



Netherlands Food and Consumer
Product Safety Authority
Ministry of Agriculture,
Nature and Food Quality

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**To the Head of Agency of the Netherlands Food
and Consumer Product Safety Authority**

**From the Director of the Office for Risk
Assessment & Research**

**Advice on the risks of certain models of boilers of
the Nefit brand following effectiveness study
modifications**

**Office for Risk Assessment
& Research**

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Background

In July 2018, the Office for Risk Assessment & Research (Bureau Risicobeoordeling & Onderzoek, BuRO) issued an advice to the Inspector General of the Netherlands Food and Consumer Product Safety Authority (NVWA) on the risks of some models of TopLine HR boilers produced by the company Nefit. This manufacturer has been carrying out a corrective action aimed at these models of boilers for several years. The action consists of replacing the burner set with a new type, in some cases accompanied by replacing the heat exchanger.

In 2016, the NVWA called upon the manufacturer to be more urgent given the risk of fire. Subsequently, in 2017, broadcaster RTL asked company C+B Advies en Expertise to draw up a report on the safety of the aforementioned boilers. This report, together with a critical assessment by two independent external experts, formed the basis for BuRO's advice of July 2018.

In summary, BuRO advised the Inspector General to ask the producer to provide all information necessary to assess whether the models in question still pose risks after the modifications and to continue to alert the producer to his legal responsibility to demonstrably effectively modify all defective boilers within a reasonable period. The Inspector General was also advised to actively contribute to informing consumers about necessary actions to control the risks of heating boilers and to enter into discussions with inspection and certification bodies about the effectiveness of inspection requirements for covering risks and identifying problems with appliances.

TNO (Netherlands Organisation for Applied Scientific Research) was commissioned by Nefit to test the effectiveness of the modifications to Nefit TopLine boilers. For the fire safety aspect, TNO called in the company Efectis, which specializes in fire research. The results were published in November 2018 (TNO, 2018).

Based on the care for product safety, BuRO has decided on its own initiative to research whether the safety risk to consumers has been controlled: Is it possible to assess whether the risks of the models concerned are controlled after modification on the basis of the report by TNO commissioned by Nefit? This advice is a complement to the advice previously issued, which remains valid insofar as non-modified boilers of the models in question are still in use.

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Parallel to the realisation of this advice, the NVWA investigated the safety of boilers of the brand Agpo Ferroli. The letter on the progress of this investigation was sent to the Dutch House of Representatives on 4 October 2019 (Bruins, 2019). The results of this investigation, reported in the appendix to the chamber letter, are not dealt with separately in this advice.

Approach

The starting point for assessing the risks after modification of the boilers concerned is the TNO report (TNO, 2018). The research in this report focuses on three types of heat exchangers in circulation, in combination with a new type of burner, the so-called V3 burner. The original V1 burner is the subject of a recall and must be replaced. According to the manufacturer, this TNO report substantiates the safety of modified boilers. Underlying documents and instructions are also involved in the assessment.

BuRO asked an independent scientific expert with knowledge of heating installations to provide a critical assessment of the TNO report. This assessment is added to this advice as an annex.

When it became clear, after studying the TNO report (TNO, 2018) and the critical assessment, advice would be given to the Inspector General of the NVWA on the risks of some models of TopLine HR boilers, this opinion was shared in draft with the Enforcement Directorate of the NVWA. This led to questions to Nefit to which a response was received. Where relevant, this reaction has been mentioned in this document.

In addition to the above, the relevant legislation and regulations and the developments in the field of gas appliances, of which central heating boilers are part, have been scrutinized.

Findings

The TNO report (TNO, 2018) deals with Nefit's two underlying main questions, substantiated by experimental research:

1. Is release of carbon monoxide (CO) from the appliance to the installation room possible and, if so, under what circumstances can CO leakage occur? *TNO considers the risk of spreading CO to the home with Topline appliances with a B3M heat exchanger and a replacement V3 burner to be very low.*
2. Does the possibility of fire exist with the construction models described and if so, under what circumstances can this possibility occur? *TNO and Effectis consider the risk of fire for Topline appliances with a B3M heat exchanger and a replacement V3 burner to be very small. This is valid under the condition that Nefit's instructions regarding periodic maintenance are observed. This includes checking that the burner clamps are securely fastened.*

The external expert consulted by BuRO makes several comments on the experiments on which these conclusions are based. In summary these comments are (Annex 1):

- Based on the information regarding the selection by TNO of boilers to be tested, taken from the boilers returned to Nefit after a recall, it is not sufficiently plausible that no boilers with greater damage are present among consumers.
- Furthermore, it has not been demonstrated that the tests with intentional damage are representative of the (worst case) situation in the field.
- Also, the external expert made technical comments on both the CO and temperature measurements in the test setup.

