BG RCI
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Rohstoffe und chemische Industrie

T 021e

Gas Detection Equipment for Toxic Gases/Vapours and Oxygen

Use and Operation

Safe Engineering

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VISION ZERO.

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VISION ZERO is the vision of a world without occupational accidents and work-related illnesses. In this connection the avoidance of lethal and severe occupational accidents and illnesses is given highest priority. The goal of a comprehensive culture of risk prevention is VISION ZERO.

Further information concerning the VISION ZERO Prevention Strategy is available at: http://visionzero.global/

This Code of Practice particularly deals with the Golden Rule **"Identify Hazards – Control Risks"**

Table of Contents

Page

1 Area of Application

Gas detection equipment for toxic gases and vapours, whether fixed, transportable, or portable, is used when there is a potential risk to persons or the environment due to an accumulation of toxic gases. Such equipment can be an aid to risk reduction by detecting the presence of toxic gases and issuing appropriate audible and/or visual warnings. It can also be used to trigger specific safety measures (e.g. ventilation, plant shutdown, evacuation, or rescue measures).

This Code of Practice gives instructions for
> Design,
> Initial commissioning,
> Use,
> Maintenance,
> Controls,
> Repair
of electrically operated devices for the detection and measurement of
toxic gases and vapours or oxygen in air at workplaces.

This document is a compilation of practical experience intended to support the user. Further information can be found in the standard EN 62990-2[1].
It deals with gas detection systems, which may consist of
> Gas transport to the sensor (diffusion or sampling),
> Gas detector (with external or internal sensor),
> Power supply,
> Activation of connected safety equipment.

This Code of Practice applies to gas detection equipment, which forms a part of an operational safety concept and has the main task to indicate the presence of a toxic gas or vapour in the air and to output an indication and/or trigger a warning in the presence of a toxic gas or vapour.

For determination and assessment of exposure by inhalation in accordance with § 6 of the Gefahrstoffverordnung – GefStoffV (Ordinance on Hazardous Substances)[2] the provisions of TRGS 402[3] shall be considered first and foremost beyond this Code of Practice.

Gas detection equipment provided to warn of an oxygen deficiency or excess oxygen also fall under the scope of this Code of Practice. An oxygen measurement can be useful to detect a decrease of the oxygen concentration below the limit impairing human health or when high concentrations may cause a risk to health.

In the case of gas detection equipment for toxic gases or oxygen which does not fall under this scope, application of the measures described here is also strongly recommended.

In the case of gas detection equipment, which is also used for flammable gases, the regulations of Code of Practice T 023[4] shall also be applied.

Laws, legal ordinances and design requirements for gas detection equipment are listed in Annex 1.

1 See Annex 1 No. 12
2 See Annex 1 No. 6
3 See Annex 1 No. 7
4 See Annex 1 No. 10

2 Terms

The following terms apply in this Code of Practice:

2.1 Gas Detection Equipment

Equipment for detecting of hazardous gas concentrations. In addition to the actual gas detection device, it also includes the associated power supply, possibly a sampling system, sample gas conveyance and switching contacts or signals.

2.1.1 Fixed Gas Detection Equipment

Equipment for which all parts are intended for fixed installation.

2.1.2 Transportable Gas Detection Equipment

Equipment that is not intended to be carried but can easily be moved from place to place.

2.1.3 Portable Gas Detection Equipment

Equipment that can be easily carried from place to place and used while being carried due to its design.

2.1.4 Personal Gas Detection Equipment

Portable equipment attached to a person that monitors the atmosphere in the breathing zone so that an exposure to toxic gases or vapours can be determined. In this Code of Practice, it is treated like a portable gas detection equipment.

2.2 Toxic Gas

General term for a gaseous or vaporous hazardous substance that meets the criteria for health hazards set out in Part 3 of Annex I to Regulation (EC) No 1272/2008[5].
In particular, these are the following hazards: acute toxicity[6], skin corrosivity/irritation, serious eye damage/eye irritation, respiratory or skin sensitization, germ cell mutagenicity, carcinogenicity, reproductive toxicity, specific target organ toxicity (single exposure), specific target organ toxicity (repeated exposure), aspiration hazard.

2.3 Zero Gas

Test gas that contains neither the target gas nor interfering impurities.

5 See Annex 1 No. 5
6 Carbon dioxide is used in this document because of its acute toxic effects, which are considered by the occupational exposure limit values applicable to the substance, even if it is not so classified in the said regulation.

2.4 Test Gas

Gas mixture of known composition used to calibrate and adjust gas detection equipment.

2.5 Surrogate Test Gas

Gas/air mixture used instead of a test gas that is difficult to handle.

2.6 Calibration

Comparison of the reading of a gas detector with a known test gas concentration, without adjustment.

2.7 Adjustment

Settings that are made to set zero and sensitivity of a gas detection device using a known zero gas or test gas.

2.8 Measuring Gas

Mixture reaching the sensor in real application. In general, it consists of air, target gas and other components.

2.9 Target Gas

Gaseous substance to be detected in the measuring gas and of which is to be warned.

2.10 Measuring Point

Location where the gas inlet of the gas detection equipment is located.

2.11 Parameter Settings

Settings of gas detection equipment necessary for its operation. These include e.g. the target gas, alarm set points and alarm configuration.

2.12 Alarm Set Point

A setting of the equipment at which the measured concentration will cause the equipment to initiate an indication, alarm or another output function.

2.13 Latching Alarm

The alarm indication remains even if the gas concentration falls below the alarm set point again. Manual acknowledgement is required to reset the alarm.

2.14 Non-latching Alarm

The alarm indication is automatically reset when the gas concentration falls below the alarm set point again.

2.15 Time of Response t_x

Time interval, between the time when an instantaneous change between clean air and test gas, or vice versa, is produced at the equipment inlet, and the time when the reading reaches a stated percentage x of the stabilized signal on the test gas.

2.16 Reaction Time

Time until a defined reaction of the gas detection equipment can be observed. This can be a particular reading or a triggered alarm. The reaction time can depend on various factors, e.g. response time of the gas detector and the properties of gas sampling.

2.17 Leak Monitoring

Monitoring of a possible gas release point by a measuring point in the immediate vicinity.

2.18 Alarm Value (in-house specification)

Preset concentration value which, based on the in-house risk analysis and risk assessment or official requirements, should not be exceeded, e.g. during object and leak monitoring.

2.19 Occupational Exposure Limit (OEL of TRGS 900)

The occupational exposure limit is the limit value of the time-weighted average concentration of a substance in the air at the workplace in relation to a specified reference period. It indicates the concentration of a substance up to which acute or chronic harmful effects on health are generally not to be expected[7].

Actual limit values are published in TRGS 900[8] or announced by the German Federal Ministry of Labour and Social Affairs in accordance with § 7 Sect. 11 GefStoffV[9].

2.20 Safety Function

The function triggered by a gas detection equipment in the event of an alarm to establish a safe state, for example visual/acoustic alarm signal (alarm), ventilation of the endangered area, opening/closing of valves/gates (automatic switching functions) or shutdown of endangered systems or system parts (automatic triggering of emergency functions).

7 § 2 sect. 7 of the GefStoffV, see Annex 1 No. 6
8 See Annex 1 No. 8
9 See Annex 1 No. 6

3 Selection Criteria

A gas detection equipment may only be used for such gases and vapours and in such ambient conditions (pressure, temperature, humidity) for which the gas detection equipment is suitable according to the manufacturer‘s specifications. The Instructions in the manufacturer’s operating manual shall be observed.

