	-	-	-
Multi-point	-	-	-	-
Single-point	0.16	2.77	-	2.77

Note: Population figures provided by GfK Marketing Services Ltd. (Reference 7.1.1). Population figures were not available for all appliance types and therefore risk values could not always be calculated. Space and water heater population data was based upon 1998/99 returns.

2.5.4 Trends (1989/90 -1998/99)

Trends regarding CO Poisoning incident fatalities by appliance type are given below in Table 12 and are also shown in Figure 16, which is in section 2.5.1 of the report. This table has been completed as fully as possible using information that was available from the 1999/00 DIDR forms and from historical records held by Advantica (Reference 7.1.2).

Table 12 - Trend data of the number of fatalities due to CO incidents, by appliance type

Appliance	*Year*							
	92/93	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**	**99/00**
C/H Boilers -Total	**17**	**10**	**13**	**-**	**15**	**5**	**13**	**17**
Back boiler unit	-	-	1	-	3	-	6	-
Floor standing	-	-	6	-	2	2	1	1
Floor standing combi	-	-	-	-	-	-	-	-
Thermal storage unit	-	-	-	-	-	-	-	-
Wall mounted	-	2	1	-	5	2	3	9
Wall mounted combi	4	2	2	-	3	1	1	7
Warm air unit	1	1	2	-	1	-	2	-
Cookers -Total	**2**	**4**	**2**	**-**	**5**	**4**	**4**	**6**
Free standing	-	-	-	-	5	4	4	6
Built-in oven	-	-	-	-	-	-	-	-
Built-in hob	-	-	-	-	-	-	-	-
Space Heaters -Total	**14**	**12**	**8**	**-**	**4**	**10**	**5**	**-**
Balanced flue g .f.	-	-	-	-	-	-	-	-
Cabinet heater	-	-	-	-	-	-	-	-
Decorative g .f.	-	-	-	-	-	-	-	-
Flueless heater	-	-	-	-	-	-	-	-
Inset live fuel effect g .f.	-	-	-	-	-	-	-	-
Rad. & rad. con. g .f.	-	-	-	-	3	10	5	-
Wall heater	-	-	-	-	-	-	-	-
Tumble Dryers	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Water Heaters -Total	**5**	**3**	**5**	**-**	**1**	**3**	**1**	**1**
Bulk storage	-	-	-	-	-	-	-	-
Circulator	-	-	-	-	-	-	-	-
Multi-point	-	-	-	-	-	-	-	-
Single-point	-	-	-	-	1	3	1	1
Other	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**
Column total	**38**	**29**	**31**	**-**	**25**	**22**	**23**	**24**

Trends in terms of the risk of a fatality by appliance type, expressed as FPPY values are shown below in Table 13. This table has also been completed as fully as possible using information that was available from the 1999/00 DIDR forms and from historical records held by Advantica.

Table 13 - Trend data of fatalities per person per year (FPPY)

Appliance	*Year*							
	92/93	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**	**99/00**
C/H Boilers -Total	**0.38**	**0.17**	**0.27**	**-**	**0.38**	**0.12**	**0.31**	**0.43**
Back boiler unit	-	-	-	-	0.39	-	0.79	-
Floor standing	-	-	-	-	0.23	0.26	0.14	0.17
Floor standing combi	-	-	-	-	-	-	-	-
Thermal storage unit	-	-	-	-	-	-	-	-
Wall mounted	18.3	37.5	0.65	-	0.27	0.11	0.18	0.63
Wall mounted combi	1.1	0.54	0.54	-	1.1	0.17	0.13	0.84
Warm air unit	0.67	0.70	1.38	-	0.76	-	1.60	-
Cookers -Total	**0.06**	**0.01**	**0.07**	**-**	**0.16**	**0.13**	**0.12**	**0.18**
Free standing	-	-	-	-	0.24	0.19	0.18	0.29
Built-in oven	-	-	-	-	-	-	-	-
Built-in hob	-	-	-	-	-	-	-	-
Space Heaters -Total	**0.42**	**0.36**	**0.24**	**-**	**-**	**-**	**-**	**-**
Balanced flue g .f.	-	-	-	-	-	-	-	-
Cabinet heater	-	-	-	-	-	-	-	-
Decorative g .f.	-	-	-	-	-	-	-	-
Flueless heater	-	-	-	-	-	-	-	-
Inset live fuel effect g .f.	-	-	-	-	-	-	-	-
Rad. & rad. con. g .f.	-	-	-	-	0.16	0.54	0.28	-
Wall heater	-	-	-	-	-	-	-	-
Tumble Dryers	-	-	-	-	-	-	-	-
Water Heaters -Total	**1.3**	**0.90**	**1.47**	**-**	**-**	**-**	**-**	**-**
Bulk storage	-	-	-	-	-	-	-	-
Circulator	-	-	-	-	-	-	-	-
Multi-point	-	-	-	-	-	-	-	-
Single-point	-	-	-	-	3.81	8.78	2.60	2.77
Other	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Column total	**0.34**	**0.28**	**0.29**	**-**	**-**	**-**	**-**	**-**

Note: In Table 13 all the FPPY values are x10^{-6}

2.6 APPLIANCE INSTALLATION DETAILS - ANALYSIS OF SECTION 6 OF DIDR

Incident appliances were installed new at 33 sites (52%). They were second hand at 3 sites (5%) of sites and it was unknown if the appliance was fitted as new or second hand for the remaining 27 (43%) incident locations. The time period when the incident appliance was fitted, before the incident, is given in Table 14 along with the number of appliances in each age group.

Table 14 - Installation period for incident appliances

Appliance type	*Age (years)*						*Total*
	0 - 5	*6 - 10*	*11 - 15*	*16 - 20*	*Over 20*	*Unknown*	
New	4	9	3	1	3	13	33
Second-hand	1	1	0	0	0	1	3
Unknown	0	3	3	2	2	17	27
Column total	**5**	**13**	**6**	**3**	**5**	**31**	**63**

The incident appliance was known to have been installed by a CORGI registered fitter (or equivalent) in 8 incidents, by a non-CORGI registered fitter in 1 case and by DIY persons in 1 incidents (4%). Unknown persons fitted the remaining 53.

In 30 incidents the appliance was fitted to current standards (48%). The appliance was installed to the standards current at the time of installation in 16 (25%) of the 63 incidents recorded. The appliance was not installed to any appropriate standards in 14 incidents and it was unknown for the remaining 3 incidents. These details are given below in Table 15

Table 15 – 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*
CORGI or equivalent	2	4	1	1	**8**
Non-CORGI	0	0	1	0	**1**
DIY	1	0	0	0	**1**
Unknown	27	12	12	2	**53**
Column total	**30**	**16**	**14**	**3**	**63**

Typical reasons given for non-compliance with appliance installation included: no cooker stability bracket (3 times), return air ductwork faults (3 times), incorrect appliance location in a bedroom (2 times), undersized pipework, no flue guard and a fire sealed within a fireplace.

2.7 FLUE DETAILS - ANALYSIS OF SECTION 7 OF DIDR

The majority of appliances were open flued. There were 46 (73%) which were individual, natural draft and one which was individual with an integral fanned draught. There were also 9 individual room sealed flues, 4 of which were fanned, and 7 flueless appliances. The four which were individual room sealed, fanned flue appliances were all wall mounted boilers. Three had a pressurised case and 1 had a depressurised case. Flueing details are given in Figure 17.

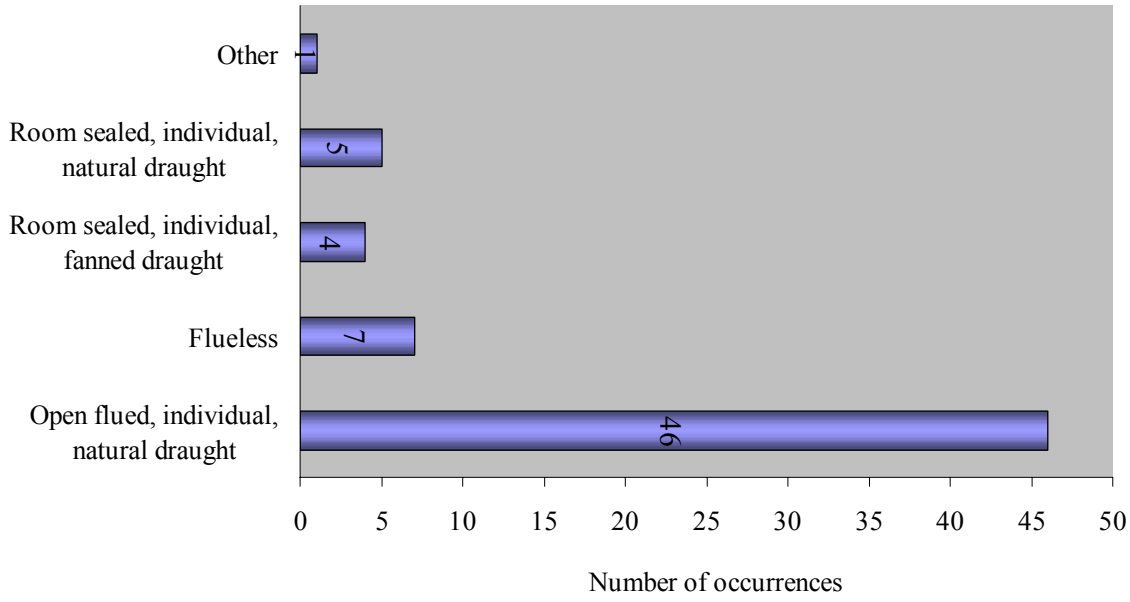

Figure 17 - Incidents by flue type

The analysis of flues to standard, excluding flueless appliances, is given in Figure 18. There were 37 incidents (66%) where the flue was not to any appropriate standards, 10 (18%) of flues to current standards, 7 (12%) to standards applicable at the time of installation and 2 (4%) where the investigator was unsure/ didn't know.