The conclusions of TNO apply under certain conditions. As stated in TNO's answer to the second question, a requirement is a properly installed and secured burner set. When burner clamps are not tightened, there is a risk of both fire and CO poisoning. TNO's experiments show that boilers with loose burner clamps can be in operation. Despite the improvements made to the design, loose burner clamps remain possible. The locking pin only has attention value (TNO 2018), the chamfered cams are only available if the heat exchanger is of a more recent type.

According to an overview provided by Nefit to the NVWA, 83% of the boilers in the Netherlands had a corrective action on May 15, 2019, for 16,000 known appliances this still had to take place. The location of just over 6,000 boilers in The Netherlands was not (yet) known. Adequate modification of the boilers depends not only on the technical effectiveness of the modification but also on the expert implementation of the corrective action. This includes a proper assessment of the condition of the appliance and, where necessary, replacement of the heat exchanger and insulation.

Both TNO and the external expert point out the great importance of maintenance for the safe use of the boilers. Without regular maintenance, there are health risks for the end-user. TNO indicates that the need for regular maintenance applies to all types of boilers. The external expert asks the question whether because of this the boilers in question are in compliance with the regulations for gas appliances (product safety).

European rules for placing on the market of gas appliances stipulate¹ that a manufacturer may assume normal use. This includes the correct installation of an appliance and maintenance following the manufacturer's instructions. Also, it concerns use according to the purpose of the use or the reasonably foreseeable use. These principles do not necessarily lead to inherently safe products, because risks may also be controlled by instructions for use and maintenance. As a result, the responsibility in the use phase lies to a large extent with the consumer. The essential safety requirements for gas appliances were amended when the Gas Appliances Regulation came into force and take inherently safe design as a starting point (in the Dutch translation intrinsically safe).

On 28 May 2019, the Dutch House of Representatives voted in favour of an amendment to the Woningwet (Housing Act). Given the risks of carbon monoxide

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¹ The Gas Appliances Regulation (Regulation (EU) 2016/426) has been in force since 21 April 2018. It replaces the Gas Appliances Directive 2009/142/EC, which was preceded by Directive 90/396/EEC. The definition of normal use is similar in these texts.

(Dutch Safety Board, OVV, 2015), when the amendment comes into force it will be prohibited to carry out work on gas-fired appliances without a valid certificate. The requirements for the certification of companies and persons who are allowed to carry out work are being laid down in the Dutch Building Decree 2012. After the amendment to the Housing Act comes into force (at a time to be determined by royal decree, based on Minister Ollongren's letter of 27 May 2019 expected on 1 July 2020 with a transitional period of one year) owners of gas-fired appliances will have to take the initiative to call in a certified company for (yet to be specified) activities. This way the possibility remains that boilers are not maintained in such a way that the risks of fire and carbon monoxide poisoning are controlled, as is the case under the current system.

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In summary, the observations made during the drafting of this advice provide several facts that have no direct relationship with the TNO report, but are relevant in addition to the advice previously issued:

- The models in question where the burner set has not been replaced (up to 22,000 units in the Netherlands) and units, where the top profile has been buckled, are not safe.
- The legislation and regulations in the field of central heating boilers have been set up in such a way that (even after the amendment of the Housing Act to introduce a system of certification for installation companies and their personnel) owners themselves are responsible for the safety of the central heating boiler in the use phase.

Answer to the question

Is it possible to assess whether the risks of the models concerned are controlled after modification on the basis of the report by TNO commissioned by Nefit?

Based on the TNO report it can be stated that with a new burner set the models in question pose less risk. However, risks are not excluded. Concerning the content of the report, there are uncertainties about the representativeness and validity of the research. Also, it is clear that maintenance, as well as the knowledge and skills of the installer, are essential for the safe operation of the boiler. The TNO report, therefore, does not provide sufficient information to assess whether the models in question have been controlled after the modifications.