The suitability of a gas detection equipment, including the selection and positioning of the measuring points, the measuring ranges, the alarm setpoint and the reaction time, shall be assessed with respect to the specific application in the risk assessment. If the necessary expertise is not available, the support of specialists, testing institutions or the manufacturer shall be obtained.

Note: Requirements for a specialist are described in section 11.4. A list of (German) specialists can be found on the website www.exinfo.de under page ID: #WARM (see “4. Spezialisten”).

There are many application criteria which shall be taken into consideration, but which are not all covered by this Code of Practice. The standard EN 62990-2[10] provides a comprehensive overview.

Particular attention shall be paid to:
> Intended application (e.g., plant monitoring, clearance measurement)
> Gases or vapours to be detected
> Measuring ranges and measurement uncertainties
> Environmental conditions
> Cross sensitivities
> Interfering gases and vapours
> Possible damage to the sensor (e.g., due to sensor poisons or gas concentrations above the measuring range)
> Reaction time
> Potentially explosive atmospheres

The two main areas of application of gas detection devices for toxic gases are:
> Monitoring the concentration for compliance with the exposure limits at workplaces.
> Alarming, where the focus is on the time until the alarm is triggered, for example in the case of leakage monitoring.

In principle, devices whose operating behaviour has been assessed in accordance with EN IEC 62990-1 type HM[11] (exposure measurement) or type SM (general applications) or for oxygen in accordance with EN 50104[12] shall always be used.

Conformity with the standards can be confirmed by a manufacturer-independent testing institution or by the manufacturer. The results of this assessment, including possible application limitations, shall be evaluated by the employer with respect to his specific application. For some applications the equipment requires a performance certificate from an independent testing institution.

With gases that are very difficult to handle, e.g. arsine, phosgene, hydrogen chloride, the application of the test methods described in the standards can only be possible with limitations or not at all. In these cases, the manufacturer, the expert employer, or an independent testing institution shall validate the suitability for the specific application by other suitable methods.

If a gas detector meets the requirements of the standards mentioned, the user can assume that the detector can be used for most applications and the performance will not deteriorate significantly by normal changes of the ambient conditions. When measuring under non-atmospheric conditions, e.g. process gases, the manufacturer shall be consulted.

10 See Annex 1 No. 12
11 See Annex 1 No. 11
12 See Annex 1 No. 13

If technically possible at reasonable effort, gas detection equipment for monitoring toxic gases and vapours near limit values shall ensure a lower limit of the measuring range (determined in accordance with EN IEC 62990-1) of max. 30 % of the limit value.

For monitoring of limit values this means, e.g.:

Target Gas	Occupational Exposure Limit of TRGS 900[13]	Exceedance Factor[14]	Lower Limit of the Measuring Range, max.
H_2S	5 ppm	2 (I)	1.5 ppm
CO	30 ppm	2 (II)	9 ppm
CO_2	5000 ppm	2 (II)	1500 ppm

Gas detection devices for use in potentially explosive atmospheres shall meet the safety requirements for electrical equipment laid down in European Directive 2014/34/EU[15] and shall be marked correspondingly.

13 The applicable values of TRGS 900 (see Annex 1 No. 8) shall be used.
14 For further information see section 2.3 of TRGS 900
15 See Annex 1 No. 1

4 Specification of the Target Gas

The toxic gas to be detected on site is to be identified as target gas. The concentration is generally indicated in the unit “ppm”[16]. Substance properties are described e.g. in the freely accessible database GESTIS[17].

Different gases or gas mixtures may occur frequently in the monitored area. The sensors of common gas detector types are sensitive to other gases. On the one hand, this characteristic can be helpful if the gas is also to be monitored at the same time. On the other hand, this is a cross interference that may lead to false alarms. In this case
> the relative sensitivities, and
> the respective alarm thresholds
for the gases shall be considered when choosing the target gas.

If the expertise necessary for the appropriate selection of the target gas is not available, the support of experts[18], testing institutions[19] or the manufacturer shall be obtained.

16 Abbreviation for “parts per million”. This unit can be easily converted into the unit ml/m³ which is also frequently found in the literature for the indication of limit values. Corresponding conversion factors are given in a large number of publications, e.g. in the GESTIS database (see Annex 2 No. 17).
17 See Annex 1 No. 14
18 See www.exinfo.de, page ID #WARM (under “4. Spezialisten”)
19 See www.exinfo.de, page ID #WARM (under “4. Spezialisten”)

5 Alarm Set Points

The alarms and the measures to be taken when the alarm is triggered shall be defined specifically for each application by the employer as part of their risk assessment. For many substances, the conditions for triggering an alarm (threshold value, averaging) are defined by regulations for the respective application.

Gas detection equipment generally has a pre-alarm and a main alarm. A pre-alarm allows to take early measures before the main alarm is triggered. One example is the activation of a ventilation system that limits the increase in concentration by diluting it with air. The main alarm is only triggered if these measures are not effective. The main alarm is generally latching and the pre-alarm is typically non-latching. For latching alarms, it shall be checked in situ whether the hazardous state was eliminated before the alarm will be quitted and operation will start again.

Personal gas detection equipment usually has an additional alarm function, which is preceded by an averaging function to weight the measured values over time.

On the one hand, the alarm set points of the gas detection equipment shall be set low enough for the specific application so that the associated protective measures can take effect in good time if they are exceeded. On the other hand, they shall be set high enough to avoid false alarms as much as possible. Experience has shown that frequent false alarms lead to a habituation effect and subsequently to non-compliance.

When setting the alarm set points, delays, for example due to gas transport, the setting time of the gas detection equipment and the protective measure taking effect, shall be considered. Lowering the alarm set points leads to an earlier alarm.

6 Monitoring Oxygen Deficiency and Excess Oxygen

The measurement of oxygen may be necessary to warn of
> oxygen deficiency (e.g. concentration falling below the health-endangering limit for humans), or
> excess oxygen (e.g. increased risk of fire).

Alarm set points for oxygen deficiency are selected at 19 % v/v (pre-alarm) and 17 % v/v (main alarm) generally if atmospheric conditions are present.

The alarm set points for applications in monitoring areas with an oxygen-reduced or oxygen-enriched atmosphere during the intended operation shall be specified individually for the application. General recommendations cannot be given; if necessary, the support of experts, testing institutions or the manufacturer shall be obtained.

Note: For simultaneous monitoring for oxygen deficiency and excess oxygen, the alarm set points < 19 % v/v and > 23 % v/v are generally chosen. The concrete application or other regulations may necessitate different alarm set points.

Monitoring of the oxygen concentration in chemical processes is not within the scope of this Code of Practice.

Gas detection equipment for oxygen monitoring within the scope of explosion protection is in the scope of Code of Practice T 023[20].

20 See Annex 1 No. 10

7 Fixed Gas Detection Equipment

7.1 Design of Fixed Gas Detection Equipment

Gas detection equipment shall be planned by specialists as defined in section 11.4. The recommendations in EN 62990-2[21] and the specifications in the manufacturer's instructions shall be observed.

Gas detection equipment shall be installed and operated in such a way that unauthorized persons cannot make changes to the setting elements. Software-based devices are generally equipped with corresponding access barriers by the manufacturer. The employer shall ensure that only authorized persons have access to the corresponding codes or auxiliaries.

All components of the gas detection equipment shall be installed in such a way that they are accessible for maintenance work with reasonable effort.

7.1.1 Increased Availability

The power supply shall be dimensioned such that the unrestricted operation of the gas detection equipment and the alarm equipment is ensured.

The failure of the regular power supply shall release a status indication as defined in section 7.2.3.

To increase the availability of gas warning equipment, an uninterruptible power supply can be used to ensure the function of the gas warning equipment if the regular power supply fails. The backup power supply should maintain its function until the normal supply status is restored or the monitored area is brought to a safe state.

