DUTCH
SAFETY BOARD

Summary
Carbon monoxide

Understated and misunderstood danger

Summary
Carbon monoxide
Understated and misunderstood danger

The Hague, November 2015

The reports issued by the Dutch Safety Board are open to the public.
All reports are also available on the Safety Board's website www.safetyboard.nl

Source photo cover: an arbitrary central heating boiler (source: ANP, Lex van Lieshout)

Dutch Safety Board

When accidents or disasters happen, the Dutch Safety Board investigates how it was possible for them to occur, with the aim of learning lessons for the future and, ultimately, improving safety in the Netherlands. The Safety Board is independent and is free to decide which incidents to investigate. In particular, it focuses on situations in which people's personal safety is dependent on third parties, such as the government or companies. In certain cases the Board is under an obligation to carry out an investigation. Its investigations do not address issues of blame or liability.

Visiting address: Anna van Saksenlaan 50
2593 HT The Hague
The Netherlands

Postal address: PO Box 95404
2509 CK The Hague
The Netherlands

Telephone: +31 (0)70 333 7000

Fax: +31 (0)70 333 7077

Website: www.safetyboard.nl

CONTENTS

CONSIDERATION

Throughout the Netherlands, there are still people who are unaware of the risks of illness and even death associated with exposure to carbon monoxide in the home. These risks are nonetheless present in over 90 percent of the Dutch homes that have gas installations. All of the parties involved, from residents and home owners to installers, manufacturers, government bodies and the emergency services, lack sufficient knowledge of the scope of this problem and its defining characteristics. It is the view of the Dutch Safety Board that each of these parties bears responsibility for the prevention and management of carbon monoxide accidents.

To begin with, residents and owners have a crucial personal responsibility for the safety of the combustion installations in their homes. The general assumption among all the parties is that the potential for carbon monoxide hazards is limited to homes where this responsibility is neglected. This can occur, for instance, when open, non-flued appliances are used in areas with insufficient ventilation and with appliances that receive insufficient maintenance. That assumption, however, has proven wrong. In many of the accidents it investigated, the Safety Board found that residents and/or owners had acted in accordance with their responsibility to ensure that their installation was functioning safely. Many had their gas furnaces installed and/or periodically maintained by a professional installer with a quality certification. This finding has led to a review of the overall picture and indicates that efforts to reduce accidents should not focus exclusively on residents/owners, but should also identify areas for improvement among manufacturers and installers.

Manufacturers are responsible for producing installations that are safe. The Safety Board has observed, however, that manufacturers do not produce *failsafe* installations that shut down automatically when a potentially hazardous situation arises. Moreover, manufacturers fall short when it comes to producing *foolproof* installations, which limit the risk of incorrect use by residents/owners and installers. In addition, some of the carbon monoxide detectors on the market are unreliable.

Installers, meanwhile, have a duty to ensure the that gas appliances are safely installed and maintained. However, the Safety Board has discovered that this duty is not being properly fulfilled. In the majority of cases, professional maintenance work is limited to the appliance itself. Installers do not check whether the entire installation is functioning safely in conjunction with the building's system. Furthermore, installers are not always fully competent. The existing safeguards to ensure acceptable quality standards among installers are insufficient.

What can be done to resolve the problems among installers and manufacturers identified in this report? Government action in this area has been tending towards deregulation and, in view of this trend, the Safety Board acknowledges that recommendations aimed at introducing new regulations on combustion installations and those who install them

will gather little support. The idea underlying deregulation is that individuals and companies should fulfil their responsibilities with minimal regulatory interference and without the need for inspections in the home.

As an alternative to government regulation, efforts are currently focusing on quality control in the private sector. The underlying premise is that liability will serve as a stimulus to suppliers and their clients to maintain strict standards. However, the Safety Board argues that this approach can only be of limited use in preventing carbon monoxide accidents. A significant percentage of the clients who require installation and maintenance of gas appliances in their homes are individual consumers with limited technical understanding and knowledge of their responsibilities as commissioning clients. Currently, these consumers are not in a position to evaluate in advance whether a company is capable of delivering the standard of service required or to determine whether this standard has been met once the job is done. Even the installation service industry is unable to take full responsibility for safe combustion installations. While this industry has established various quality labels, it is clear that self-regulation provides insufficient guarantees of safety in a market that is both fragmented and highly price-competitive.