Advice NVWA-BuRO

To the Inspector General of the NVWA

- Ask Nefit to substantiate the following points in the TNO report:
 - o The representativity of the sample
 - o The validity of the temperature measurement and the CO measurement.
- Urge the manufacturer again to trace the not yet known owners, in the Netherlands and abroad, of an appliance with a V1 burner set. Special attention should be paid to owners without a maintenance contract.
- Urge the manufacturer to further ensure that the burner set is replaced and the appliance is regularly checked for proper operation.

To the Minister for Healthcare and Sports

- Strive for agreements at European level to ensure that new boilers are both designed and built inherently safe so that adequate measures are taken in the event of leaks or overheating. In doing so, use the possibilities offered by the essential requirements in the Gas Appliance Regulation and (harmonised) standards.
- Check which general requirements for carrying out maintenance on boilers have to be set in addition to the manufacturer's specific requirements in connection with the risk of fire and CO poisoning.
- Start a campaign to encourage boiler owners to have regular maintenance carried out under the manufacturer's instructions to prevent CO poisoning and fire.

Yours sincerely,

*Prof. Antoon Opperhuizen
Director Office for Risk Assessment & Research*

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Substantiation

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Background

Since the end of 2009 manufacturer Nefit has been replacing parts of certain TopLine HR boilers. In that year, the manufacturer ascertained that the burner cover above the burner was not always correctly closed after carrying out maintenance. According to Nefit's safety warning, the clamps of the burner cover may be loose, hot flue gases may enter the appliance and cause melting damage or fire. At a later stage, it was found that the top profile could deform, resulting in space between the heat exchanger and the burner allowing a gas/air mixture and flue gases to flow out, resulting in the risk of fire and carbon monoxide poisoning.

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Initially, the manufacturer assumed that only boilers with the bigger model of heat exchanger, the 3BL, were affected, in combination with the original burner set (V1). This led to a safety alert and notification in the RAPEX system (European rapid alert system for the exchange of information between the European Member States on dangerous non-food products). At a later stage, it turned out that flue gas leakage could also occur in heat exchangers of model 3BM, which could lead to a house fire. The measure chosen by the manufacturer was the installation of a new type of burner, which, among other things, allows for more overlap between the burner and the top profile of the heat exchanger and lessens the possibility of the escape of flue gas. However, this depends on the deformation of the top profile and fixing of the burner.

Originally, the measure was carried out gradually by service engineers during regular maintenance. In 2016, however, the NVWA found that the risk of fire was greater than initially estimated by the manufacturer. Various critical questions were then put to the producer, particularly about the B3M heat exchanger model. Substantiation has been requested for the statement that leakage with this model does not lead to an unsafe situation.

In February 2017 the manufacturer published a warning to the public and to the building services sector, and the NVWA issued a new RAPEX notification because of 'serious risk' in boilers with a 3BM heat exchanger. The NVWA also pressed for more urgency in repairing boilers already in operation.

Following a request within the scope of the Dutch act on public access to government information (Wet Openbaarheid Bestuur, WOB) of broadcaster RTL Nieuws, a report was drawn up by company C+B Advies en Expertise, commissioned by RTL. This report was published in January 2018 and made available to the NVWA. The C+B report states that the modified boilers would not be safe to use even after the corrective actions have been taken.

After the C+B report was published, the manufacturer decided to have research conducted by TNO.

In July 2018, after studying the C+B report, the Director of the Office for Risk Assessment & Research (BuRO) issued an advice to the Inspector General of the Dutch Food and Consumer Product Safety Authority (NVWA) on the risks of the Nefit brand boilers referred to above. In summary, the Inspector General was advised:

- Ask the manufacturer to provide all information necessary to assess whether the models in question still pose risks after the modifications.
- Continue to remind the producer of his legal responsibility to modify all defective boilers demonstrably effectively within a reasonable period.
- Actively contribute to informing consumers about the importance of periodic maintenance, advise consumers to install a reliable carbon

monoxide detector and advise consumers to cooperate with the producer's corrective actions.

- Together with the inspection and certification bodies, to examine whether the current requirements used by the inspection and certification bodies in the context of type-examination sufficiently cover the risks in question and to make agreements on identifying problems with appliances which prove to be unsafe in terms of construction after installation.