If parts of the alarm equipment are not covered by the backup power supply, this shall be considered when designing the safety concept.

To further increase availability, a redundant design of the gas warning equipment can be helpful.

7.1.2 Gas Sampling

Aspirated gas detection equipment shall be equipped with a flow monitor providing an indication in case of flow failure.

For discontinuous measurement, e.g. use of automatic measuring point selector switches or intermittent measuring mode, the time taken for the alarm to be triggered is prolonged by the maximum occurring cycle time.

Depending on their length, sampling lines delay the alarm activation. Therefore, they shall be kept as short as possible. The estimated time delay shall be considered in the risk assessment.

Parts of the sampling system which are in contact with the measuring gas shall be suitable for the operation conditions. Some gases tend to adhere (to adsorb) to surfaces, resulting in a decrease of the concentration in the measuring gas. This effect can be significant, particularly with low gas concentrations and reactive gases. Adsorbed gases or vapours can desorb later and cause a signal even though there are no active gas leaks or other obvious sources of gas in the monitored atmosphere at that time (memory effect). The adsorption/desorption characteristics of each gas or vapour and of the sampling line shall be taken into consideration during planning and installation of the system. The material of the sampling line shall be selected in a manner that such effects are avoided.

21 See Annex 1 No. 1

Condensation can occur in the sampling system if the measuring gas cools down or is compressed during transport. Not only water vapour but also other components contained in the gas, including the target gas itself, can condense.

Condensate can impair the sample gas transport and hence the gas supply to the sensor if the sampling line becomes clogged. On the other hand, the measured value decreases if the component to be measured is absorbed in the condensate or condenses out itself. Furthermore, subsequent samples can be contaminated if the condensate out evaporates again later. It may be necessary to heat the sampling line to avoid condensation. In potentially explosive atmospheres, lines and heating facilities shall comply with the applicable regulations.

A safe drainage of the sampled gas and condensate shall be ensured.

When sampling the measuring gas from a potentially explosive atmosphere, measures are necessary to prevent zone entrainment. Parts of the sampling system which are in contact with the measuring gas shall be suitable for at least the same zone from which the sample gas is drawn in. A safe drainage of the sampled gas shall be ensured. For zone separation suitable flame arresters (fittings) can be installed on the inlet side and, if necessary, also on the outlet side of the gas detection equipment (explosive decoupling). The suitability of the flame arrester as a component according to the European Directive 2014/34/EU[22] shall be approved for the respective application.

7.1.3 Installation and Design Documents

The employer shall store the following documents appropriately:
> Manufacturer’s instructions and maintenance instructions for the gas detection equipment
> EU declaration of conformity
> Proof of measurement and functional design to fulfill the protection objective
> Commissioning protocol
> Installation plans and circuit diagrams
> Planning documents
> Type and concentration of the test gases to be used
> Parameter settings of the gas detection equipment
> Modifications and extensions of the gas detection equipment

7.2 Operation of Fixed Gas Detection Equipment

The instructions and recommendations in the manufacturer’s instructions shall be followed.

7.2.1 Initial Commissioning of the Fixed Gas Detection Equipment

Gas detection equipment shall be tested for proper function after installation by a competent person (gas detection equipment)[23]. The extent of the test should – as far as possible at this moment – correspond to that of a system check as described in section 7.3.1.3. However, at least the tests described for the functional check in section 7.3.1.2 shall be performed in conjunction with the testing of the switching functions of the gas detection equipment. The results shall be recorded. The record can be used as part of a higher-level test before commissioning of the overall system by a competent person as defined in TRBS 1201 Part 1[24].

22 See Annex 1 No. 1
23 For the term “Competent Person (gas detection equipment)”, see section 11.3.
24 See Annex 1 No. 3

7.2.2 Operating Instructions

The employer shall draw up operating instructions if gas detection equipment is used. It should contain at least:
> The measures to be initiated in the event of an alarm
> The measures to be initiated in the event of status indications
> The measures to be initiated in the event of non-availability
> The person(s) to be informed in the event of an alarm, a status indication or a failure of the gas detection equipment
> The persons responsible for checks and maintenance

If emergency plans or alarm plans for the plant to be monitored do exist, the contents of the operating instructions may be integrated there.

7.2.3 Alarms and Status Indications

Alarms (pre-alarm and main alarm) and status indications (fault and maintenance) shall be transmitted to a reporting office, e.g. to a control room or any permanently manned location, where type and origin of alarms and indications shall be distinguishable. From there, appropriate measures are initiated in accordance with the operating instructions.

If an audible and a visual alarm are given at the same time, the audible alarm may be silenced while the alarm is still active.

If safety outputs (e.g. alarm activation, switching functions) of gas detection equipment are deactivated for maintenance purposes, this state shall be clearly signaled to the reporting office, to avoid the gas detection equipment remaining in this state by mistake.

7.2.4 Measures in the Event of Non-Availability

If the whole gas detection equipment or such a number of measuring points are not available (e.g. in the event of a fault, failure, or maintenance work) that plant sections cannot be monitored adequately, appropriate measures shall be taken to ensure that safety is maintained even during the down time of the gas detection equipment. The necessary replacement measures shall be laid down in the operating instructions, depending on the operational conditions of the plant under consideration of the personnel and temporal intervention options. These include, e.g., individually or in combination:
> Use of non-fixed gas detection equipment
> Additional ventilation measures
> Interruption of the supply of toxic gases, vapours, or liquids
> Purging or emptying of plant sections
> Switching off plants or plant sections

Regardless of the alternative measures taken, the availability of the gas detection equipment shall be restored immediately.

7.3 Maintenance of Fixed Gas Detection Equipment

The gas detection equipment shall be maintained at regular intervals to ensure the proper performance, which requires appropriate knowledge. If the employer does not have this knowledge, he shall contact the manufacturer, specialists or testing institutions that have the appropriate knowledge of the gas detection equipment installed. The specifications and recommendations in the instructions shall be observed.

The maintenance measures are divided into visual checks, functional checks and system checks which shall be carried out at regular intervals. Any faults discovered shall be remedied immediately.

The maintenance measures, the results and assessment as well as any adjustment and repair work carried out shall be documented and the records shall be stored. The records shall also be checked regularly.[25]

Electronic documentation of the records of inspections and repairs is permitted.

7.3.1 Checks of Fixed Gas Detection Equipment

7.3.1.1 Visual Check

The visual check includes at least the following actions:
> Check of gas detection equipment for mechanical damage visible from the outside
> Check of the gas inlets (e.g. for clogging due to dust or dirt)
> Check of the sampling system (e.g. for mechanical damage, condensation of water or solvents)
> Check of the readiness of operation, no alarm or special states activated

The check shall be carried out by a Trained Person[26].

The corresponding documentation shall contain:
> Identification of the gas detection equipment (e.g. plant section, measuring point)
> Confirmation that the check has been carried out
> Faults discovered
> Date and clear identification of the person carrying out the check

7.3.1.2 Functional Check

The functional check includes at least the following actions:
> Visual check as described in section 7.3.1.1
> Application of zero gas and test gas for
  • Checking and assessing the measured value (calibration)
  • and correction of the indication (adjustment), if necessary
  • Checking and assessing the reaction time according to the specification in the manufacturer’s instructions
> For sampling systems, if installed:
  • Checking the equipment of sample gas transport, sample gas conditioning and associated monitoring devices
  • Checking flow rate
  • Checking tightness of the entire sampling system

Triggering of switching functions is not necessary at functional checks.

The check shall be carried out by Qualified Personnel[27].