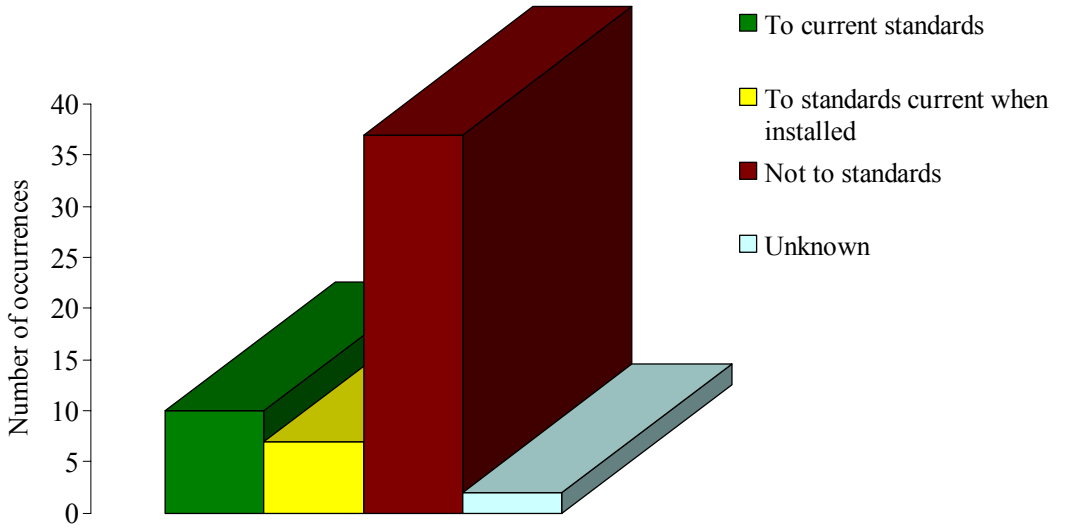

Figure 18 - Flues to standard

The "flue flow and continuity check" was passed by 13 flues and failed by 19. The investigator was unable to carry out this test, or the result was unknown for the remainder. The flue was said to be susceptible to "chilling" at 13 incident sites.

Flue liners were reported to have been fitted in 11 cases. In 6 cases the liner was fitted at the same time as the appliance, in 1 case the liner was not fitted at the same time as the appliance and in 4 cases it was not known when the liner was fitted. The liner was said to be fitted within a purpose built chimney at 2 sites and not so at 7 sites.

The number of flueing faults found are given in Table 16 (report section 2.10). A breakdown of the flueing faults, by appliance type, is given in Appendix B. Details of the flue compliance to standards, for each incident appliance, are also given in Appendix B.

> Note: The "flue flow and continuity check" is a visual test generally carried out using a smoke pellet to observe that the flue passes the smoke produced to atmosphere via the flue terminal and with no leakage from the flue. Flues susceptible to "chilling" are likely to have long lengths of external flue, mounted on external walls in positions vulnerable to cold or high winds.

2.8 PERMANENT VENTILATION - ANALYSIS OF SECTION 8 OF DIDR

Permanent ventilation was said to be required in 46 (73%) of the incidents and was not required in 17 (27%) cases. Where ventilation was required it had been provided in 39 incidents (85%). The analysis of ventilation provided to standard is given in Figure 19. When provided it was to current standards in 9 installations (23%) and to standards current when installed in 1 installation. It was not to any appropriate standards in 28 installations (72%). The investigator was unsure/didn't know for the remainder.

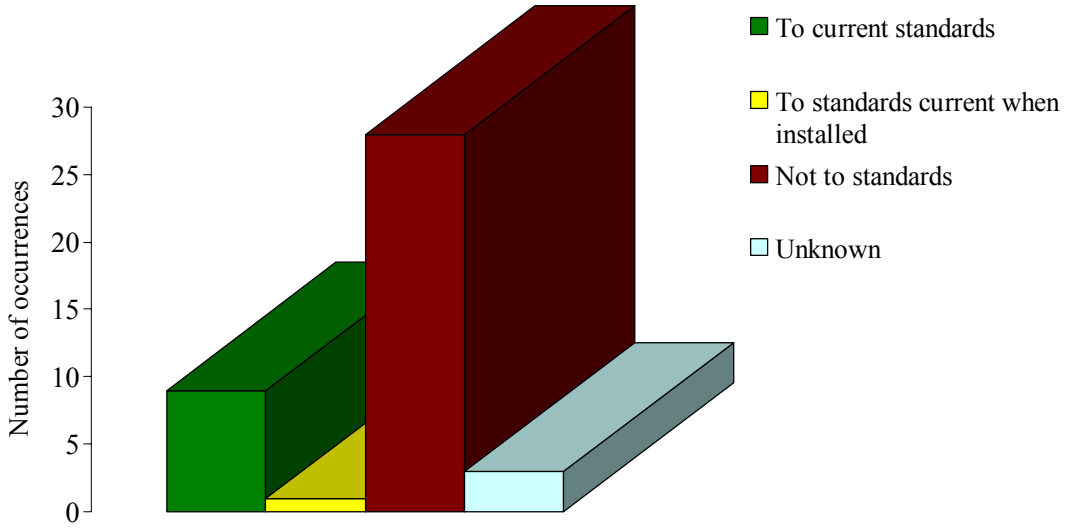

Figure 19 - Ventilation to standard

Where air vents were fitted they were unobstructed at 21 of the incidents, they were partially obstructed at 3 of the incidents and obstructed in 11 incidents. In 7 incidents the ventilation was totally ineffective. Of those with totally or partially obstructed ventilation 3 were blocked intentionally and 7 unintentionally.

Incident appliances were fitted in compartment/cupboards in 20 incidents. The compartment/cupboard was to standards applicable at the time of installation in 2 (10%) instances. It was not to standards in 17 (85%) instances. In one case it was unknown whether the compartment/cupboard met the standards applicable at the time of installation. The analysis of compartment/cupboards provided to standard is given in Figure 20.

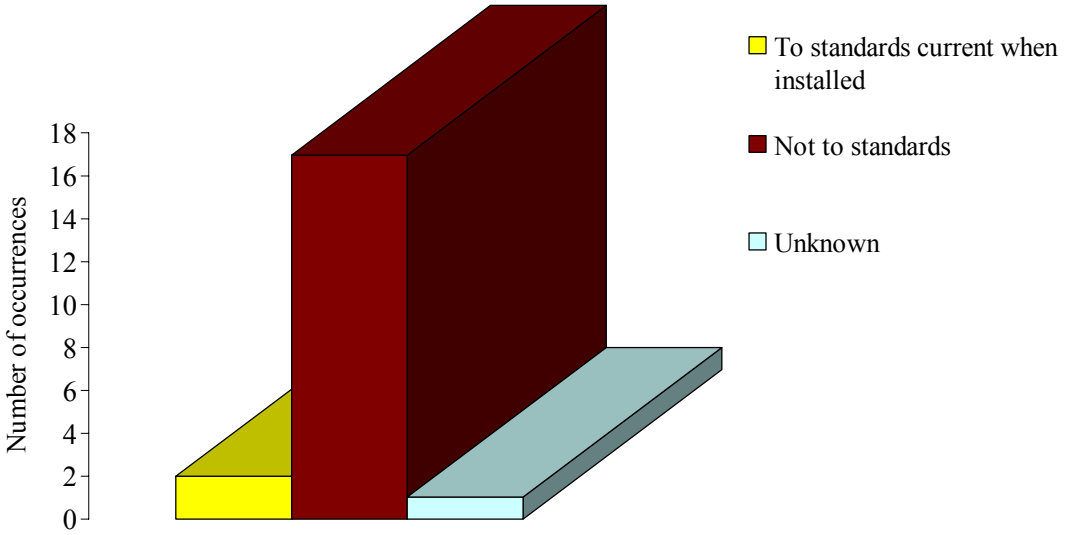

Figure 20 – Compartment/cupboards to standard

Extract fans, recirculating fans, tumble dryers or cooker hoods were reported to have been in use during two incidents.

The number of overall ventilation faults found are given in Table 16 (report section 2.10). A breakdown of the ventilation faults, by appliance type, is given in Appendix B.

2.9 SAFETY DEVICES - ANALYSIS OF SECTION 9 OF DIDR

A total of 10 safety devices were noted as being fitted within the incidents investigated. Nine were downdraught detectors and one was a battery powered CO alarm. In only 1 case was the safety device found to be non-operational. This was for a battery powered CO alarm manufactured by SF Detection Ltd. In a further case there was no entry as to the operational state of one of the downdraught detectors.

2.10 ON-SITE CHECKS - ANALYSIS OF SECTION 10 OF DIDR

The following details in Table 16 are for all incident appliances. They give the total numbers of faults found upon incident appliances. In Appendix B a breakdown of the information from the DIDR is given by appliance type. The number of faults, by main fault groups, are listed below in Figure 21. This is followed by Figure 22 where for comparison purposes each individual fault has been shown,