It is the Safety Board's view that the government could do more to protect private consumers against the potential hazards associated with combustion installations. Lack of regulation has resulted in the current gaps in the system designed to protect consumers from these hazards. By introducing supplementary regulations and monitoring, the government can ensure compliance with a set of minimum safety requirements - requirements which must be observed at all times, regardless of any additional burden that the installers may perceive.

SUMMARY

Background, objectives and research questions
In response to serious concerns, the Dutch Safety Board decided to launch a study into the causes of carbon monoxide accidents. The study is designed to address misgivings about the current understanding of carbon monoxide-related hazards and/or the effectiveness of current measures to prevent carbon monoxide accidents.

The term *carbon monoxide accident* in this report refers to the unintended release of a high concentration of carbon monoxide gas in a room or enclosed space that could potentially be occupied by people. The Safety Board has identified two areas for introducing new measures. The first area is *prevention*: measures aimed at preventing carbon monoxide from being produced and entering a room or enclosed space. The second area is *damage control*: measures focused on timely detection, preventing further exposure and poisoning, and ensuring that victims receive adequate care.

This study seeks to determine why carbon monoxide accidents occur despite the current presumed level of knowledge. The Safety Board also plans to issue recommendations on eliminating the potential causes of carbon monoxide accidents and limiting the effects of such accidents. It formulated two research questions:

- how do carbon monoxide accidents occur; and
- why do the parties involved sometimes fail to prevent these accidents?

Carbon monoxide: an underestimated danger
It is not entirely clear how many carbon monoxide accidents occur annually in the Netherlands, or how many lives are lost as a result. According to the figures available, such accidents account for 5 to 10 deaths each year and a few hundred cases of poisoning in which the victim survives. Nonetheless, private consumers and emergency care workers do not always recognize exposure to carbon monoxide, and carbon monoxide poisoning can even be overlooked as the cause of death. Having reviewed a number of indicators, the Safety Board believes that the scale of this problem is three to five times greater than current estimates suggest.

Carbon monoxide: a misunderstood danger
Based on documentation and interviews with relevant parties, the Safety Board has concluded that there are many false assumptions about the release of carbon monoxide gas. Open, non-vented appliances (especially boilers) have long been considered the category with the highest risk. Ventilation is a particularly crucial factor with this type of appliance and many have been replaced by closed vented models, especially central heating boilers. As a result, the number of boiler-related accidents has dropped, though this alone has not eliminated all potential hazards. The fact remains that combustion

installations, such as central heating boilers, can only function safely if they are properly installed and the entire installation is maintained and monitored in conjunction with the building's system.

The Safety Board's study on carbon monoxide accidents found that this is not the case in many instances. The accidents that occur are caused by a wide range of complex and interconnected factors. However, all of the accidents showed one aspect in common: residents are exposed to carbon monoxide in cases where measures are not taken to ensure the safety of the entire installation in conjunction with the building's system. By 'measures' Board means procedures that go beyond examining the appliance itself and include monitoring the ventilation, air supply, flue gas ducts, outlets, etc. Many of the carbon monoxide accidents in this study involved combustion installations (mainly gas) that had been serviced by a certified installer who may have omitted necessary steps or done poor quality work. This might be due to time pressure, or an exclusive focus on checking the appliance itself without monitoring the entire installation in conjunction with the building.

Key role for installers and manufacturers in reducing carbon monoxide accidents

The Safety Board's most important conclusion is that residents and home owners are not only ones with a key role in preventing carbon monoxide accidents. A significant number of the accidents reviewed in this study occurred in homes where the residents/owners had their appliances installed and periodically maintained by a certified installer. The Safety Board defines the term 'certified installer' as an installer who is officially affiliated with one or more of the industry's quality label organizations (e.g. members of UNETO-VNI, SEI, Sterkin, BRL6000, Kwaliteitsvakman and OK-CV). In most of the cases, the accidents did not result from insufficient safety awareness on the part of residents/owners, as they had done everything within their power to ensure their safety.