The corresponding records shall contain:
> Identification of the gas detection equipment (e.g. plant section, measuring point)
> Composition of the test gases used
> Measured values at zero gas and test gas before and after calibration/adjustment

25 For an example of recordings for a stationary gas warning device and recording control of stationary gas warning devices, see www.exinfo.de, page ID #9UUN.
26 For the term “Trained Person”, see section 11.1.
27 For the term “Qualified Personnel”, see section 11.2.

> Assessment of reaction times
> Faults discovered
> Work carried out
> Date and clear identification of the person carrying out the work

The functional check replaces a visual check due at the same time.

7.3.1.3 System Check

The system check includes at least the following actions:
> Functional check as described in section 7.3.1.2
> Checking all safety functions including the triggering of switching functions (e.g., starting technical ventilation or other measures listed in the explosion protection document)
> Checking the safety-relevant parameter settings by comparing target/actual values, including at least the measuring range, target gas, alarm set points and settings of the switching outputs
> Checking the reporting and recording devices
> For sampling systems, if available: additional application of test gas at the measuring point to check and evaluate the measured value display and response time

The check shall be carried out by a Competent Person (Gas Detection Equipment)[28].

The corresponding records shall contain:
> Identification of the components of the gas detection equipment (e.g. plant section, measuring point) and the associated safety devices
> Composition of the test gases used
> Deviations of the parameter settings from target values
> Measured values at zero gas and test gas before and after calibration/adjustment
> Assessment of reaction times
> Faults discovered
> Work carried out
> Date and clear identification of the person carrying out the work

The system check replaces a functional check (and visual check) due at the same time.

Note: A Competent Person shall carry out the system check in close cooperation with the employer, in particular when checking the safety functions. If this is not possible due to operational reasons, interfaces shall be specified and documented where the system check ends. The system check can also be performed part by part. The employer is responsible for ensuring that the system check is performed completely within the intervals specified.

7.3.1.4 Inspection of the Records

The inspection includes at least the following actions:
> Checking the completeness of the maintenance records of the checks described in sections 7.3.1.1 to 7.3.1.3
> Checking whether necessary measures identified during maintenance were carried out in due time
> Checking if installation documents and operating instructions as described in sections 7.1.3 and 7.2.2 are complete and up-to-date

The inspection of records shall be carried out by a Competent Person (Gas Detection Equipment)[29].

28 For the term “Competent Person (gas detection equipment)”, see section 11.3.
29 For the term “Competent Person”, see section 11.3.

The corresponding records shall contain:
> Identification of the gas detection equipment (e.g. plant area, measuring point)
> Confirmation that the inspection has been carried out
> Inadequate records discovered
> Date and clear identification of the person carrying out the work

Unless longer intervals are demanded by other regulations, the following applies: The records on visual checks and functional checks shall be kept until the records have been inspected. The records on the inspections of the records and system checks shall be kept for 10 years.

7.3.2 Calibration and Adjustment

The calibration with test gases is performed to check the measured value displayed. The procedure is part of the functional check and the system check.

For diffusion sensors, the gas shall be applied via suitable accessories (e.g. test gas adapters) with the flow rate specified by the manufacturer.

Always adjust zero first, then the sensitivity. Finally, it is recommended to check zero again.

The test gas used for calibration shall in general be equivalent to the target gas. As far as technically possible, the test gas concentration should be known with a maximum uncertainty[30] of ± 10 % (relative).[31]

If the target gas is difficult to handle as test gas, a surrogate test gas may be used. The surrogate test gas and the associated sensitivity setting value shall be specified and documented in consultation with the manufacturer of the gas detection equipment. Therefore, the sensitivity of the device for the target gas and the surrogate test gas shall be known. If only a surrogate test gas is used, it will not be possible to ensure that the sensitivity for the target gas is present permanently. During the system check, additional measures shall be taken to reveal poisoning, ageing and impairment of the gas inlet. The procedure should be agreed upon with specialists, testing institutions or the manufacturer.

With gases particularly dangerous or difficult to handle, calibration and adjustment may be carried out at a location different from the point of operation. After installation of the sensor at the point of operation, the reaction shall be tested by applying gas.

The selection of suitable gases for checking zero can be restricted by the measuring principle. The selection should be made in accordance with the manufacturer's recommendations. The use of ambient air is only possible if it is ensured that the air is free of target gas and gas for which the gas detector has a cross-sensitivity at the time of calibration.

The two main areas of application of gas warning devices for toxic gases are:
> Monitoring the concentration for compliance with the exposure limit values at workplaces.
> Alarming, where the focus is on the time until the alarm is triggered, for example in the case of leakage monitoring.

Calibration is performed with a test gas concentration which causes a reading corresponding to the limit value respectively the main alarm. Assistance can be provided by specialists, testing institutions or the manufacturer. Adjustment of the display is generally only necessary if the deviation determined during calibration for the zero point is more than ± 10 % of the (main) alarm value or for the sensitivity more than ± 20 % of the target value.

In the case of other measuring ranges or oxygen measurement, the test gas concentrations, calibration procedures and tolerable deviations shall be defined on a case-by-case basis. Assistance can be provided by specialists, testing institutions or the manufacturer.

30 According to EN ISO 6142
31 Particularly at low concentrations of toxic gases higher deviations are also tolerable at the actual state of the art

7.3.3 Specification of Check Intervals

The intervals to be observed are determined as follows:

1. If sufficient experience is available for the reliability and accuracy of the measuring principle and the gas detection equipment used, the check intervals for an application under the same operating and ambient conditions can be fixed based on this experience.

2. If sufficient experience is not available for the reliability and accuracy of the measuring principle and the gas detection equipment used for the intended application, two functional checks shall be carried out at four-week intervals after commissioning. If no readjustment is required in accordance with section 7.3.2, further functional checks shall be carried out every two months. If no readjustment is required during these function checks, the maximum interval from the following table can be used.

3. If adjustment is already necessary in the first eight weeks, the function check shall be carried out at shorter intervals. Based on the experience gained, the intervals shall then be set in such a way that, generally, no unacceptable deterioration is to be expected between the functional checks. If the intervals become unacceptably short, it should be considered whether a more suitable measurement method can be selected.

7.3.3.1 Recommendation for the Maximum Intervals between Individual Checks

Type of Check	Intervals
Visual Check	1 month
Functional Check	4 months (when using self-test routines as described in section 7.3.5: 1 year in maximum)
System Check	1 year
Inspection of Records	3 years

7.3.3.2 Fundamentals

The intervals between checks specified here apply to a wide range of common applications. If sHORTƟR or longer intervals for the checks result from the risk assessment in accordance with § 3 section 6 of the Betriebssicherheitsverordnung (BetrSichV – Ordinance on Industrial Safety and Health), these shall be used as the basis for checking the gas warning equipment.

7.3.3.3 Additional Checks

If the operating or environmental conditions change, the procedure according to number 2 of section 7.3.3 shall be applied again.

If the measuring range is exceeded during operation, the zero point and sensitivity may have changed permanently. In this case, the gas detection equipment shall be subjected to a function check soon afterwards, regardless of the regular interval. The function check shall then be repeated after approximately one week.

7.3.4 Repair

If a functional check proves that the sensitivity of a sensor has become so low that the required value can no longer be set or variations of climatic or operational conditions cause false alarms frequently, the sensor (or the sensing element) shall be replaced.

Note: As a rule, replacement is recommended if the residual sensitivity falls below 50 % of the initial sensitivity. When using electrochemical sensors, it shall also be considered that the lifetime is limited due to the operating principle even under optimum operating conditions. At the end of the lifetime, the loss of sensitivity generally occurs in a short-term period. If there are long intervals between the functional checks, provident replacement of the sensors at the end of the probable lifetime is recommended.