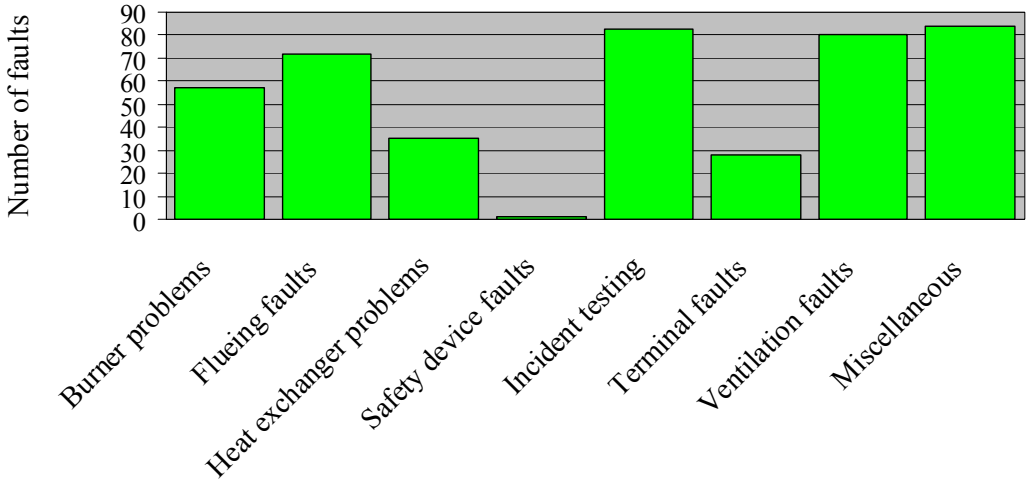

Figure 21 - Main fault groups

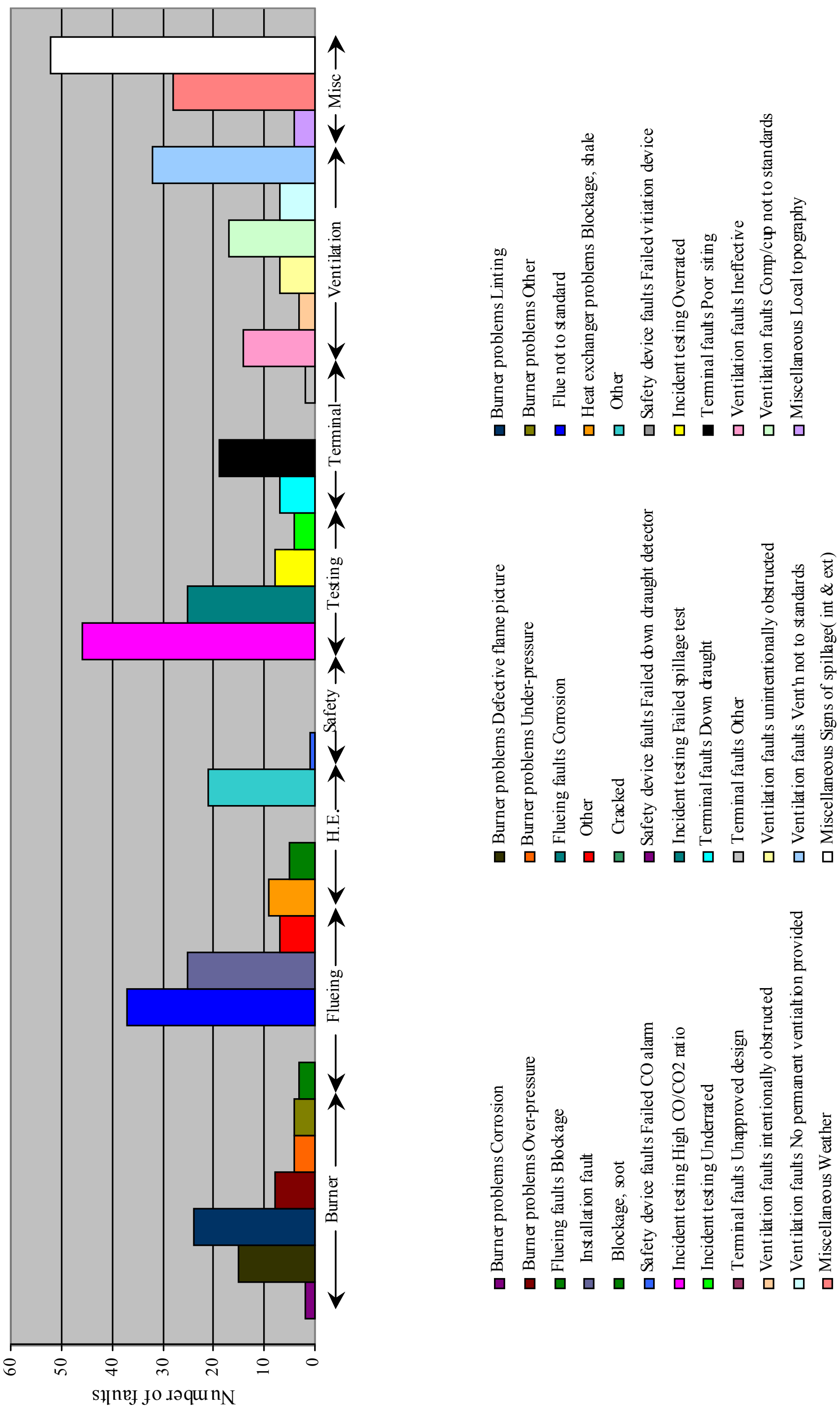

Figure 22 - Individual faults

Table 16 - Incident appliance faults

Fault group	*Number of faults*	*Fault group*	*Number of faults*
Burner		**Incident testing**	
Corrosion	2	High CO/CO2 ratio	46
Defective flame picture	15	Failed spillage test	25
Linting	24	Overrated	8
Over-pressure	8	Underrated	4
Under-pressure	4	**Terminal**	
Other	4	Down draught	7
Flue		Bad siting	19
Blockage	3	Unapproved design	0
Corrosion	0	Other	2
Flue not to any standard	37	**Ventilation**	
Installation fault	25	Air vent/vents ineffective	14
Other	7	Air vents obstructed - intentionally	3
Heat exchanger		Air vents obstructed - unintentionally	7
Blockage - shale	9	Compartment/cupboard not to any standards	17
Blockage - soot	5	No permanent ventilation provided	7
Cracked	0	Ventilation provided was not to any standard	32
Other	21	**Miscellaneous**	
Safety device		Local topography	4
Failed CO alarm	1	Weather	28
Failed down draught	0	Signs of spillage – outside the appliance	29
Failed vitiation device	0	Signs of spillage – inside the casing	23

Note: In Table 16 the numbers quoted are the number of appliances found with the fault listed.

In the above table the details of the burner "Other" comments are as follows: Pot and tinfoil covered all burners on a cooker, Hole in burner, Defective radiant carrier and Cracks visible.

The details of the flue "Other" comments are as follows: Major leakage around flue seal, Flue canopy not adequately sealed, Flue not lined with flexible liner, Liner had fallen down, DIY flue extension, Fan running slow, and Casing incorrectly fitted after service.

The details of the heat exchanger "Other" comments are as follows: Dirty (x8), White dust/deposit/oxide blockage/coating/restriction (x5), Copper sulphate, Slightly shaled, 20% blockage, Partial shale/soot, Rubble on top, Section of canopy seal missing, Defective seals and Fins slightly distorted.

The details of the terminal "Other" comments are as follows: Damaged and No terminal fitted.

There were 9 cases where information was given of signs indicating that the appliance required servicing.

The burner pressure test results indicated that 8 appliances were set high, 4 were set low, 4 were not tested and the remainder were correctly set. The appliance rating test results indicated that 8 appliances were set high, 4 were set low, 10 were not tested and the remainder were correctly set. The CO/CO2 test results indicated 46 appliances were found with a high reading, 9 had a correct reading and in 8 cases the reading could not be taken.

In 70% of cases (44 incidents) CO from the incident appliance was proven to be able to enter the incident property when tested in the as-found condition. When tested in the as-found condition there were 40 incidents (63%) where a sufficient concentration of CO was shown to have been produced by the incident appliance which would have been expected to have resulted in the level of COHb found in the victim/victims. In 35 (56%) of incidents it was indicated that the concentration of CO could be achieved in the available time.

2.11 INCIDENT APPLIANCE SERVICE HISTORY - ANALYSIS OF SECTION 11 OF DIDR

The DIDR returns show that there were 20 incident appliances covered by a regular service contract at the time of the incident and in 43 cases there was no regular service contract. Analysis of the number of tick boxes completed for the "last working visit" is given in Table 17.

Table 17 - Details of the last working visit

Last working visit by:	*Number of tick-boxes completed*
CORGI fitter	21 (33%)
Non-CORGI fitter	1 (2%)
Other	1 (2%)
Unknown	40 (63%)

Analysis of the number of tick boxes completed for the "reason for the visit" is given in Table 18.

Table 18 - Reason for the last working visit

Reason for visit:	*Number of tick-boxes completed*
Breakdown	8 (13%)
Report of fumes	3 (5%)
Safety check/inspection	4 (6%)
Service	20 (32%)
To install the incident appliance	1 (1%)
Other	0 (0%)
Unknown	27 (43%)

Analysis of the number of tick boxes completed for the time period involved between the last working visit and the incident are given in Table 19.

Table 19 - Interval between the last working visit and the incident

Time between the last working visit and the incident	*Number of tick-boxes completed*
Less than 6 months	12 (19%)
6 months to 1 year	12 (19%)
1 year to 2 years	8 (13%)
More than 2 years	3 (5%)
Unknown	28 (44%)
Not applicable	0 (0%)

Investigation of the 20 sites where regular servicing was said to be carried out showed the last working visit was by 14 CORGI registered fitters and by 6 "unknown" fitters. The reasons for the visits were servicing (10), breakdown (5), safety check (3), report of fumes (1) and unknown (1).

Analysis of who attended to carry out the last working visit are as follows: Breakdowns were dealt with by 6 CORGI registered fitters, 1 unknown fitter and 1 electrician. Fume reports were dealt with by 2 CORGI registered fitters and 1 non-CORGI registered fitter. Safety checks/inspections were dealt with by 3 CORGI registered fitters and 1 unknown fitter. Servicing was dealt with by 10 CORGI registered fitters and 10 unknown fitters. Installing the incident appliance was dealt with by 1 CORGI registered fitter.

2.12 HISTORICAL INFORMATION - ANALYSIS OF SECTION 12 OF DIDR

A safety warning notice had been attached to the incident appliance or at the gas meter prior to the incident on 7 occasions. It was legible at 6 sites. The notes were as follows: Immediately Dangerous label (3), Sub Standard notice (1), Transco warning label (1), a 5 minute maximum use label on the single-point water heater (1) and an undefined label attached to a boiler.

Prior to the incident, the incident "appliance" had been inspected following reports of fume spillage in 4 incidents. There were 3 reports of incident "installations" being inspected following reports of fume spillage. The occupants reported experiencing symptoms typically associated with CO poisoning at 7 incident sites. No reports indicated that the incident appliance/installation had ever been disconnected following reports of fume spillage.

2.13 INCIDENT CAUSE/CAUSES - ANALYSIS OF SECTION 13 OF DIDR

Details of the established cause/causes of all the incidents are summarised in Table 20. There were multiple entries entered on some DIDR forms in this section. This results in the total number of causes given exceeding the total number of incidents.

Table 20 – Incident causes

Incident cause (s)	*Total number recorded*
Appliance fault	14
Appliance installation fault	9
Customer misuse of the appliance	8
Flue/terminal fault	29
Lack of servicing	28
Sub-standard compartment	9
Sub-standard servicing	4
Ventilation fault	16
Not known/not yet established	2
Other	4

The causes indicated under "Other" were as follows: Intermittent spillage, Over pressurised, Builders work on chimney and Case incorrectly fitted.

Within report section 2.10 it also lists that the weather contributed to the poor performance of the appliance in 28 incidents and local Topography in 4 incidents.

3 GENERAL DISCUSSION

This is the fourth analysis of CO incident information provided by the use of the DIDR form within the gas industry.

The types of incidents featured in 1999/00 were much the same as in previous years. The majority of incidents (46) involved open flue appliances with only 9 involving room sealed appliances and 7 involving flueless appliances. Central heating appliance incidents resulted in 88% of the total number of fatal and non-fatal casualties. The next highest appliance group was space heaters at 6.5%, followed by cookers at 4.5%. In terms of the number of fatalities, by appliance types, central heating appliances also led to the majority at 71%, with cookers next at 25% and water heaters at 4%.