These cases occurred because the professional companies involved had not properly ensured the safe functioning of the combustion installations. The companies in question included both installation service providers who install and maintain these appliances, and manufacturers who produce components for installations.

The Safety Board believes it is vital for installers to be aware that their installation and maintenance services could literally mean the difference between life and death. It is absolutely essential, therefore, that installation service companies as well as individual contractors should be competent professionals.

The accidents also clearly revealed the need for an integrated approach to these appliances and their functioning within the building, in terms of both installation and maintenance. In the view of the Safety Board, it is necessary for manufacturers of products, such as appliances and flue gas duct systems, to collaborate with the installation service industry to create *failsafe* and *foolproof* gas installations. Such an approach would identify safety issues and alert users to them, result in installations that shut down automatically if necessary, and protect consumers from any serious safety hazards resulting from mistakes in their installation, use or maintenance. Residents/owners and

the installers and manufacturers they select share a joint responsibility for overall safety throughout the life cycle of a combustion installation that is maintained in conjunction with the building's system.

Detection and diagnostics

When measures to prevent a carbon monoxide accident fail, timely detection and/or diagnosis is crucial to reducing further exposure and ensuring that the victims receive proper care. Experience has shown that residents, care providers and emergency care workers do not always recognize carbon monoxide poisoning. In some instances, emergency workers equipped with carbon monoxide meters discovered the problem by coincidence.

Carbon monoxide detectors are an effective tool for alerting residents/owners to concentrations of carbon monoxide gas. However, they are not always reliable due to problems, such as malfunctioning sensors and low batteries. Moreover, consumers do not always follow the user instructions properly (e.g. concerning placement) or respond appropriately to the alarm.

Industry and government guarantees

Under current legislation and regulations, combustion installations are required to function safely in conjunction with the building's system. Nonetheless, the government exercises very little supervision to enforce compliance in practice. Installers, who are responsible for ensuring safety in terms of installation and maintenance, are not always competent. Although the industry itself has introduced a number of quality labels, there are still major gaps in the industry's provision of safeguards against potential hazards. While the legislation and regulations also stipulate standards for component manufacturers, they do not state that these components have to be conducive to producing installations that are *failsafe* and *foolproof*.

The Netherlands: a country lagging behind

Many residents/owners have no other option than to heat their home with gas. The Dutch government has encouraged people to use gas heating and most homes are not equipped for heating alternatives, such as electrical systems. Compared to neighbouring countries where gas is also a major heat source, the Netherlands is lagging behind when it comes to establishing and organizing a system aimed at safeguarding the quality of the services installers provide and ensuring the safety of combustion installations. In other countries, installation maintenance is mandatory, installations are subject to periodic inspections, and installers are required to meet competence standards and have their work inspected regularly. Some countries even require carbon monoxide detectors in addition to these measures as a back-up precaution in the event of a malfunctioning installation. The table below shows the areas where the Netherlands is lagging behind in relation to other countries.

Aspect	Mandatory registration	Installation monitoring	Installers	Supervision
The Netherlands	None	Only > 100 kW	Certification not required	None
Germany	Accidents and malfunctions	Delivery, adjustments, replacement	Certification required	Grid operator/ chimney sweeper
Belgium	Accidents	Periodic maintenance	Certification required for gas installation	Grid operator
Great Britain	Accidents and malfunctions	Mandatory annual inspection and maintenance for rental housing	Certification required	HSE, Gas Safe Register
Denmark	Unknown	Mandatory maintenance every 1-2 years	Certification required	Grid operator

Table 1: The Netherlands' system for safely functioning installations compared to neighbouring countries.

Recommendations

Residents/owners bear an important responsibility for the safety of the installations in their homes. However, many of the accidents in this study occurred in homes where the residents/owners had had their appliances installed and periodically maintained by a professionals installer with a quality certification. This finding shows that safety issues are often attributable not to residents/owners but rather to professional companies (installation service providers and manufacturers).