The operating and maintenance instructions apply to repairs and the replacement of parts of the gas detection equipment. For safety reasons, only original spare parts from the manufacturer of the gas detection equipment or parts specified in the instructions may be used.

Note: For work that may affect the ignition protection of the electrical equipment, further requirements may need to be observed.

To carry out further repair work, an appropriate qualification is required, which can be acquired, for example, through training provided by the manufacturer of the gas detection equipment. The person carrying out this work or the employer is responsible for the proper function and condition of the gas warning equipment after repair.

After a repair, a function check or system check must be carried out prior to recommissioning, depending on the type of repair.

7.3.5 Gas Detection Equipment with Automatic Self-Test Routines

For gas detection equipment with automatic self-test routines, the interval for functional checks may be extended to 1 year in maximum. The following methods are currently available:

> Automatic calibration: At defined intervals (e.g. daily, but at least weekly), zero gas and test gas is automatically supplied to the gas detection equipment. Deviations from the required values shall be determined and assessed. It shall be ensured that an adjustment is initiated immediately when the tolerable deviations are exceeded.

> Self-diagnosis: The method shall have been evaluated by a notified test house. The following procedures are currently known:

- Gas detection equipment with the measuring principle infrared absorption which monitors the failure of the light source and an excessive deterioration of the detector signal due to contamination, or
- Gas detection equipment with the measuring principles flame ionization or flame temperature which monitor the flame and the flow rate of the gas sample.

8 Portable Gas Detection Equipment

Portable equipment is characterized by the fact that it is carried by persons and is therefore exposed to different stresses than fixed gas detection equipment. This chapter describes the resulting requirements.

Due to the frequently varying operating locations and conditions, the probability of sudden damage to portable gas detection equipment is higher. Irrespective of the long-term stability of the equipment, this can result in an immediate impairment of the measuring performance. That is the reason why the extent and frequency of the checks differ from those for fixed gas detection equipment.

The use of suitable automated check and adjustment facilities is permitted.[32]

8.1 Selection of Portable Gas Detection Equipment

The requirement to use a portable gas detection equipment is derived, for example, from a risk assessment or the application of technical regulations. The necessary selection is made before procurement and before use.

Portable gas detection equipment may only be procured after the suitability of the equipment in question for the intended protective function has been assessed by a specialist in accordance with section 11.4. Specific operating conditions and limits for the intended application shall be defined and documented so that they are available for the instruction of users.

The recommendations in EN IEC 62990-2[33] and the information in the manufacturer's instructions shall be observed.

8.1.1 Power Supply

The power supply, usually in the form of batteries, shall be sufficient to ensure operation for the intended period of use.

When using additional batteries to extend the operating time, it is important to note the conditions under which the batteries may be changed.

8.1.2 Gas Sampling

Portable gas detection equipment can be equipped with a pump to suck in the sample gas. If a sampling equipment (e.g., hose with probe) is used for suction, it shall be checked for leaks.

The use of a sampling device leads to a delay in the measured value display depending on its volume. The volume should therefore be as low as possible. The expected delay shall be considered in the risk assessment.

All parts of the sampling system that carry sample gas shall be suitable for the operating conditions.

Some gases tend to adhere (adsorb) to surfaces, which leads to a decrease in concentration in the sample. This behavior can be particularly significant at low gas concentrations and with reactive gases. It can also happen that adsorbed gases or vapours later desorb and cause a signal even though there are no longer any active gas leaks or other obvious sources of gas in the monitored atmosphere at that time (memory effect). The adsorption/desorption properties of each gas or vapour and the line shall be considered during use. The material of the extraction device shall be selected in such a way that such effects are avoided. In addition, it is recommended that the response time is checked regularly by feeding test gas to the gas inlet of the sampling system.

32 See www.exinfo.de, page ID #9UUN
33 See Annex 1 No. 12

Condensation can occur in the sampling system if the measuring gas cools down during transport. Not only water vapour, but also other components contained in the gas, including the target gas itself, can condense.

On the one hand, the condensate can impair the sample gas delivery and thus the gas supply to the sensor if the sample line becomes clogged. On the other hand, the measured value decreases if the component to be measured is absorbed in the condensate or condenses itself. Furthermore, subsequent samples can be contaminated if the condensate evaporates again later.

A safe drainage of the sampled gas and condensate shall be ensured.

When sampling the measuring gas from a potentially explosive atmosphere, it shall be ensured that the parts of the gas detection equipment that carry the measuring gas are at least suitable for the zone from which the measuring gas is extracted.

8.1.3 Design Documents

The employer shall store/archive the following documents in a suitable manner:
> Manufacturer’s instructions and maintenance instructions for the gas warning equipment
> EU Declaration of Conformity
> Proof of measurement and functional design to fulfill the protection objective
> Protocol of initial commissioning
> Records about:
  - Application principles
  - Selection criteria
  - Type and concentration of the test gases to be used
  - Configuration and settings of the gas warning equipment
  - Accessories used
  - Calibration or test station

8.2 Operation of Portable Gas Detection Equipment

When not in use, portable gas detection equipment shall be stored in accordance with the manufacturer’s instructions in such a way that harmful influences (e.g., avoidance of poisoning of sensors by certain substances, temperature and humidity, low-shock, and low-vibration storage) on the equipment and sensors are safely avoided. This also applies when the equipment is switched off.

The information and recommendations in the manufacturer‘s instructions shall be observed.

Portable gas detection equipment is used in various areas of application, for example:
> Personal protection
> Devices for clearance measurements
> Working in hazardous areas

The use of portable gas detection equipment depends on the respective operational requirements. This can e.g. be regulated as follows:
> in the general or company-specific risk assessment
> in the release procedure
> in the relevant instructions for clearance measurement, for example in accordance with DGUV Regel 113-004

8.2.1 Initial Commissioning of the Portable Gas Detection Equipment

Before first use, the portable gas detection equipment, and accessories, e.g., test and adjustment equipment, pumps, hoses, shall be checked for proper function. The extent should correspond to a system check in accordance with point 8.3.1.3.

8.2.2 Operating Instructions

When using a portable gas detection equipment, the employer shall draw up operating instructions. It should contain the following points:

> Carrying out the visual check and the function test
> The measures to be initiated in the event of an alarm being triggered (e.g., leaving the work area)
> The measures to be initiated in the event of status indications or failure of the equipment (e.g., stop work, replace equipment immediately in the event of a fault)
> The persons to be notified in the event of an alarm being triggered, a status indication or a device failure
> The group of persons responsible for checks and maintenance

8.2.3 Qualification for the Use of Portable Gas Detection Equipment

Persons who will use portable gas detection equipment shall be instructed in their proper application before use. This includes, among others:

> Contents of the operating instructions according to section 8.2.2
> Basic knowledge of how to use the equipment and the meaning of the display elements
> Correct handling to fulfill the measuring task, e.g., do not wear portable gas detection equipment under clothing
> Detecting obvious changes in the portable gas detection equipment
  • Gas inlet opening
  • Mechanical damage

The instruction shall be documented.

In addition to the above-mentioned contents, there may be special requirements for the use of portable gas detection equipment, for example the specialist knowledge for clearance measurement in accordance with DGUV Grundsatz 313-002.

8.3 Maintenance of Portable Gas Detection Equipment

The gas detection equipment shall be maintained at regular intervals to ensure proper performance, which requires appropiate knowledge. If the employer does not have this knowledge, he shall contact the manufacturer, specialists or test institution that have the necessary knowledge on the gas detection equipment installed. The specifications and recommendations in the instructions shall be observed.

The maintenance measures are divided into visual check and display check, functional checks and system checks, which shall be carried out at regular intervals. Any faults discovered shall be remedied immediately.