In addition to the domestic incidents reported above there were seven LPG domestic reported incidents, covered in Appendix C, including one which resulted in 3 fatalities, and 4 non-domestic incidents reported in Appendix D.

3.1 INCIDENT DETAILS

The number of domestic CO incidents fully investigated, reported and analysed for use in this report was 63.

The majority of the incidents took place during the heating season, which is in line with previous records. Figure 1 shows a very similar profile for each of the four reports issued.

Study of the postcode areas in which the incidents occurred show that only one code featured with 2 exact matches. This was ST5, an area within the Stoke on Trent Post Town area. When analysed by Post Towns there were 8 incidents in London, 4 in Birmingham and 3 in Doncaster.

3.2 CASUALTY DETAILS

The total number of incidents reported, at 63, was within the range of incidents reported as part of this series of reports and the historical data presented. In the previous annual report for 1998/99 there were 107 CO incidents that were analysed and in the years between 1989/90 and 1997/98 it varied between 64 and 102 incidents. From Figure 4 it is not possible to state if there is any trend in the number of reportable CO incidents being investigated.

The total number of fatalities reported, at 24, was within the range of fatalities reported as part of this series of reports. This was for data since 1995/96. During this period the number reported has been between 22 and 25. Historical data presented within this series of reports indicated a range of 28 to 38 for the period 1989/90 to 1994/95. This appears to indicate an average 25% reduction in the number of annual fatalities due to CO incidents.

Non-fatal casualties recorded, at 130, was at the low end of the numbers reported between 1989/90 and 1999/00. This range was 121 to 231. It is too early confirm if this trend indicates a general reduction in the number of non-fatal casualties. The most serious casualties in group N1, where casualties spent over 24 hours in hospital, were recorded at 20 persons for 1999/00. This indicates a number at the bottom end of the range previously recorded. The preceding 3 years reported numbers were 49, 16 and 47.

The casualty age profile, shown in figure 5, shows close similarity with the figures given in the previous three reports of this series.

The total FPPY figure of 0.53 x 10^{-6} is in line with the figures calculated in previous years, since 1995/96. This value of FPPY falls within, what would normally be considered as, the "broadly accepted region" of HSE's criteria for the tolerability of risk. However, societal concerns over gas safety override averaged numerical considerations. Values of Overall IPPY and CPPY values are also similar to previous years values, but at the lower end of the range recorded since 1989/90.

3.3 INCIDENT LOCATION DETAILS

From the figures on occupancy quoted in section 2.3 it can be seen that there were more incidents within owner occupied properties than in tenanted properties. This is in line with previous reports. The proportion of incidents in each occupancy group is also generally in line with the occupancy statistics for England. But when a relative risk analysis is carried out it indicates that tenanted/privately owned accommodation is the area of greatest relative risk, followed by tenanted/council accommodation. Tenanted/privately owned accommodation also featured as the highest relative risk category in the past 3 reports. Owner occupied and tenanted/housing association properties show the lowest relative risks.

Comparison of the relative risk factors (based on a division of the percentage split of DIDR reported incidents for that group by the national percentage of occurrences of that group - 100 being the overall average factor, and using the figures quoted in section 2.3) shows that the tenanted/council group has a relative risk factor of 117. This was calculated as follows ((17.6/15) x 100) = 117. Owner occupied properties have a relative risk factor of 99, the tenanted/housing association group has a relative risk factor of 0 and tenanted/privately owned accommodation is the area of greatest relative risk with a factor of 144. Although this is the highest relative risk factor, over other types of accommodation this year, it is lowest that the tenanted/privately owned group has achieved over the four years that have been reported.

Incidents took place more often in terraced and semi-detached properties during the period 1996/97 to 1998/99. During 1999/2000 the proportion of incidents taking place in detached houses increased markedly from a 7 to 11% range up to 21%. This increase was matched by a similar decrease in the proportion of incidents taking place in terraced houses. Overall the most incidents still take place in terraced houses (33%), followed during 1999/00 by detached houses (21%).

Like previous years the number of incidents that took place across all property types is not in broad agreement to the proportions of each type of property within Britain/England. This is shown in Table 5. For 1999/00 the accommodation statistics and other national statistics used in this report have become segregated due to devolution. The values for England are now used within this report due to their close agreement with previous British statistics.

There have been variations noted which affect each property style identified in Table 5. Looking at the 4 reports in this series, the incidents in flats or maisonettes did occur above that expected from comparison with accommodation statistics. Converted flats were up to 2.5 times what was expected during 1998/99. But for 1999/00 this property style is back in line with its accommodation proportion. The number of incidents taking place in terraced houses/bungalows had increased to 1.8 times more than would be expected if the results were independent of property type during 1998/99. But for 1999/00, although above what was expected, this has reduced to 1.3 times.

Incidents in detached and semi-detached properties previously featured below expected levels. This rose to 0.5 times during 1998/99. During 1999/00 the level of incidents was the same for semi-detached properties at 0.5 times below expected levels. But detached properties changed to be above expected levels by 1.4 times. Detached and terraced properties were the two property styles that feature with incidents both 8% above that expected from a comparison to the proportions of each type of property within Britain/England.

Where the age was specified for the incident property, it is the newer properties, post 1966, that are seen to feature more often in incidents at 39%, with those built between pre 1945 the next highest group at 32%. As in the above case the proportion of incidents is not inline with the age profile of properties in Great Britain/England. The proportion of incidents taking place in older properties is 0.8 times less than expected and those built between 1946 and 1965 are 1.3 times more than expected. The trend noted in previous reports was for incidents to occur more often than expected in pre 1945 properties by about 17%. This report indicates incidents are taking place more in line with property statistics and the number in older properties has reduced considerably.

3.4 CASUALTY & APPLIANCE LOCATION

The majority of appliances that led to incidents were, as in previous years, located in the kitchen of the incident sites. The next most common areas were the living room/lounge, bedroom and utility room with 4 in each. These are as would be expected for the typical majority of domestic gas appliances. However, the greatest numbers of casualties were located in the bedroom, followed by the living room/lounge and then by the kitchen. Appliances located in other rooms affected almost all the casualties in the bedroom and the living room/lounge. All of incidents, where details were completed, showed they took place with the casualties and incident appliance in the same property. In only 2 incidents were the details not coded.

The analysis of the floor on which incident appliances were located show that as would be expected the majority were on the ground floor, where most kitchens are located. Data is not available for how many appliances are installed in compartments, but it is likely to be a significantly lower percentage than the 32%, which was found to be the number of incident appliances located in compartments.

3.5 INCIDENT APPLIANCE DETAILS

The total number of incidents was made up of 51 incidents involving central heating boilers, 6 incidents involving cookers, 4 involving space heaters and 2 involving water heaters. These figures are very similar to those given in the last three annual reports. They are described in the following table. As previously reported central heating boilers were involved in the majority of CO incidents and were responsible for the majority of casualties.

Table 21 - Trend data of incident occurrences

Appliance	*Year*			
	1996/97	***1997/98***	***1998/99***	***1999/00***
C/H Boilers	54 (81%)	70 (72%)	79 (74%)	51 (81%)
Cookers	5 (7%)	6 (6%)	7 (6%)	6 (10%)
Space Heaters	5 (7%)	16 (17%)	18 (17%)	4 (6%)
Water Heaters	1 (2%)	5 (5%)	3 (3%)	2 (3%)
Other	2 (3%)	0 (0%)	0 (0%)	0 (0%)
Column total	**67**	**97**	**107**	**63**

The fatality trend tables indicate that natural gas appliances are responsible for a broadly similar number of fatalities over the eight-year period. This year, and the three previous years, do show a trend towards a small reduction in the total number of fatalities. In this period wall mounted boilers were responsible for most fatalities (9). The next largest group was wall mounted combi boilers with 7 fatalities and then free standing cookers with 6 fatalities. Central heating boilers and cookers appear to be responsible for a similar number of fatalities each year, whereas space heaters and water heaters show a general reduction. The level of fatalities recorded for 1999/00 was particularly low, with only 1 fatality due to a single-point water heater and for the first time in the last four years there were no fatalities due to space heating. Also of note is that there were no fatalities due to back boiler units and warm air units.

Single point water heaters continue to appear to present a greater risk (2.77×10^{-6}) than other appliance types and are the only appliances to have risk values which are above what would normally be considered as the "broadly accepted region" of HSE's criteria for the tolerability of risk (1×10^{-6}). These appliances are, and have been, recognised as a major problem in the past. This has led to industry initiatives to overcome the problem. The number of people at risk from single point water heaters and their FPPY value may be expected to remain high whilst older appliances without safety controls are still in use. It can be seen from the appliance survey carried out by GfK Marketing Services that the numbers of these appliances in use appears to be very low, compared to the other appliance groups. But they still present the highest risk to their users. Looking at other appliance risk values it can be seen that wall mounted combi boilers are the next highest category with a value of 0.84 during this period.

The majority of non-fatal casualties continue to be related with central heating boilers. The number of non-fatal casualties associated with all central heating boilers is about 7 times the number of fatalities that took place. This is a change on the previous two years where the same ratio was 15 to 1 and 38 to 1. Wall mounted boiler incidents were responsible for the highest number of casualties, followed by wall mounted combi boilers and floor standing boilers. They were not the highest risk though, when looking at CPPY values, where warm air units at 4.1 are highest followed by wall mounted combi boilers at 4.07. This year there were no non-fatal casualties related to single-point water heaters and so unlike the previous 2 annual reports this appliance did not feature as the highest CPPY risk.

The IPPY values did include a single-point water heater incident. The IPPY risk values followed the trend of the past 2 years. This was single-point water heaters being the highest risk, followed by various central heating boiler units.

There were no reports of any incidents involving condensing appliances or tumble dryers during this reporting period, or in the previous three years already reported. Condensing boilers and tumble dryers are now becoming more common in domestic properties. Condensing boilers have modern safety features and controls with a room sealed, balanced flue. It would be expected that they will continue to rarely feature in CO incident reports. Tumble dryers also have modern safety controls and a low gas input rate. With only a small installed population they are also likely to rarely feature in CO incident reports.

In line with last year's results many installations feature substandard flueing and ventilation. As is the situation in a number of cases the appliance itself was not at fault, rather the installation. A point of concern is that many compartments were found to be substandard and many warm air units had faults with return air ductwork. A potential problem appears to be with replacement appliances which have been badly installed in existing compartments.

In incidents involving cookers and water heaters it was found that the incidents were high risk and the resulting casualties were most likely to be fatally affected by the incident. Approved servicing could probably have prevented both water heater incidents. Cooker burner problems and customer misuse of the appliance was a common feature of these incidents.