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In November 2018 TNO published a report on the effectiveness of modifications to Nefit Topline boilers (TNO, 2018).

Following the publication of the TNO report, BuRO has investigated whether the Inspector General can assume, based on the TNO report, that all information is available to assess whether the models in question still pose risks after the modifications.

Hazards associated with boilers

The hazards of boilers are described in the earlier BuRO advice (BuRO, 2018). Three different failure scenarios have been identified: the clamps used to attach the burner hood to the combustion chamber may be incorrectly positioned, the seal (gasket) between the burner hood and combustion chamber may be mounted twisted, and the top of the combustion chamber (the top profile) may deform.

All these construction and assembly problems lead to leakage from the combustion chamber. It may concern uncombusted gas/air mixture or hot combustion gases. Around the combustion chamber, there is the outer jacket of the boiler, which is connected to the outside air via the air inlet but is not completely gas-tight towards the rest of the house.

From the space inside the outer jacket, a fan normally draws in the outside air, which is mixed with natural gas and then goes to the burner. The ratio between air and gas determines the extent to which carbon monoxide (CO) is produced during combustion; for optimal combustion, some excess air is needed.

Uncombusted gas/air mixture creates a fire hazard; incidents have been reported in which fires started in the home. Hot combustion gases can cause damage to the outer jacket of the boiler. They are also sucked in by the fan; this causes recirculation of combustion gas. The boiler can handle some recirculation, but this results in a changed gas/air ratio: the gas valve does not react to the composition of the air sucked in, but only adjusts the amount of gas to the flow. Due to the changed ratio (less oxygen for the same amount of gas), the boiler can produce (much) more carbon monoxide, which can eventually be released from the non-gas-tight outer jacket. Whether this scenario occurs will strongly depend on the pressure difference with the rest of the house, which depends on wind direction and force, and the presence of mechanical ventilation.

In the previous opinion, it was not yet possible to make a statement about the degree of danger posed by the flue gases. Some experiments were carried out with loose burner clamps (TNO 2018, section 5.3.2). More than 500 ppm CO has been detected in the jacket and the upper detection limit of the measuring apparatus of 5000 ppm CO has been exceeded in the flue gases. Coupled with the fact that experts in the 2018 advisory report do not rule out the possibility that the pressure in the mantle may exceed that in the living space, this poses the risk of a flow of CO into the living space.

Interpretation of the TNO report by the external expert

The TNO report deals with two main questions asked by Nefit. The answers to these questions are supported by experimental research.

1. Is release of carbon monoxide (CO) from the appliance to the installation room possible and, if so, under what circumstances can CO leakage occur? *TNO considers the risk of spreading CO to the home with Topline appliances with a B3M heat exchanger and a replacement V3 burner to be very low.*
2. Does the possibility of fire exist with the construction models described and if so, under what circumstances can this possibility occur? *TNO and Efectis consider the risk of fire for Topline appliances with a B3M heat exchanger and a replacement V3 burner to be very small. This is valid under the condition that Nefit's instructions regarding periodic maintenance are observed. This includes checking that the burner clamps are securely fastened.*

To investigate whether BuRO can endorse the answer given by TNO, several elements from the investigation were further examined. The opinion of the external expert is taken into account. This is shown point by point below.

Original burner set (V1 burner)

The Enforcement Directorate of the NVWA has established that the original appliances did not meet the essential safety requirements of the Gas Appliances Directive in force at the time. On this basis, the RAPEX notification was issued in 2017, with the corrective measure of recalling the boilers (or modifying the burner set).

According to Nefit's notification to the NVWA on 15 May 2019, approximately 95% of the addresses where a boiler with originally a V1 burner was installed were known at that time. 83% of these had already been adjusted. In absolute numbers, it concerns a total of 128,090 delivered central heating boilers, of which the location is known for 122,079, and 106,079 were modified. For more than 6,000 boilers it is not known where they are and whether they are still in use. Also, 16,000 boilers still need to be modified.

The TNO report only deals with boilers with a new type of burner (V3). All previous types, characterized as V1, are not included in the study. The TNO report recommends actively tracing the remaining owners of a boiler with the original type of burner, even if these owners have not taken out a maintenance contract (TNO, 2018, page 86, the third point for attention). On this basis, the independent expert concludes that a V1, especially in combination with the B3M 2.5 heat exchanger, is still used (DNV-GL, 2019, page 3). This is also evident from the data provided by Nefit on the corrective action.