The measures, their results and assessment as well as any adjustment and/or repair work carried out shall be documented. The records shall also be checked regularly.[34]

Electronic documentation of the records of inspections and repairs is permitted.

34 An example of recordings for a portable gas detection equipment and recording control of portable gas detection equipment, see www.exinfo.de, page ID: #9UUN

8.3.1 Checks of the Portable Gas Detection Equipment

8.3.1.1 Visual Check and Display Test

They include at least the following actions.

Visual Check
> Check of the equipment and the accessories for mechanical damage
> Check of the gas inlets (e.g. for clogging due to dust or dirt)
> Check of readiness of operation, no alarm or special states activated when switched on
> If a pump is used: Perform tests of function and tightness including sampling accessories.

Display test:
> Checking the charge condition of the batteries.
> Application of suitable gas mixtures for testing the indication and alarm function:
The employer shall specify a criterion for determining whether the test is passed. The response time of the equipment shall be taken into consideration. The recommendations in the manufacturer‘s instructions or in Code of Practice T 055 shall be observed.
Note: Simple checking of zero in ambient air does not meet the requirements of this display test.

The check shall be carried out by a Trained Person[35].

The corresponding records shall contain:
> Identification of the gas detection equipment (e.g. type, serial number)
> Confirmation that the check has been carried out
> Faults discovered
> Date and clear identification of the person carrying out the work

8.3.1.2 Functional Check

The functional check includes at least the following actions:
> Visual check as described in section 8.3.1.1
> Application of zero gas and test gas for
- Checking and assessing the measured value (calibration) and adjustment, if necessary
- Checking and assessing the reaction time according to the specification in the instruction manual

The check shall be carried out by Qualified Personnel[36].

The corresponding records shall contain:
> Identification of the gas detection equipment (e.g. type, serial number)
> Composition of the test gases used
> Measured values at zero gas and test gas before and after calibration/adjustment
> Assessment of the reaction times
> Faults discovered
> Work carried out
> Date and clear identification of the person carrying out the work

The functional check replaces a visual check and display test due at the same time.

35 For the term “Trained Person”, see section 11.1.
36 For the term “Qualified Personnel”, see section 11.2.

8.3.1.3 System Check

The system check includes at least the following actions:
> Functional check as described in section 8.3.1.2
> Checking the safety-relevant parameter settings by comparing target/actual values, including at least the measuring range, target gas, alarm set points and acceptance criteria of the display test
> If a data logger is installed: Export of the data and checking for plausibility
> Assessing the state of the battery
> Assessing the condition of accessories (e.g. hoses, filters)

Automated check and adjustment facilities shall be examined as part of the system check.

The check shall be carried out by a Competent Person (Gas Detection Equipment)[37].

The corresponding records shall contain:
> Identification of the gas detection equipment (e.g. type, serial number)
> Composition of the test gases used
> Deviations of the parameter settings from the target values
> Measured values at zero gas and test gas before and after calibration/adjustment
> Assessment of the reaction times
> Faults discovered
> Work carried out
> Date and clear identification of the person carrying out the work

The system check replaces a functional check (and visual check) due at the same time.

8.3.1.4 Inspection of the Records

The inspection includes at least the following actions:
> Checking the completeness of the records on the checks described in sections 8.3.1.1 to 8.3.1.3.
> Checking the implementation of the necessary measures identified during maintenance.
> Checking that the operating instructions as described in section 8.2.2 are complete and actual.

The inspection of records shall be carried out by a Competent Person (Gas Detection Equipment)[38].

The corresponding records shall contain:
> Identification of the gas detection equipment (e.g. type, serial number)
> Confirmation that the inspection was carried out
> Inadequate records discovered
> Date and clear identification of the person carrying out the work

8.3.2 Calibration and Adjustment

The calibration with test gases is performed to check the measured value. The procedure is part of the functional check and the system check.

The gas is usually applied using suitable attachments (e.g., test adapters) with the volume flow rates specified by the manufacturer.

37 For the term “Competent Person (gas detection equipment)”, see section 11.3.
38 For the term “Competent Person”, see section 11.3.

Test gas shall be applied to equipment in pump mode, non-pressurized in accordance with the manufacturer's specifications.

Always adjust zero first, then the sensitivity. Finally, it is recommended to check zero again.

The test gas used for calibration shall in general be equivalent to the target gas. As far as technically possible, the test gas concentration should be known with a maximum uncertainty[39] of ± 10 % (relative).[40]

If the target gas is difficult to handle as a test gas, a surrogate test gas may be used. The surrogate test gas and the associated sensitivity setting shall be determined and documented in consultation with the manufacturer of the gas detector. The sensitivities of the device for the target and surrogate test gas ahall be known. If only a surrogate test gas is used, it will not be possible to ensure that the sensitivity for the target gas is present permanently. During the system check, additional measures shall be taken to reveal poisoning, ageing and impairment of the gas inlet. These should be coordinated with specialists, testing institutions or the manufacturer.

Test gas mixtures with several gas components are available on the market, which are mainly intended for the calibration of multi-gas detectors. With certain devices, however, the use of the test gas mixture can lead to damage to individual sensors or to incorrect adjustment due to cross-sensitivities. Before using such test gas mixtures, it shall therefore be ensured whether the intended mixture is safe to use for the devices to be checked.

The selection of gases suitable for checking the zero point may be restricted by the measuring principle. The selection should be made in accordance with the manufacturer's recommendations. The use of ambient air is only possible if it is ensured that the air is free of target gas and gas for which the gas detector has a cross-sensitivity at the time of calibration.

The two main areas of application for portable gas detection equipment for toxic gases are:
> Monitoring the concentration for compliance with the exposure limit values at workplaces.
> Alarming, where the focus is on the time until the alarm is triggered, for example in the case of leakage monitoring.

The calibration for toxic gases is carried out with a test gas concentration that ensures sufficient accuracy of the device in the range of the alarm thresholds. Assistance can be provided by specialists, testing institutions or the manufacturer. Adjustment of the display is generally only necessary if the deviation determined during calibration for the zero point is more than ± 10 % of the (main) alarm value or for the sensitivity more than ± 20 % of the target value.

For other areas of application or for oxygen measurement, the test gas concentrations, calibration procedures and permissible deviations shall be determined on a case-by-case basis. Specialists, testing institutions or the manufacturer can provide assistance.

As part of every functional check, the response time shall be checked and compared with the maximum permissible time specified in the risk assessment. If the specified values are exceeded, either the sensor of the gas detection equipment shall be replaced or the accessories for the gas path, e.g., filters or hoses, shall be checked and repaired if necessary.

39 According to EN ISO 6142
40 Particularly at low concentrations of toxic gases higher deviations are also tolerable at the actual state of the art

8.3.3 Specification of Check Intervals

8.3.3.1 Recommendation for the Maximum Intervals between Individual Checks

Type of check	Intervals
Visual Check and Display Test	Before each work shift If it is foreseeable that the equipment will be used beyond the change of shift, this check can also be carried out every working day
Functional Check	4 months
System Check	1 year
Inspection of Records	3 years

8.3.3.2 Fundamentals

The visual inspection and display test shall be carried out so close to the time of use that the occurrence of a functional impairment can be reliably ruled out in the intervening time interval.

The intervals between checks specified here apply to a wide range of common applications. If shorter or longer intervals for the checks result from the risk assessment in accordance with § 3 section 6 of the Betriebssicherheitsverordnung (BetrSichV – Ordinance on Industrial Safety and Health), these shall be used as the basis for checking the gas detection equipment.