Data on the age of incident appliances is often not coded. Where provided it was mainly for central heating boilers and showed a higher risk from 6 to 15 year old appliances rather than younger or older models.

3.6 APPLIANCE INSTALLATION DETAILS

As would be expected the information available shows the majority of appliances are new when installed. The installation period for incident appliances includes a similar amount of data to that given in Table 10 – Age of incident appliances. From the limited data given it shows 6 to 10 year old installations as at the highest risk.

In about three quarters of the incidents the appliances had been installed correctly and to the relevant standards. In the majority of cases where the appliance was not fitted to standard it was by an "unknown person". In only 3 incidents was it known that the appliances had been installed second-hand and in only 1 incident was it reported that the appliance was fitted by DIY persons. In the majority of incidents, information was not forthcoming on whether the appliance was bought new or who fitted the appliance.

3.7 FLUE DETAILS

As in previous years the majority of incidents involved open flue appliances (75%). Approximately 66% (37) of all flues fitted were not installed to appropriate standards and in 45% (25) of all incidents where a flue was fitted the flue had an installation defect. Flue blockage had taken place in 3 (5%) incidents where a flue was fitted. When checked by a flue flow and continuity check 59% of flues failed the check. There were 19 flue terminals reported to be badly sited and 7 flues that were liable to suffer from downdraught problems. Basic flue and terminal installation faults should be picked up during routine servicing of open flue appliances and this is an area where the service engineer requires continued diligence.

The weather was thought to contribute to the poor performance of the appliance in 28 incidents. This is a common factor in CO incident reports as most incidents occur during the cold and windy months of the year. In fact peak numbers of incidents are often noted on the coldest days of the winter. Often when a cold northerly or easterly wind is experienced there is also an increase in the numbers of CO incidents.

Casing seal faults were reported on 2 of the 3 incidents involving room sealed Potterton Netaheat boilers.

3.8 PERMANENT VENTILATION

In many incidents during the reporting period the permanent ventilation required had not been provided, or if it was provided it had not been to standards and/or had become restricted. Such factors can affect flue performance and in combination with other faults are generally acknowledged to contribute towards the causes of CO incidents. As a common fault at incident sites this is an item that can be improved by continued customer awareness campaigns and during routine servicing. Details of the numbers of ventilation faults noted at incidents are given in Table 16 within section 2.10.

It has already been noted that incident appliances installed in compartments feature in a higher percentage of incidents than expected. The results of the analysis show that almost all these compartments were not to relevant standards. The typical faults found should be apparent during routine servicing to qualified service engineers. Ventilation faults are a relatively simple fault to identify and cure, but if open flued appliances are to continue in use their safe operation needs to be checked annually and any ventilation faults corrected.

3.9 SAFETY DEVICES

There are now an increasing number of safety devices being noted at incident sites and in the majority of cases they appeared to be in working order. The numbers in use however are still likely to be small by comparison with the total numbers of gas appliances installed. Unfortunately the only CO alarm fitted at an incident site was an SF detector installed on a landing. It was battery powered and was found to be non-operational. The incident featured a boiler which was mounted in a compartment on the landing. It had substandard ventilation and flueing. The weather was also noted as a contributory factor. Two young casualties were in bedrooms and 3 casualties were in the living room/lounge. In this situation it is likely that an operational CO alarm could have warned the occupants in the living room/lounge of the danger from the CO being produced by the boiler.

3.10 ON-SITE CHECKS

A combination of factors were present at most incident sites, with several separate occurrences probably leading to the production of CO. These could particularly include a combination of flue, ventilation and appliance faults. When investigated it was found that often there were similar faults on the appliance i.e. the appliance had a high CO/CO2 ratio and was spilling products, there was a defective flame picture and linting had also taken place. These were the most common faults noted from the on-site checks and which would be addressed during routine servicing. Details of the numbers of faults noted at incidents are given in Table 16 within section 2.10. To a lesser extent almost all of the faults listed on the DIDR form have taken place somewhere and have been discovered during an investigation.

There were also signs of spillage on the outside of the appliance which would be apparent to the occupants at 29 sites. It can be concluded that the need for annual servicing and to raise awareness of the signs of poor operation of gas appliances is a matter that needs to be continually brought to the attention of gas users.

3.11 INCIDENT APPLIANCE SERVICE HISTORY

Where information was provided it shows that only 20 of the incident appliances were covered by a regular service contract and the conclusion from this section of the report is that it is likely that the majority of incident appliances are not regularly serviced.

Details of who made the last working visit to attend to the incident appliance are not being provided at many incidents. There could be several reasons for this, but it is likely that servicing is so irregular that customers may have not established any long term contact with any particular servicing engineer. This is also implied when looking at the data relating to the interval between the last working visit and the incident.

3.12 HISTORICAL INFORMATION

Details entered in this section indicated only a small proportion of incidents featured appliances or installations which had previously been suspected of fume spillage. When questioned occupants at 11% of incident sites said they had experienced any of the symptoms that are typically associated with CO poisoning. It would be expected that at most CO incidents the levels of CO produced by the incident appliance would build up progressively over a considerable period of time. The reasons and situations why occupants seem to be only seriously affected above a threshold value, and on a particular day, is beyond the scope of this report. But what can be shown is that many typical faults are found at incident sites and that by addressing these then many incidents can be avoided.

3.13 INCIDENT CAUSE/CAUSES

Details of the incident causes, given by the investigators, highlight particularly that flue/terminal faults and a lack of servicing are the most common causes identified. The weather is also identified in a similar number of incidents. Ventilation and appliance faults are the next most common causes. This confirms details already given in this report and indicates that a substantial number of CO incidents could be avoided by regular, thorough safety checks and/or servicing.

4 SUMMARY

4.1 The number of domestic related CO poisoning deaths reported, at 24 during 1999/00, was in line with previous trends.

4.2 The majority of all CO incidents involved open flued appliances.

4.3 Central heating appliances were responsible for the majority of fatal and non-fatal casualties.

4.4 The over-all FPPY figure of 0.53×10^{-6} is within, what would normally be considered as, the "broadly accepted region" of HSE's criteria for the tolerability of risk. However societal concerns over gas safety override averaged numerical considerations.

4.5 The only appliance type that was above the HSE's criteria for the tolerability of risk was single-point water heaters (2.77×10^{-6}).

4.6 The most common room location for casualties was in the bedroom.

4.7 There was an above average risk of a CO incident in tenanted accommodation that was privately owned.

4.8 Flueing and ventilation faults were common in many domestic incidents.

4.9 Flue/terminal faults and a lack of servicing were the most common incident causes.

4.10 There were 7 LPG and 4 non-domestic incidents reported during 1999/00.

5 CONCLUSIONS

Analysis of the CO incident statistics, collected from the Downstream Incident Data Report form, has produced results in line with previous years results. The analysis identifies the most common faults found at incidents. This information can be used to improve customer safety, target expenditure on CO incident prevention and further research work.

6 RECOMMENDATIONS

6.1 The continuing importance of collecting and analysing incident statistics needs to be stressed. Without this data the risks associated with appliances, installations etc, cannot be accurately assessed and acted upon.

6.2 The data should be made available to all interested parties, i.e. those concerned with the safety, transportation and supply of gas and also to those involved in the installation and maintenance of gas appliances.

7 DATA USED AND REFERENCES

7.1 DATA USED

7.1.1 Appliance Population Statistics - Statistics for Great Britain provided by GfK Marketing Services Ltd., Sheer House, Station Approach, West Byfleet, Surrey KT14 6NL.

7.1.2 Historical Incident Data - Advantica database.

7.1.3 Number of Natural Gas Customers - Best estimates, for Great Britain, obtained from Lattice Group plc company records.

7.1.4 Population & Housing Statistics for England - The size of the average household has been calculated from figures produced by the Office for National Statistics and published in the Annual Abstract of Statistics. Housing data has been obtained from the Survey of English Housing published by the Department of the Environment, Transport and the Regions

7.2 REFERENCES

7.2.1 Definitions of FPPY, CPPY and IPPY - Advantica Reports.

APPENDIX A DEFINITIONS AND THE USE OF FPPY, IPPY AND CPPY VALUES

a) Fatalities Per Person Per Year (FPPY)

FPPY is a measure of the risk of death from owning a specific appliance type.

FPPY is defined as:-

$$FPPY = \frac{\text{Number of Fatalities}}{\text{Number of people at risk x Appliance Population}}$$

Notes:

1) In the report the number of people at risk is taken as the average number of people per household (2.26 in 1999/00). - provided from Government Statistics - see report section 7.

2) The "Overall FPPY" is calculated, as above, except that "Appliance Population" is replaced by the number of customers - see report section 7.

3) The appliance population figures used have been taken from information provided by GfK Marketing Services- see report section 7.

b) Incidents Per Person Per Year (IPPY)

IPPY is a measure of the risk of having an accident with a specific appliance type.

IPPY is defined as:-

$$IPPY = \frac{\text{Number of Incidents}}{\text{Number of people at risk x Appliance Population}}$$

c) Casualties Per Person Per Year (CPPY)

CPPY is a measure of the risk of being injured by owning a specific appliance type.

CPPY is defined as:-

$$CPPY = \frac{\text{Number of Casualties}}{\text{Number of people at risk x Appliance Population}}$$

APPENDIX B TABLES, BY APPLIANCE TYPE, SHOWING THE NUMBER OF FAULTS AND INDIVIDUAL INCIDENT DETAILS

Table B/A1 shows the tables included in this appendix. They have been completed for the appliance groups only where there were relevant incident appliances to describe. The appliance groups have been ordered in the same way as that used in section 2.5.2 of the report and within Table 9.

The nomenclature adopted allows data to be presented for any of the appliance groups. This has the advantage that tables with the same code may be readily identified, which can aid the comparison on a year-by-year basis. However, groups may not have been implicated in incidents in any particular year, so they are indicated in this appendix as "no reported incident".