Selection of heat exchangers

The heat exchangers used for the experimental research come from a group of almost 1800 so-called field returns, used central heating boilers that returned to Nefit after an exchange operation. It is not clear to what extent the field returns are representative for the entire population. Based on what is stated in the TNO report, it is not excluded that boilers are in use with a new V3 burner, while there is more damage to the heat exchanger than in the field returns. According to the external expert consulted, the experiments on the 45 boilers selected for the

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study do not cover the risks in case boilers with more damage are in circulation. (DNV-GL, 2019, page 4).

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To simulate greater damage to the top profile of the heat exchanger, TNO has deliberately damaged one of the heat exchangers. The external expert questions to what extent this is representative of the actually occurring damage.

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The report does not discuss appliances where the top profile is buckled (in the report referred to as *buckling*), where flue gas leakage and leakage of gas/air mixture can occur, resulting in a fire risk. According to the data in the TNO report, buckling occurs in practice with B3M heat exchangers (TNO, 2018, figure 10, page 28). The TNO report makes no further statement on this matter.

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In all the experiments discussed in the TNO report, the question is to what extent the selection is representative for the entire population. It is therefore not clear to what extent the conclusions apply to the whole population.

In response to questions from the Enforcement Directorate of the NVWA, Nefit states the following concerning the representativeness of the selection:

- Concerning representativeness, reference is made to the TNO report. The (intentionally caused) serious damage is considered sufficient to take into account the possibility that there could be specimens in the field that are more severely damaged than the field returns.
- Concerning buckling, it is stated that the different departments of Nefit have used a different definition for buckling. Where one department used buckling for a local extreme deflection, the other department recorded field returns under buckling that should have been classified as heavy deflection.

According to BuRO, several questions concerning representativeness remain after this reaction, such as the relevance of the intentionally caused damage. In addition, a supplement to the report concerning the confusion and relevance of the concept of buckling is desirable.

Comments on the measurements

With regard to the measurement of carbon monoxide (CO) concentrations, the external expert notes that the TNO report does not pay attention to the calibration of the measuring equipment and the measurement uncertainty associated with this equipment. Measurements are conducted after stabilisation of operating conditions, without specifying what is meant by stabilisation. It is not recorded how it is determined that the CO (and CO₂) concentration is stable. (DNV GL, 2019, page 2)

With regard to temperature measurements with an infrared camera, the expert consulted poses the question what the effect on the measurement is of 'briefly removing the front panel'. This leaves the possibility that different temperatures are measured than with the panel closed. This could have been substantiated with several closed panel reference measurements. However, this was not included in the TNO report. (DNV GL, 2019, page 2-3)

BuRO believes that substantiation of the measurements is necessary to provide clarity about the reliability of these measurements.

In response to questions from the Enforcement Directorate of the NVWA, Nefit states the following about the measurements:

- When measuring values (CO and temperature) recording is delayed until the values were stable for some time, with the front panel mounted.
- The CO meter was calibrated by regular verification with a known concentration of CO
- Temperature is determined with both thermocouple and infrared image. Both methods have limitations, but in the end, gave similar results. On this basis, the influence of removing the panel is considered to be limited.

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According to BuRO, a supplement to the report with a more detailed description of stable operating condition and the calibration of CO meters is necessary (more extensive and more specific than in the response to the Enforcement Directorate of the NVWA) to substantiate the validity of the conclusions. The reflection on the validity of the temperature measurements in the reaction can be added so that the results can be properly interpreted.

Burner clamps

The TNO report qualitatively assesses the measures to prevent loosening or incorrect fastening of the burner clamps as sufficient. A comment made by TNO is that TNO "cannot quantify the probability of not or not properly securing the burner clamps in practice, because in addition to the technical execution of the burner clamp, behaviour, care and level of knowledge of the installer play a role". (TNO 2018, page 48)

As described in one of the failure scenarios in the previous BuRO advice, if the burner clamps are not closed properly, gas/air mixtures intended for the burner and flue gases can escape from the burner. This may lead to high concentrations of CO and a fire hazard (BuRO, 2018).