8.3.3.3 Additional Checks

After exceptional situations, e.g. dropping from heights > 1 m, ingress of humidity or measuring ranges being exceeded, a visual check and display test shall be carried out immediately.

If there is a risk that damaging influences affect the equipment, e.g. contact with sensor poisons, it may be necessary to perform the display test during the working shift several times.
If the equipment has not been checked in accordance with 8.3.3.1 for more than two months, at least one functional check shall be carried out before it is used again.

8.3.3.4 Check Intervals for Equipment used in Emergencies

Equipment that is used for time-critical operations by authorities and organizations with safety tasks[41] and for which a daily visual check and display test are not possible, for example because it is a volunteer fire department or a guard station that is not permanently manned, can be deviated from the daily visual check and display test as follows:

> A visual check but no display test shall be performed before direct use.
> For this purpose, at least one display test for accuracy[42] shall be carried out after use (this includes deployments and exercises). If this is not passed, a functional check shall be carried out.
> Visual checks and display tests shall be performed every 4 weeks.

When following these procedures, suitable storage of the equipment shall be ensured and corresponding specifications of the manufacturer shall be kept (e.g., avoidance of poisoning of sensors by certain substances, temperature and humidity, low-shock and low-vibration storage).

41 For example, fire departments, police, rescue services, customs, aid organizations, technical relief organizations, disaster control units
42 According to procedure 2 as per information sheet T 055 question 3.9

8.3.4 Repair

If a visual check or display test reveal that a target value has not been reached, the equipment shall be sent for repair.

If a functional check proves that the sensitivity of a sensor has become so low that the required value can no longer be set or variations of climatic or operational conditions cause false alarms frequently, the sensor (or the sensing element) shall be replaced.

Note: In general, replacement is recommended when the sensitivity falls below 50 % of the initial sensitivity. When using electrochemical sensors, it shall also be considered that the lifetime is limited due to the operating principle even under optimum operating conditions (typically 1 to 3 years, depending on the measuring gas). At the end of the lifetime, the loss of sensitivity generally occurs in a short-term period. If there are long intervals between the functional checks, provident replacement of the sensors at the end of the probable lifetime is recommended.

The operating and maintenance instructions apply to repairs and the replacement of parts of the gas detection equipment. For safety reasons, only original spare parts from the manufacturer of the gas detection equipment or parts specified in the operating and maintenance instructions may be used.

Note: For work that may affect the ignition protection of the electrical equipment, further requirements may need to be observed.

To carry out further repair work, an appropiate qualification is required to carry out further repair work, which can be acquired, for example, through training provided by the manufacturer of the gas detection equipment. The person carrying out this work respectively the employer is responsible for the proper functioning and proper condition of the gas detection equipment after the repair.

After a repair, a functional check or system check shall be carried out on recommissioning, depending on the type of repair.

9 Transportable Gas Detection Equipment

Transportable gas detection equipment operating at a fixed location like fixed gas detection equipment for a limited time shall comply for design, operation and maintenance with the rules and regulations described in section 7.

Transportable gas detection equipment operating at frequently changing locations is to be regarded as portable gas detection equipment. It shall comply with the rules and regulations described in section 8.

10 Integration into Tests in Accordance with the Betriebssicherheitsverordnung (BetrSichV – Ordinance on Industrial Safety and Health)

Gas warning devices and detectors are considered work equipment according to § 2 (1) of the Betriebssicherheitsverordnung (BetrSichV – Ordinance of Safety and Health).

The inspections and suggested intervals described in this document assist the employer in fulfilling their responsibilities under § 3 (6) or § 4 (5) of BetrSichV and TRBS 1201 ff, particularly in establishing deadlines and personnel requirements.

For gas detection equipment, as components of monitored systems:
> either falling under Annex 2 of BetrSichV or
> are subject to permission according to § 18 (1) of BetrSichV,
the inspections outlined in this document do not replace the examinations of the entire system. However, they are designed to incorporate results into inspections according to the BetrSichV and can be used within an existing inspection concept.

If a gas detection equipment is used in potentially explosive areas, the requirements of Annex 2 section 3, Explosive Atmospheres, of BetrSichV apply.

The specified time intervals between inspections in this document apply to a broad range of typical cases concerning the requirements of BetrSichV. They can be used for gas detection equipment or gas detectors to meet the requirements according to § 4 (4) BetrSichV, provided that no shorter or longer intervals are indicated in the risk assessment under § 3, especially § 6, BetrSichV.

The same applies, by analogy, to the defined measures and requirements for maintenance.
If, when applying this Code of Practice to facilities in potentially explosive areas, regular inspections are to be waived due to a general maintenance concept according to Annex 2 section 3 No. 5.4 of BetrSichV, this should be considered and documented within the risk assessment. These considerations should include the design of the stationary gas warning device. The compliance and effectiveness of the implemented measures should be assessed during inspections in accordance with Annex 2 section 3 No. 4.1 and periodically according to Annex 2 section 3 No. 5.1 of BetrSichV.

The measures specified in sections 7.3 and 8.3 fulfill, for a wide range of typical cases, the requirements of § 10 (1) of the BetrSichV regarding the maintenance of gas warning devices and gas detectors. For the expertise required by § 10 (2) concerning maintenance measures, at least the knowledge of Qualified Personnel according to section 11.2 shall be demonstrated.

The following table establishes the connection between this Code of Practice and the requirements of the BetrSichV for inspections.

Work Equipment General Requirements and Inspection Obligations According to BetrSichV	This Code of Practice
Risk assessment and safeguard measures § 3, especially sections 3, 8, and 9, § 5	Selection and design by experts see section 7.1 or 8.1
§ 14 (1) Installation conditions, effectiveness of implemented safety measures	Initial commissioning see section 7.2.1 or 8.2.1
Basic obligations of the employer § 4 (5) sentence 3	Visual inspection and function test for portable measuring devices see section 8.3.1.1
§ 14 (2) Harmful impacts	Visual inspection see section 7.3.1.1 or 8.3.1.1
	Functional test see section 7.3.1.2 or 8.3.1.2
	System check see section 7.3.1.3 or 8.3.1.3
§ 14 (3) Before commissioning after repair or replacement	Functional or system check see section 7.3.1.2/7.3.1.3 or 8.3.1.2/8.3.1.3) Note: The replacement of parts distributed by the manufacturer to customers with identical components, and their installation according to the operating and maintenance manual, does not constitute a modification within the meaning of § 10 (5) BetrSichV
§ 14 (7) documentation	Inspection of the records see section 7.3.1.4 or 8.3.1.4
Additional guidance is provided by TRBS 1123, TRBS 1201 ff, and TRBS 1203	
If the gas warning device is a component of monitored systems as defined in Annex 2 of BetrSichV or subject to permission under § 18 (1) of BetrSichV, §§ 15 to 17 of BetrSichV, if applicable, also apply in conjunction with the relevant section or annex of BetrSichV.	

11 Requirements for Persons being Charged with the Checks

The qualifications described below refer to the gas detection equipment used in each application.

General information on the content of training is given in section 17 of EN 62990-2[43].

11.1 Trained Persons

Trained Persons who perform the visual checks as described in section 7.3.1.1 or 8.3.1.1 shall demonstrate at least the following level of knowledge by training and further regular follow-up training[44]:
> Basic knowledge of the function and design of the gas detection equipment
> Recognition of obvious changes to the gas detection equipment
> Knowledge of the device-specific test functions and assessment of the results

A written documentation of the state of knowledge is recommended.