Table B/A1 – Summary of incident fault analysis and summary tables presented

Appliance group	*Appliance sub-group*	*Code*	*Incidents*	*Appendix tables*
Central Heating Boilers	Back boiler unit	1.1	0	No reported incident
	Floor standing	1.2	8	B.1.2a & b
	Floor standing combi	1.3	0	No reported incident
	Thermal storage unit	1.4	0	No reported incident
	Wall mounted	1.5	23	B.1.5a & bi-ii
	Wall mounted combi	1.6	15	B.1.6a & b
	Warm air unit	1.7	5	B.1.7a & b
Cookers	Free standing	2.1	6	B.2.1a & b
	Built-in oven	2.2	0	No reported incident
	Built-in hob	2.3	0	No reported incident
Space Heaters	Balanced flue g .f.	3.1	0	No reported incident
	Cabinet heater	3.2	0	No reported incident
	Decorative g .f.	3.3	0	No reported incident
	Flueless heater	3.4	0	No reported incident
	Inset live fuel effect g .f.	3.5	0	No reported incident
	Rad. & rad. con. g .f.	3.6	4	B.3.6a & b
	Wall heater	3.7	0	No reported incident
Dryers	Tumble Dryers	4.1	0	No reported incident
Water Heaters	Bulk storage	5.1	0	No reported incident
	Circulator	5.2	1	B.5.2a & b
	Multi-point	5.3	0	No reported incident
	Single-point	5.4	1	B.5.4a & b

In addition, these codes have been used within the tables in this appendix :

Table B/A2 – Appliance location and flue type codes

Appliance location	*Code*	*Flue type*	*Code*
Other	0	Other	0
Bathroom	2	RS/Indiv/Natural draught/BF	1
Bedroom	3	RS/Shared/Se-duct	3
Bedsit	4	RS/Shared/U-duct	4
Dining Room	6	Open/Indiv/Natural draught	5
Utility Room	7	Open/Indiv/Fanned/Integral	6
Garage	8	Open/Indiv/Fanned/Add on	7
Hall	9	Open/Shared/Natural draught	8
Kitchen	10	Open/Shared/Fanned draught	9
Landing	11	Closed	10
Living Room/Lounge	12	Flueless	11
Shower room	13	Unbalanced	12
		RS/Indiv/Fanned draught/depressurised case	21
		RS/Indiv/Fanned draught/pressurised case	22

Table B/A3 – Cause of incident codes

Cause of incident	*Code*
Other	0
Appliance fault	1
Appliance installation fault	2
Customer misuse of the appliance	3
Flue/terminal fault	4
Lack of servicing	5
Sub-standard compartment	6
Sub-standard servicing	7
Ventilation fault	8
Not known/not yet established	9

B.1 CENTRAL HEATING BOILERS

B.1.1 BACK BOILER UNIT – NO REPORTED INCIDENT

B.1.2 FLOOR STANDING BOILER

Table B.1.2a - Central heating boilers : floor standing boiler : Summary fault analysis

number of incidents=8

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	1		High CO/CO_2 ratio	5
Defective flame picture	4		Failed spillage test	4
Linting	3		Overrated	1
Over-pressure	0		Underrated	0
Under-pressure	0		**Terminal**	
Other	0		Down draught	1
Flue			Bad siting	3
Blockage	1		Unapproved design	0
Corrosion	0		Other	0
Flue not to any standard	5		**Ventilation**	
Installation fault	3		Air vent/vents ineffective	1
Other	1		Air vents obstructed - intentionally	1
Heat exchanger			Air vents obstructed - unintentionally	0
Blockage - shale	1		Compartment/cupboard not to any standards	3
Blockage - soot	2		No permanent ventilation provided	1
Cracked	0		Ventilation provided was not to any standard	6
Other	1		**Miscellaneous**	
Safety device			Local topography	1
Failed CO alarm	0		Weather	6
Failed down draught	0		Signs of spillage – outside the appliance	4
Failed vitiation device	0		Signs of spillage – inside the casing	3

Table B.1.2b - Central heating boilers : floor standing boiler : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
ST5	(3)	24	7	Unknown			Glow-Worm Super 52	5	4,5,8
WA15	(7)		7	Unknown	Current		Glow-Worm Hideway 80	5	9
DN36	(1)		10	Unknown			Potterton C50/15	5	4,5,8
DE72	(3)	6	7	Unknown	Current		Glow-worm Hideaway 50	5	5,6,8
AL2	1 (1)		10	Unknown		Current	Potterton Kingfisher	5	4
ME15	(3)		10	Unknown			Potterton Kingfisher	5	2,4,6,8
W11	(1)	24	10	Unknown	Current when installed		Potterton Kingfisher 50RS	1	4,7
LE8	(3)		10	Unknown			Potterton Kingfisher 2	5	4,7,8

B.1.3 FLOOR STANDING COMBI – NO REPORTED INCIDENT

B.1.4 THERMAL STORAGE UNIT – NO REPORTED INCIDENT

B.1.5 WALL MOUNTED BOILER

Table B.1.5a - Central heating boilers : wall mounted boiler : Summary fault analysis

number of incidents=23

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	0		High CO/CO_2 ratio	17
Defective flame picture	5		Failed spillage test	7
Linting	12		Overrated	2
Over-pressure	3		Underrated	1
Under-pressure	1		**Terminal**	
Other	0		Down draught	4
Flue			Bad siting	7
Blockage	0		Unapproved design	0
Corrosion	0		Other	2
Flue not to any standard	15		**Ventilation**	
Installation fault	9		Air vent/vents ineffective	6
Other	4		Air vents obstructed - intentionally	1
Heat exchanger			Air vents obstructed - unintentionally	4
Blockage - shale	5		Compartment/cupboard not to any standards	9
Blockage - soot	2		No permanent ventilation provided	3
Cracked	0		Ventilation provided was not to any standard	10
Other	7		**Miscellaneous**	
Safety device			Local topography	2
Failed CO alarm	1		Weather	10
Failed down draught	0		Signs of spillage – outside the appliance	10
Failed vitiation device	0		Signs of spillage – inside the casing	8

Table B.1.5bi - Central heating boilers : wall mounted boiler : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
SP2	(2)	10	9	Unknown	Current		Myson Apollo 15-30C	5	5
WV4	2		10	Unknown			Glow-Worm Fuelsaver MK 2 40R	5	5
RM11	1	15	10	Unknown			Potterton Netaheat 10/16 MK2	22	1,3,4
EH32	(3)		9	Unknown			Vaillant Compact VC	5	4,5,6,8
NG5	(5)	10	10	Unknown	Current when installed		Glow-Worm Fuelsaver 75R MK2	5	5,8
SL1	(5)		10	Unknown			Glow-Worm Fuelsaver MK2 60R	5	4
BS37	1 (1)		10	Unknown	Current		Potterton Netaheat 16/22 MK2	22	1
B11	(4)		9	Unknown		Current	Glow-Worm Fuelsaver 30/40	5	5
SW2	(4)		10	Unknown	Current		Glow-Worm Economy 40B	1	3
HA9	(2)		9	Unknown			Potterton Flamingo RS40	1	1
GU22	1 (1)		10	Unknown			Vaillant VCW 25/1 T3WH	5	4
WD1	1 (1)	15	10	Unknown	Current	Current	Potterton Flamingo CF50	5	5

Table B.1.5bii - Central heating boilers : wall mounted boiler : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
EH34	(5)	8	11	CORGI			Glow-Worm Fuelsaver 50R MK2	5	1,6,8
BN14	(2)		10	Unknown		Current	Glow-Worm Fuelsaver MK2 50CF	5	4,5
L20	(3)		3	CORGI		Current	Potterton Profile 40E	21	9
L15	(4)		10	Unknown			Potterton Flamingo 35/50	5	5,0
CW12	1		3	Unknown			Glow-Worm Fuelsaver MK2 40	5	2,4,5,6,8
PE12	(2)	9	10	Unknown		Current	Myson Apollo 40C	5	4,5
SW6	(2)		10	Unknown	Current		Baxi 381 RS	1	1,5
DN14	2		10	Unknown			Glow-Worm Fuelsaver CF50 MK2	5	4
LN2	(1)	20		Unknown	Current		Potterton Netaheat 10/16	22	7
B76	(2)	15	10	CORGI			Potterton Flamingo 50 CF	5	4,5
BB8	(1)		10	Unknown	Current when installed		Worcester Heatslave Junior	1	0

B.1.6 WALL MOUNTED COMBI BOILER

Table B.1.6a - Central heating boilers : wall mounted combi boiler : Summary fault analysis

number of incidents=15

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	0		High CO/CO_2 ratio	12
Defective flame picture	1		Failed spillage test	8
Linting	4		Overrated	2
Over-pressure	3		Underrated	2
Under-pressure	2		**Terminal**	
Other	1		Down draught	1
Flue			Bad siting	9
Blockage	1		Unapproved design	0
Corrosion	0		Other	0
Flue not to any standard	13		**Ventilation**	
Installation fault	10		Air vent/vents ineffective	6
Other	2		Air vents obstructed - intentionally	1
Heat exchanger			Air vents obstructed - unintentionally	2
Blockage - shale	3		Compartment/cupboard not to any standards	4
Blockage - soot	1		No permanent ventilation provided	3
Cracked	0		Ventilation provided was not to any standard	12
Other	5		**Miscellaneous**	
Safety device			Local topography	1
Failed CO alarm	0		Weather	11
Failed down draught	0		Signs of spillage – outside the appliance	10
Failed vitiation device	0		Signs of spillage – inside the casing	9

Table B.1.6b - Central heating boilers : wall mounted combi boiler : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
WV11	7		10	Unknown			Vaillant VCW 20/1 T3 WH	5	4,5,0
B42	(4)	6	10	CORGI		Current	Ferroli 77CF	5	5
B37	(3)	9	10	CORGI			BKL Heatmaster DFF	6	5
HX3	(2)		10	Unknown			Vaillant VCW 25/1 T3WH	5	4
DN11	(4)	2	9	Unknown			Vokera Maxin 24 CF	5	4,6,8
KT3	(3)		0	CORGI			Vokera 18/72 DMCF	5	4
N17	(1)	7	10	Unknown			Vaillant VCW GB 240H	5	5
WS3	(2)	7	3	Unknown			Vaillant VCW GB 240H	5	2,4,5,8
HD7	(2)		10	Unknown			Vokera 18/72 DMCF	5	4,5,8
ST5	(4)		9	Unknown	Current		Saunier Duval SD 223C	5	6,8
CF64	(1)	3	2	Non-CORGI			Worcester 240 OF	5	2,4,6,8
SE7	(3)		10	Unknown			Vaillant VCW 20/1 T3WH	5	4,5,8
SW12	(1)		10	Unknown			Vaillant VCW GB 240H	5	1,4
W6	(2)		0	Unknown			Vaillant VCW GB 240H	5	1
BS24	(2)		10	Unknown			Vaillant VCW 25/1 T3WH	5	2,4