In new types of heat exchangers, the cam behind which the burner clamp must catch is chamfered. It is stated that by chamfering the cam it should be immediately visible that the burner clamp is correctly positioned, or that the clamp is hanging loose. The independent scientific expert reports that there is no instruction as to how this chamfering should be done in practice. It is not part of the burner assembly instruction set. BuRO concludes that it is not intended to do this in situ. The cams of the heat exchanger will only be chamfered when the heat exchanger is replaced.

The TNO report provides no insight into the behaviour of installers and the extent to which assessment of the condition of and work on boilers has been carried out correctly. A measure to prevent incorrect positioning of the burner, the locking pin, has merely attention value. The locking pin can also be locked if the clamp is not properly secured (TNO, 2018, page 47). The chamfering of the cams and an additional compression spring should improve the tightening of the clamp. TNO recommends Nefit 'to check in practice whether, when a V1 burner is replaced by a V3 burner, installers actually check for leakage of flue gases as stated in the Nefit maintenance instructions and whether not (properly) positioned burner clamps are found' (TNO, 2018, page 85).

TNO has carried out some tests with loose V3 burner clamps (TNO 2018, section 5.3.2, page 59). The result of this was that the temperature in the jacket did not

rise high enough to pose a fire risk, but that on the other hand the CO concentrations rose to undesirable values (above the upper detection limit of 5000 ppm in the flue gases). The TNO report describes that with loose burner clamps the test appliance did not function properly and switched off, but also started up again (TNO 2018, page 84). The external expert deems that these, together with the fact that original heat exchangers do not have chamfered cams, are gaps in the control of end-user risks (DNV-GL 2019, page 6).

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Ageing burner gasket

For statements about the ageing of the burner gasket, the TNO report describes an endurance test by Nefit in section 5.2. During four years a boiler with a flat top profile and equipped with a V3 burner set was tested. According to the external expert, the results of the test are only valid if there is a flat top profile when installing a V3 burner set (DNV-GL, 2019, page 10). The TNO report makes no statement about the safety of damage to the top profile. It is therefore not possible to indicate whether the results are representative for the entire population. Checking the top profile when replacing the burner set is not part of the instruction. This means that the conclusions on ageing are not valid for the whole population when the anomalies in the field have not been taken into account.

Distribution of CO

In the TNO report, calculations and in-situ measurements are presented regarding the distribution of CO from an appliance to the room. For this purpose, the boiler with V3 burner and limited damage was used. The calculations have not been further verified by the external expert and apart from previous observations regarding the measurements, there are no reasons to doubt the results presented. However, according to the external expert, the representativeness of the chosen boiler is questionable. If boilers are in circulation showing greater damage, the results are not representative of the entire population (DNV-GL, 2019, page 13). BuRO endorses this and notes that no situation with loose burner clamps has been simulated, a situation that involves greater risk.

Origin of melting damage field returns

The TNO report, Section 5.2.1, Table 5, discusses the melting damage observed in the field returns. Reported on page 61: *In several cases of (melting) damage, the unit was equipped with a (replacement) V3 burner at the time of exchange. This does not automatically mean that the damage was done with this burner. The damage may also have occurred with the previously mounted V1 burner. Possibly the melting damage when replacing the V1 burner was overlooked or replacement was considered unnecessary or 'too much hassle'.*

Apart from the risk, which, according to the experimental results, is considered low, one can only guess based on the location of the damage in the housing whether the damage occurred before a burner was changed. The TNO recommendations advise recording the date, number of burning hours and any melting damage to the insulation.

This can be extrapolated to all maintenance and replacement operations. To have insight in what has been done to a boiler and whether there are deviations from a previous inspection, it is necessary to record findings.

Regular maintenance

The TNO report mentions several times that when regular maintenance is not carried out or is not carried out correctly, the (fire) safety of the appliances is at stake (TNO 2018, page 46, 47, 48, 57, 65, 68 and in the conclusions and recommendations page 82-84). Maintenance is also essential for modified devices. This means that the knowledge, skills and actions of the person who maintains and assesses the appliance play a crucial role in the safety of the boilers.