The Safety Board would like to draw attention to the gaps in the system that is supposed to ensure the safety of combustion installations. These gaps can be found in the safeguards provided by the industry as well as governmental supervision. Interviews with a range of parties in the industry have revealed a willingness to introduce structural improvements to the current system.

The Board considers the relevant parties in the industry to include installers, manufacturers (of appliances, supply and outlet ducts and carbon monoxide detectors), umbrella organizations (e.g. UNETO-VNI, VfK, NHK, RoGaFa) quality assurance organizations (KvINL, Sterkin, Zelfstandigen Bouw, SCIOS, Sfeerverwarmingsgilde) and grid operators (via their umbrella organization, *Netbeheer Nederland*).

Given the large number of parties involved, each with their own interests, and the importance of an integrated approach, responsibility cannot be placed with the industry alone. The Board argues, therefore, that the government should assume the task of overseeing a system that ensures the safety of consumers in their homes. The Safety Board also feels that the Minister for Housing and the Central Government Sector (responsible for safe housing, including installations) and the Minister for Health, Welfare and Sport (responsible for the safety of products such as gas appliances and carbon monoxide detectors) should fulfil a special regulatory role in this supervision.

The Dutch Safety Board urges both ministers to draw on the findings of this report in working with relevant parties to develop an integrated approach to the prevention of carbon monoxide accidents, and to establish a system that ensures adequate safeguards for consumers with gas installations in their homes. To this end, the Board has drawn up the following recommendations for the ministers, based on the assumption that these measures will be implemented in collaboration with the relevant parties mentioned earlier in this report.

To the Minister for Housing and the Central Government Sector and the Minister for Health, Welfare and Sport:

1. Establish a uniform regulation that stipulates mandatory certification for all service providers who install and/or maintain combustion installations in homes and other buildings. This regulation should ensure professional competence among installers working as individual contractors or for installation service companies in every aspect of servicing combustion installations, including maintenance in conjunction with the building's system. This regulation should uphold the trust of residents/owners and other consumers by monitoring the workmanship of installers and the results of that workmanship (i.e. safely functioning installations).

   Note: The Safety Board considered recommending mandatory inspections for the instalment of combustion installations, as well as periodic inspections. However, given the practical implications, the Board decided against such a recommendation. Instead, the Board concludes that the legal regulation recommended above should introduce vigorous measures to improve the system designed to ensure the safety of combustion installations. In the event that the certification regulation outlined above proves to be insufficient, the relevant parties should nonetheless consider incorporating these additional inspections into the system.

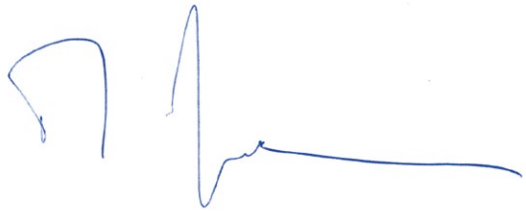
2. Establish legal requirements (possibly in a European context) that will result in installations that are *failsafe* and *foolproof* across the board.

3. Publicly disclose the full test results of carbon monoxide detectors immediately to enable residents/owners to make well-considered decisions about their purchase.

4. Establish additional legal requirements (possibly in a European context) to ensure the reliability and effectiveness of carbon monoxide detectors. Follow this up by advocating the use of reliable and effective carbon monoxide detectors in homes and public buildings.

5. Take measures to inform residents/owners, installers and emergency care workers about the hazards associated with carbon monoxide.

6. Monitor problems and the effectiveness of measures by registering and investigating carbon monoxide accidents.



T.H.J. Joustra
Chairman, Dutch Safety Board

M. Visser
General Secretary

DUTCH
SAFETY BOARD

Visiting Address
Anna van Saksenlaan 50
2593 HT The Hague
T +31(0)70 333 70 00
F +31(0)70 333 70 77

Postal Address
PO Box 95404
2509 CK The Hague

www.safetyboard.nl