B.1.7 WARM AIR UNIT

Table B.1.7a - Central heating boilers : warm air unit : Summary fault analysis

number of incidents=5

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	0		High CO/CO_2 ratio	5
Defective flame picture	2		Failed spillage test	3
Linting	0		Overrated	2
Over-pressure	2		Underrated	0
Under-pressure	0		**Terminal**	
Other	1		Down draught	1
Flue			Bad siting	0
Blockage	0		Unapproved design	0
Corrosion	0		Other	0
Flue not to any standard	3		**Ventilation**	
Installation fault	2		Air vent/vents ineffective	1
Other	0		Air vents obstructed - intentionally	0
Heat exchanger			Air vents obstructed - unintentionally	1
Blockage - shale	0		Compartment/cupboard not to any standards	1
Blockage - soot	0		No permanent ventilation provided	0
Cracked	0		Ventilation provided was not to any standard	2
Other	1		**Miscellaneous**	
Safety device			Local topography	0
Failed CO alarm	1		Weather	1
Failed down draught	0		Signs of spillage – outside the appliance	1
Failed vitiation device	1		Signs of spillage – inside the casing	2

Table B.1.7b - Central heating boilers : warm air unit : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
DY6	(3)	4	7	CORGI	Current when installed	Current	Johnson & Starley J55-65 MAF	5	2
KY7	(4)		10	Unknown			Johnston & Starley J25-32	5	1
WD3	(2)		9	Unknown			Johnson & Starley JT 19-25	5	2,7
S40	(1)	27	6	Unknown			Lincoln LNCB 35/44 DL LR	5	1,4,5,6, 8
NE25	(2)			CORGI	Current when installed	Current	Johnson & Starley J25-32	5	3

B.2 COOKERS

B.2.1 FREE STANDING

Table B.2.1a - Cookers : free standing : Summary fault analysis

number of incidents=6

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	1		High CO/CO_2 ratio	4
Defective flame picture	2		Failed spillage test	0
Linting	2		Overrated	0
Over-pressure	0		Underrated	0
Under-pressure	0		**Terminal**	
Other	1		Down draught	0
Flue			Bad siting	0
Blockage	0		Unapproved design	0
Corrosion	0		Other	0
Flue not to any standard	0		**Ventilation**	
Installation fault	0		Air vent/vents ineffective	0
Other	0		Air vents obstructed - intentionally	0
Heat exchanger			Air vents obstructed - unintentionally	0
Blockage - shale	0		Compartment/cupboard not to any standards	0
Blockage - soot	0		No permanent ventilation provided	0
Cracked	0		Ventilation provided was not to any standard	0
Other	0		**Miscellaneous**	
Safety device			Local topography	0
Failed CO alarm	0		Weather	0
Failed down draught	0		Signs of spillage – outside the appliance	0
Failed vitiation device	0		Signs of spillage – inside the casing	0

Table B.2.1b - Cookers : free standing : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
S81	1		10	Unknown			New World Apex II	11	3
DE75	1		10	Unknown			Parkinson Cowan 1100	11	3,5
HP13	(1)		10	Unknown			Leisure Profile Plus	11	3
TN24	1		10	Unknown			Main Escort	11	1
CM20	1		10	DIY			New World Flair Deluxe	11	1
E5	2		10	Unknown			Valor Vanity	11	1,3

B.2.2 BUILT-IN OVEN – NO REPORTED INCIDENT

B.2.3 BUILT-IN HOB – NO REPORTED INCIDENT

B.3 SPACE HEATERS

B.3.1 BALANCED FLUE GAS FIRE – NO REPORTED INCIDENT

B.3.2 CABINET HEATER – NO REPORTED INCIDENT

B.3.3 DECORATIVE GAS FIRE – NO REPORTED INCIDENT

B.3.4 FLUELESS HEATER – NO REPORTED INCIDENT

B.3.5 INSET LIVE FUEL EFFECT GAS FIRE – NO REPORTED INCIDENT

B.3.6 RADIANT AND RADIANT CONVECTOR GAS FIRE

Table B.3.6a - Space heaters : radiant and radiant convector gas fire : Summary fault analysis

number of incidents=4

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	0		High CO/CO_2 ratio	1
Defective flame picture	0		Failed spillage test	2
Linting	2		Overrated	0
Over-pressure	0		Underrated	1
Under-pressure	1		**Terminal**	
Other	1		Down draught	0
Flue			Bad siting	0
Blockage	1		Unapproved design	0
Corrosion	0		Other	0
Flue not to any standard	1		**Ventilation**	
Installation fault	1		Air vent/vents ineffective	0
Other	0		Air vents obstructed - intentionally	0
Heat exchanger			Air vents obstructed - unintentionally	0
Blockage - shale	0		Compartment/cupboard not to any standards	0
Blockage - soot	0		No permanent ventilation provided	0
Cracked	0		Ventilation provided was not to any standard	0
Other	0		**Miscellaneous**	
Safety device			Local topography	0
Failed CO alarm	0		Weather	0
Failed down draught	0		Signs of spillage – outside the appliance	3
Failed vitiation device	0		Signs of spillage – inside the casing	1

Table B.3.6b - Space heaters : radiant and radiant convector gas fire : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
BD6	(1)		12	Unknown	Current when installed		Main Harmony	5	4,5
WA3	(2)	10	12	Unknown			Robinson Willey Firegem	5	2,4
CV22	(1)		12	Unknown			Flavel Debonair VI	5	1,2,5
NN9	(6)		12	Unknown	Current		Valor Copperglow	5	5

B.3.7 WALL HEATER – NO REPORTED INCIDENT

B.4 TUMBLE DRYERS

B.4.1 TUMBLE DRYERS – NO REPORTED INCIDENT

B.5 WATER HEATERS

B.5.1 BULK STORAGE – NO REPORTED INCIDENT

B.5.2 CIRCULATOR

Table B.5.2a - Water heaters : circulator : Summary fault analysis

number of incidents=1

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	0		High CO/CO_2 ratio	0
Defective flame picture	0		Failed spillage test	1
Linting	0		Overrated	0
Over-pressure	0		Underrated	0
Under-pressure	0		**Terminal**	
Other	0		Down draught	0
Flue			Bad siting	0
Blockage	0		Unapproved design	0
Corrosion	0		Other	0
Flue not to any standard	0		**Ventilation**	
Installation fault	0		Air vent/vents ineffective	0
Other	0		Air vents obstructed - intentionally	0
Heat exchanger			Air vents obstructed - unintentionally	0
Blockage - shale	0		Compartment/cupboard not to any standards	0
Blockage - soot	0		No permanent ventilation provided	0
Cracked	0		Ventilation provided was not to any standard	1
Other	1		**Miscellaneous**	
Safety device			Local topography	0
Failed CO alarm	0		Weather	0
Failed down draught	0		Signs of spillage – outside the appliance	1
Failed vitiation device	0		Signs of spillage – inside the casing	0

Table B.5.2b - Water heaters : circulator : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
HU8	(1)		3	Unknown	Current when installed	Current when installed	MAXOL S15	5	1,4,0

B.5.3 MULTI-POINT – NO REPORTED INCIDENT

B.5.4 SINGLE-POINT

Table B.5.4a - Water heaters : single-point : Summary fault analysis

number of incidents=1

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	0		High CO/CO_2 ratio	1
Defective flame picture	1		Failed spillage test	0
Linting	1		Overrated	0
Over-pressure	0		Underrated	0
Under-pressure	0		**Terminal**	
Other	0		Down draught	0
Flue			Bad siting	0
Blockage	0		Unapproved design	0
Corrosion	0		Other	0
Flue not to any standard	0		**Ventilation**	
Installation fault	0		Air vent/vents ineffective	0
Other	0		Air vents obstructed - intentionally	0
Heat exchanger			Air vents obstructed - unintentionally	0
Blockage - shale	0		Compartment/cupboard not to any standards	0
Blockage - soot	0		No permanent ventilation provided	0
Cracked	0		Ventilation provided was not to any standard	1
Other	1		**Miscellaneous**	
Safety device			Local topography	0
Failed CO alarm	0		Weather	0
Failed down draught	0		Signs of spillage – outside the appliance	0
Failed vitiation device	0		Signs of spillage – inside the casing	0

Table B.5.4b - Water heaters : single-point : Incident summary

Post Code	*Number of casualties: fatal (non-fatal)*	*Appliance age (yrs)*	*Appliance location*	*Installer*	*Flue to standards*	*Ventilation to standards*	*Appliance make & model*	*Flue type*	*Incident cause(s)*
PA2	1		10	Unknown			Main Mitre	11	3,5

APPENDIX C DETAILS OF LPG INCIDENTS DURING 1999/2000 AND ANALYSIS OF THE DATA

Seven LPG incidents were reported using the DIDR Form 551/7 during the period 1999/2000. Incident A occurred in a detached, owner-occupied property, built in 1945, whilst incident B was in an owner occupied house. Incident C occurred in a semi-detached house owned by the local. It was built between 1966 and 1980. Incident D was in a first floor rented flat. Incident E was in a first floor council flat, dating from about 1950, whilst incident F occurred in a privately rented, converted flat which was below ground level. The type of property involved in incident G was not reported, except that it was owner-occupied, and built between 1946 and 1965.

Incident A (April 1999) resulted in the hospitalisation of a 55-year old male and incident B (October 1999) caused the death of one female and affected a 20-year old female and a 6-year old male. Incident C (November 1999) caused the death of a young mother, her 2-year old son and 9-month old daughter whilst D (also November 1999) resulted in the death of a 31-year old male. Incident E (December 1999) caused the death of a 47-year old male and incident F (March 2000) caused the death of a 32-year old male. Incident G (also March 2000) resulted in the hospitalisation of two people of unknown age, one male and one female.

Some details of these incidents and casualties are given in Table C1.

Table C1 - CO incidents and casualties

Incident	*Post code*	*Appliance involved*	*Numbers of fatal casualties*	*Numbers of non-fatal casualties*			
				N1	N2	N3	N4
A	GL18	Wall-mounted Combi	0	1	0	0	0
B	NP19	Cabinet heater	1	0	2	0	0
C	S2	Cabinet heater	3	0	0	0	0
D	TS8	Cabinet heater	1	0	0	0	0
E	WS3	Cabinet heater	1	0	0	0	0
F	HD1	Cabinet heater	1	0	0	0	0
G	SS9	Floor-standing boiler	0	2	0	0	0

Note: Non-fatal casualty codes are explained in Section 2.2

In all cases, the casualties were in the same properties as the appliances involved. Details of the appliance and casualty locations are given in Table C2.