The external expert asks the NVWA whether the possible decrease of the (fire) safety of an appliance in the absence of regular maintenance is a permitted situation in the context of product safety (DNV-GL, 2019, pages 13-14). After studying the regulations for the placing of gas appliances on the market, BuRO concludes that in the case of normal use, as expressed in Regulation (EU) 2016/426, Article 1(2), a manufacturer can cover risks utilizing a maintenance instruction. This will be discussed in more detail in the next section.

Risk: probability

The probability of fire or exposure to flue gases depends, as can be seen from the above descriptions, on several risk factors. According to the experimental results of TNO, the probability is low in regard to the tested, modified boilers. However, several factors are not sufficiently quantified or characterized in the available documentation:

- the extent to which the sample of boilers is representative of the whole population
- the extent to which the measurement results provide a reliable picture of temperature and CO concentration
- the correct installation of a new burner set and checking for deviations, such as damage to the insulation and deflection of the top profile of the heat exchanger.
- the expertise of the installer/maintenance technician carrying out the modification and maintenance
- the extent to which regular maintenance is carried out on the boilers

The manufacturer should quantify these factors properly; if this information is not yet available, further relevant research should be carried out.

At the population level, the risk of fire or CO poisoning depends on how many boilers are still defective. According to an overview delivered by Nefit to the NVWA on May 15, 2019, 83% of the boilers in the Netherlands had a corrective action applied, for 16000 known appliances this still had to take place. The location of just over 6000 boilers in the Netherlands was not (yet) known. An adequate modification of the boilers depends not only on the technical effectiveness of the modifications but also on the expert implementation of the corrective action.

BuRO has no knowledge to what extent this condition has been met.

A total of 182,470 units with a B3M heat exchanger have been installed in 7 different countries. According to figures supplied by the manufacturer, on 15 March 2019, there were still 29,210 addresses unknown, including the Dutch ones. Most of the boilers not tracked down have been sold in Germany (>20,000).

The following conclusions (in italics) from the advice previously issued by BuRO (BuRO, 2018) remain valid:

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A report by the Dutch Safety Board (OVV, 2015) shows that the installation and maintenance of boilers in general does not always go well and that this can lead to accidents with carbon monoxide, even if the resident engages a professional installer. The OVV has therefore advised to strengthen the system of legislation, regulations and surveillance to better protect residents against the dangers of gas-fired appliances. The advice of the OVV led to a commitment from the Minister for Housing and the Central Government Sector that regulations will be prepared. The Minister of the Interior and Kingdom Relations (BZK) recently described the progress of this process in a letter to the House of Representatives (BZK, 2017). It is intended that companies that carry out work on gas-fired appliances and the accompanying air supply and flue gas extraction must be certified. The application for a certificate shall be filed with a notified conformity assessment body (CBI) that is accredited and monitors the certified companies.

The development mentioned above clarifies that the responsibility for repairing the defective boilers currently lies mainly with the occupant/residential owner. In the current system, as well as in the proposed certification system, the NVWA has to deal with manufacturers of boilers and with the type examination body, and not with maintenance companies. Given the apparent structural defects in boilers which had a type examination, the question arises whether the risks are sufficiently controlled by the inspection requirements and the type examination and whether the type-examination body and the NVWA are informed in good time in such cases. This should be the reason for the NVWA to take a critical look at this and at least ask the examination body for a reaction.

The NVWA can also communicate about risks of boilers in general and of defective models in particular. This makes sense because the occupant/residential owner has various possibilities to reduce the risk of damage:

- installing a reliable CO detector;*
- verify whether the boiler is one of the defective models and*
- cooperate with the corrective action.*

European rules on the placing on the market of gas appliances stipulate² that a manufacturer may assume normal use. This includes the correct installation of an appliance and maintenance according to the manufacturer's instructions. Also, it concerns use in accordance with its intended purpose or in a way which can be reasonably foreseen. This is also the starting point for the underlying standards (NEN-EN-15502 series) and the risk analysis to be made by the manufacturer. In doing so, it is possible for the manufacturer to control risks not associated with normal use by means of instructions for use or maintenance, and to classify these risks lower. As a result, the responsibility in the use phase lies to a large extent with the consumer. At the time of the transition from the Gas Appliances Directive to the Gas Appliances Regulation (in force since 21 April 2018), a hierarchy of measures was included in the essential safety requirements, clause 1.3. According to this hierarchy, the first step should be to exclude or limit risks as much as possible (called intrinsically safe in the Dutch translation, inherently safe in English), followed by taking protective measures and finally informing users. The NEN-EN-15502-1 and -2(-2) standards used for the design of boilers do not enforce inherently safe design. Gas appliances produced before 21 April 2018 are not be subject to the above requirement.

² The Gas Appliances Regulation (Regulation (EU) 2016/426) has been in force since 21 April 2018. It replaces the Gas Appliances Directive 2009/142/EC, which was preceded by Directive 90/396/EEC. The definition for normal use is similar in these texts.

On 28 May 2019, the Dutch House of Representatives voted in favour of an amendment to the Woningwet (Housing Act). Given the risks of carbon monoxide (OVV, 2015), when the amendment comes into force it will be prohibited to carry out work on gas-fired appliances without a valid certificate. The requirements for the certification of companies and persons who are allowed to carry out work are being laid down in the Dutch Building Decree 2012. The amendment to the Housing Act comes into force at a time to be determined by royal decree. Based on Minister Ollongren's letter to the House of Representatives dated 27 May 2019, this is expected on 1 July 2020. There will be a transitional period of one year.

In the Netherlands, approximately 6.2 million boilers are in use in buildings. Around the year 2017, approximately 430,000 new domestic central heating boilers were installed annually (both new and as replacement in existing buildings). In the Netherlands, about 4 million boilers are serviced every two years. This means that approximately 2 million service operations are carried out every year. These numbers are expected to decline in the coming decades as more sustainable, gas-free (all-electric) homes are built in the future (House of Representatives, Tweede Kamer, 2018).

The certification scheme for work on gas-fired appliances will have to ensure the knowledge and skills of installers and maintenance engineers. It will still mainly be the owner who has to offer the gas-fired appliance to a certified company to carry out necessary work. If this does not happen, there is a risk of fire and carbon monoxide poisoning.

The exact number of accidents and incidents with gas-fired appliances cannot be determined. In the report Registration of accidents with gas appliances (Registratie van gasinstallatieongevallen achter de meter, jaaroverzicht 2017 (KIWA, 2018)), the research method is specified as obtaining the necessary information via media reports, by asking specific questions to parties involved, via existing contacts and via research assignments. There is no central registration of incidents. KIWA reports for the year 2017 56 gas installation accidents, 42 poisoning accidents, 7 fire accidents and 7 explosions, 6 of which were followed by fire. These accidents resulted in 2 fatalities and 170 casualties, 119 of which were seriously injured. The majority of the accidents here have to do with CO poisoning.

A short internet search with search terms fire, house fire and boiler, central heating, results in several dozens of incidents in which, according to media reports, fire brigade deployment is linked to a problem with a gas-fired appliance. The majority of these reports concern an (incipient) fire, often without resulting in injury. This result is only indicative, the sources have not been validated and no checks have been made as to whether the content of the reports was correct. The Dutch fire brigade does not structurally record the cause of fires.

Risk: impact

As determined in the section "hazards", CO or gas/air mixture may escape into the home if inadequate measures are not taken. This may result in a house fire.

A house fire can cause not only major material damage but also damage the health of one or more residents. In particular, the inhalation of toxic combustion gases is a potential source of damage to health.

A high concentration of CO in the living space can lead to serious health problems, possibly even to the death of one or more occupants. A concentration of 25 ppm is the limit value at which work may still be carried out; at concentrations above 150 ppm, there is an acute threat to health (OVV, 2015).

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Conclusions

1. The expert consulted by BuRO commented on the representativeness of the sample and the measurement method in the TNO report. These comments mean that the conclusions drawn by TNO in the report cannot be unreservedly endorsed.
2. The original burner set (V1) was not included in the investigation. It is assumed that this burner does not control the risks of a gas/air mixture and flue gases escaping.
3. For the 45 devices tested, the experimental results, after corrective action, indicate that risks would be controlled, taking into account conclusion 1. However, as soon as the measures have not been properly implemented (e.g. by not securing the burner clamp) and maintenance has not been carried out regularly and correctly, there is a risk, particularly concerning the outflow of flue gases.
4. The responsibility for the normal use of a gas-fired appliance lies with the user. The introduction of a certification system for carrying out work on these appliances does not ensure that owners actively offer the equipment to a certified company for installation and maintenance.

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