Table C2 - Appliance and casualty locations

Incident	*Appliance location*	*Casualty locations*	*Flue type*
A	Kitchen	Living room	21
B	Dining room	Unknown	11
C	Living room/Lounge	Living room/Lounge	11
D	Living room/Lounge	Living room/Lounge	11
E	Bedroom	Bedroom	11
F	Unspecified	Bedroom	11
G	Kitchen	Living room/Lounge	5

Note: Flue type codes are detailed in Appendix B, Table B/A2

The incident appliance make and model, and installation details where known, are given in Table C3.

Table C3 – Appliance and standards details

Incident	*Appliance make & model*	*Appliance age (years)*	*Installer*	*Appliance installed to standards*	*Flue to standards*	*Ventilation to standards*
A	Eco Hometec EC30 VCO	2	CORGI	Current	Current	No
B	Unspecified	Unknown	Unknown	Unknown	N/A	No
C	Valor 380 cabinet heater	17	Unknown	Current	N/A	No
D	Ardent Arabia 3	Unknown	Unknown	No	N/A	No
E	Corcho cabinet heater	Unknown	Unknown	No	N/A	Yes
F	Superser Impresso F90	20	Unknown	Unknown	N/A	No
G	Potterton Kingfisher CF60	Unknown	Unknown	Current	No	Unsure

The following faults and relevant observations were reported:

Incident A – The incident appliance was installed in a compartment that was not to standards. The owner had removed the appliance casing because of an ignition problem which had led to parts of the flue system being ejected into the garden. However the flue had become detached internally which allowed burnt flue gases to mix with the incoming air. The relatively new fan-flued Combi boiler had been routinely serviced within the previous six months. Wind effects were also thought likely to be a contributory factor in the incident.

Incident B – CO poisoning was thought to be due to inadequate ventilation. A report on the condition of the heater appears to have been mislaid and so further information was limited.

Incident C – The heater was found to be in reasonable condition, although the cement fixing of the radiant plaques was damaged. Other observations suggested that no regular servicing had been carried out, and that light-back was experienced during tests. An anti-vitiation device was fitted, but did not activate at a sufficiently low level of CO_2 to prevent high levels of ambient CO.

Incident D – The 13kg butane cylinder was outside the cabinet, rather than inside the casing. The connection hose had no securing clip and was not suitable for use with LPG. Fire cement around the radiant plaques was cracked and missing in places, allowing the heater to light back shortly after ignition. Tests showed that the heater was noisy, and very high levels of CO and CO/CO_2 ratio could be produced after only a few minutes. The regulator was set low by 10 mbar and safety information on the appliance gave details of required minimum room volumes and minimum ventilator size. The appliance had been located within 1m of where the body was found and there was also no purpose provided ventilation into the room

Incident E – The back of the heater and three of the castors were missing, and the connection hose was out of date. The fireguard was missing, one of the radiant plaques was cracked and much of the fire cement was loose or missing. Tests showed that light back occurred shortly after ignition, and very high levels of CO and CO/CO_2 ratio could be produced after only a few minutes. The appliance had been operated in a room volume much smaller than specified by the relevant standards or recommended by the manufacturer and in a bedroom, which is a location which is not a recommended.

Incident F – The flat contained two portable heaters, but only one was connected to a gas supply. Testing of the heater connected to a gas supply showed that the combustion products contained high levels of CO within 30 minutes of initial lighting. Light back resulted in the high levels of CO being produced. The appliance was in a generally poor condition and the front panel was missing. The burner was linted, it had a poor flame picture and the cement holding the plaques in place was loose or missing. Also one plaque was damaged. A vitiation device was present and operational. There was no purpose provided ventilation and no signs of regular servicing having taken place.

Incident G – Flue checks and CO/CO_2 ratio appeared to be satisfactory, but compartment ventilation and a flue installation fault may have been a factor in the incident, together with weather conditions and poor siting of the flue terminal. There were signs of spillage and a down-draught detector was fitted and working.

Table C4 gives the total numbers of faults found so far, at the seven installations involved.

Table C4 - Incident appliance faults

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	0		High CO/CO_2 ratio	4
Defective flame picture	1		Failed spillage test	3
Linting	1		Overrated	0
Over-pressure	0		Underrated	0
Under-pressure	1		**Terminal**	
Other	4		Down draught	0
Flue			Bad siting	1
Blockage	0		Unapproved design	0
Corrosion	0		Other	0
Flue not to any standard	1		**Ventilation**	
Installation defect	2		Air vent/vents ineffective	1
Other	0		Air vents obstructed - intentionally	0
Heat exchanger			Air vents obstructed - unintentionally	1
Blockage – shale	0		Compartment/cupboard not to any standards	1
Blockage – soot	0		No permanent ventilation provided	4
Cracked	0		Ventilation provided was not to any standard	1
Other	0		**Miscellaneous**	
Safety device			Local topography	1
Failed CO alarm	0		Weather	2
Failed down draught	0		Signs of spillage – outside the appliance	2
Failed vitiation device	0		Signs of spillage – inside the casing	1

During the period for this report an exceptional number of serious incidents resulted from the use of LPG cabinet heaters. As a result the HSE organised a press conference and issued a press release number E249:99 which gave details of potential faults which could arise and how to identify them. Press releases can be found at:

http://www.open.gov.uk/hse/press/press.htm

In particular cabinet heaters require servicing by competent persons, they require purpose provided ventilation and should only be used in large, ventilated rooms. They may have a vitiation device fitted as a safety device but as this may be designed to operate when room oxygen levels fall, rather than CO is produced, they could be of limited effect in preventing CO incidents.

APPENDIX D DETAILS OF NON-DOMESTIC CO INCIDENTS DURING 1999/2000 AND ANALYSIS OF THE DATA

Four incidents involving piped natural gas within business properties were reported, using the DIDR form 551/7 during the year 1999/2000. Incident A occurred in an hotel, incident B in a hospital laundry, incident C in a commercial kitchen and incident D at a private residential home. Properties A, B and D were originally built before 1945, while C was built in 1955.

Incident A occurred in June 1999 and affected one adult male in the hotel reception area and one adult female in a bedroom. Incident B (during November 1999) involved a 43-year old female laundry worker. Incident C occurred in January 2000, causing injury to a 53-year old female. Incident D (March 2000) affected a 58-year old male and two females, one aged 13 years and one aged 14 years. The severity of these last casualties was not reported.

Some details of these incidents and the resulting casualties are given in Table D1 below.

Table D1 – CO incidents and casualties

Incident	*Post code*	*Appliance involved*	*Number of fatal casualties*	*Number of non-fatal casualties*			
				N1	*N2*	*N3*	*N4*
A	TR7	Floor standing boiler	0	0	2	0	0
B	PA2	Tumble dryer	0	1	0	0	0
C	BS23	Free-standing cooker	0	0	0	1	0
D	EX7	Wall-mounted boiler	-	-	-	-	-

Note: Non-fatal casualty codes are explained in Section 2.2

In each case, the incident appliance was located in the same property as the casualties. Details of the appliance and casualty locations are given in Table D2.

Table D2 - Appliance and casualty locations

Incident	*Appliance location*	*Casualty locations*	*Flue type*
A	Boiler room	Reception & Bedroom	5
B	Laundry	Laundry	9
C	Kitchen	Kitchen	11
D	Kitchen	Lounge	5

Note: Flue type codes are detailed in Appendix B, Table B/A2

Details of the incident appliance make and model are given in Table D3.

Table D3 – Appliance and Standards details

Incident	*Appliance make & model*	*Appliance age (years)*	*Installer*	*Appliance installed to standards*	*Flue to standards*	*Ventilation to standards*
A	Ideal Concord C330	Unknown	Unknown	Yes	Current when installed	Yes
B	Am. Dryer Corp. ADG 50 D	3	CORGI	No	No	No
C	Blue Seal GD54 Turbo-fan	Unknown	CORGI	No	N/A	No
D	Thorn Apollo 15/30C	14	Unknown	Yes	No	No

The following faults and relevant observations were reported:

Incident A – There was evidence of spillage, flue corrosion and a partially collapsed draught diverter. No regular maintenance had been undertaken, and combustion was poor. Ventilation was inadequate, with internal ducts allowing high CO levels to move from the boiler room throughout the hotel.

Incident B – The heat exchanger, flue and terminal were blocked, and the back draft damper was jammed due to lint. Make-up air and exhaust ducts were sub-standard, allowing reverse flow of combustion products. A safety inspection had been carried out during the previous year, and the down-draught detector was operational, but did not prevent high levels of ambient CO.

Incident C – This second-hand cooker had been installed the previous year, but without any provision for ventilation and also inadequate provision for fume extraction. After a history of pilot-outage, the gas regulator had been removed, so that the appliance was operating at twice the recommended working pressure and gas rate. This resulted in a poor flame picture and high CO levels. CO poisoning symptoms had been reported previously.

Incident D – The flue was sub-standard with evidence of down-draughting, and ventilation was partially blocked although this was unintentional. There were signs of spillage, and the heat exchanger was blocked by sulphate. A safety inspection had been carried out during the previous year, following reports of fumes and CO poisoning symptoms. High levels of CO/CO_2 ratio were measured, and the weather was thought to play a significant part. A battery-powered CO alarm of unknown manufacture was located two floors above the incident, but failed to detect the emissions.

Table D4 gives the total numbers of faults found at the four installations involved.

Table D4 – Incident appliance faults

Fault group	*Number of faults*		*Fault group*	*Number of faults*
Burner			**Incident testing**	
Corrosion	0		High CO/CO_2 ratio	1
Defective flame picture	1		Failed spillage test	2
Linting	0		Overrated	1
Over-pressure	1		Underrated	0
Under-pressure	0		**Terminal**	
Other	1		Down draught	1
Flue			Bad siting	2
Blockage	1		Unapproved design	0
Corrosion	1		Other	1
Flue not to any standard	2		**Ventilation**	
Installation defect	0		Air vent/vents ineffective	1
Other	2		Air vents obstructed - intentionally	0
Heat exchanger			Air vents obstructed - unintentionally	1
Blockage - shale	0		Compartment/cupboard not to any standards	0
Blockage - soot	0		No permanent ventilation provided	1
Cracked	0		Ventilation provided was not to any standard	2
Other	2		**Miscellaneous**	
Safety device			Local topography	0
Failed CO alarm	0		Weather	2
Failed down draught	0		Signs of spillage – outside the appliance	3
Failed vitiation device	0		Signs of spillage – inside the casing	1

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