11.2 Qualified Personnel

Qualified Personnel who perform functional checks as described in sections 7.3.1.2 or 8.3.1.2 shall demonstrate at least the following level of knowledge by training and regular follow-up training[45]:
> Level of knowledge of Trained Persons[46]
> Knowledge of the instructions and maintenance manual and of the operation of the control elements
> Basic knowledge of the measuring principle
> Knowledge of the test gases to be used and their proper handling
> Knowledge how to carry out calibration and adjustment
> Knowledge of the criteria for assessment of the results of the functional checks

A written documentation of the level of knowledge is recommended.

11.3 Competent Persons (Gas Detection Equipment)

Competent Persons (Gas Detection Equipment) who perform commissioning in accordance with section 7.2.1 or 8.2.1, the system checks in accordance with section 7.3.1.3 or 8.3.1.3 and the recording checks in accordance with section 7.3.1.4 or 8.3.1.4 shall possess at least the following knowledge through training and further periodic training courses[47], in addition to the general requirements specified in TRBS 1203[48] or, if used in potentially explosive atmospheres, the requirements of Annex 2 section 3 No. 3.1 BetrSichV and TRBS 1201-1.
> Level of knowledge of the Qualified Personnel[49]
> Comprehensive knowledge of the use and potential applications of gas detection equipment and gas detectors
> Knowledge of the influences on the measuring principle – the influence of interfering gases, ambient conditions, and the detection limits of the measuring principle
> Knowledge of influences on the measuring performance – times of response and influence of accessories such as e.g. filters, sampling lines, gas conditioning
> Comprehensive knowledge of the operation, maintenance, and repair of the gas detection equipment

43 See Annex 1 No. 12
44 Recommended intervals: 2 years
45 Recommended intervals: 2 years
46 For the term “Trained Person”, see section 11.1
47 Recommended intervals: 2 years
48 See Annex 1 No. 4
49 For the term “Qualified Personnel”, see section 11.2.

> General knowledge of potential applications and limits of commonly used measuring principles for the measurement of flammable gases and of oxygen
> General knowledge of the physical and chemical properties of the substances to be monitored

A written documentation of the state of knowledge is recommended.

11.4 Specialists

Specialists are persons with technical training and recent practical experience of working in the field of gas detection technology including:
> Comprehensive knowledge of potential applications and limits of common methods for measuring flammable gases and of oxygen
> Knowledge of the physical and chemical properties of the substances to be monitored
> Knowledge of gas dispersion
> Knowledge of occupational safety and explosion protection, particularly in the assessment of hazards related to potentially explosive atmospheres
> Knowledge of the applicable regulations
> Continuing education

Annex 1: Bibliography

Laws, ordinances, and legal text of the Accident Prevention Regulations **are binding legal standards.** Deviations require permission of the competent authority and the competent Accident Insurance Institution (e.g. Berufsgenossenschaft). Issuing a special dispensation requires compensation measures at the same safety level at least.

Deviations from the technical rules for regulations, implementation instructions for accident prevention regulations (DGUV regulations) and DGUV rules are permitted if it is documented in the risk assessment that the same level of safety can be achieved by other means.

DGUV information, information sheets and DIN/VDE standards are **non- binding legal standards.** They are regarded as important assessment standards and rules of technology from which deviations are possible if the same level of safety can be achieved by other means.

Sources of Information on the Internet

The publications of the BG RCI as well as an extensive part of the state regulations and rules and those of the statutory accident insurance institutions (around 1700 titles) are available in the BG RCI's compendium of occupational safety and health. There is a charge for using the compendium on the Internet. A free, time-limited trial access is offered.

For further information see www.kompendium-as.de.

For detailed information on BG RCI publications and media and to order, see mediencenter.bgrci.de.

Numerous leaflets, annexes, and forms from leaflets and DGUV rules as well as supplementary work aids are available free of charge in the Prevention Media Center at mediencenter.bgrci.de.

Accident prevention regulations, DGUV rules, DGUV principles and lots of DGUV information can be found on the homepage of the German Social Accident Insurance (DGUV) at publikationen.dguv.de.

1. EU Publications in the Official Journal of the European Union

Source of supply: Bundesanzeiger-Verlag, P.O. Box 10 05 34, 50445 Cologne, Germany Free download at http://eur-lex.europa.eu/de/index.htm and www.exinfo.de, Page ID: #QNEM

1 Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast) (for equipment and protective systems placed on the market from 20.04.2016).

2. Laws, Ordinances, Technical Rules

Source of supply: Bookstore
Free download at www.bundesrecht.juris.de (laws and regulations) or www.baua.de (technical rules) and www.exinfo.de, page ID: #2BC9

2 Ordinance on Safety and Health Protection in the Use of Work Equipment (Ordinance on Industrial Safety and Health – BetrSichV) with Technical Rules for Industrial Safety (TRBS) or Ordinance on Protection against Hazardous Substances (Ordinance on Hazardous Substances – GefStoffV) with Technical Rules for Hazardous Substances (TRGS), in particular:

3 TRBS 1201: Prüfungen von Arbeitsmitteln und überwachungsbedürftigen Anlagen

4 TRBS 1203: Zur Prüfung befähigte Personen

5 Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labeling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 (CLP Regulation)

6 Ordinance on Hazardous Substances (Gefahrstoffverordnung – GefStoffV) with Technical Rules for Hazardous Substances (Technische Regeln für Gefahrstoffe – TRGS), in particular:

7 TRGS 402: Identification and assessment of the risks from activities involving hazardous substances: inhalation exposure

8 TRGS 900: Arbeitsplatzgrenzwerte

3. Accident Prevention Regulations, DGUV Rules, DGUV Principles, Codes of Practice and Other Publications of Accident Insurance Institutions

**Sources of supply: Berufsgenossenschaft Rohstoffe und chemische Industrie,
Postfach 10 14 80, 69004 Heidelberg, mediencenter.bgrci.de or Jedermann-Verlag GmbH, Postfach 10 31 40, 69021 Heidelberg, www.jedermann.de, verkauf@jedermann.de and at www.exinfo.de, Seiten-ID: #MAMS**

Member companies of the BG RCI can obtain the following publications (down to the next source reference) free of charge in quantities commensurate with the size of the company.

9 Merkblatt T 055: Gaswarneinrichtungen und -geräte für den Explosionsschutz – Antworten auf häufig gestellte Fragen

10 Code of Practice T 023e: Gas Detection Equipment for Explosion Protection – Use and Operation (DGUV Information 213-057)

4. Standards

Sources of supply: Beuth-Verlag GmbH, Burggrafenstraße 6, 10787 Berlin, www.beuth.de or VDE-Verlag GmbH, Bismarckstraße 33, 10625 Berlin, www.vde-verlag.de

11 EN IEC 62990-1: Workplace atmospheres – Part 1: Gas detection equipment – Requirements for the performance of equipment for the measurement of toxic gases

12 EN IEC 62990-2: Workplace atmospheres – Part 2: Gas detectors – Selection, installation, use and maintenance of gas detectors for toxic gases and vapours

13 EN 50104:2020-08: Electrical apparatus for the detection and measurement of oxygen – Performance requirements and test methods

Standards are subject to regular revisions. The editions cited here were valid at editorial deadline. When using this Code of Practice, the latest editions shall be applied.

5. Other Publications and Media

14 GESTIS substance database of the DGUV at www.dguv.de/ifa/stoffdatenbank with information for the safe handling of hazardous substances and other chemical substances in the workplace. It provides information on important physical and chemical data as well as special regulations on the individual substances, in particular on classification and labeling according to the GHS in accordance with the CLP Regulation. It contains information on around 8700 substances.

15 List of performance tested gas detection equipment: www.exinfo.de, Page ID: #6HY9

Sources of supply: Jedermann-Verlag GmbH, Postfach 10 31 40, 69021 Heidelberg, www.jedermann.de and Berufsgenossenschaft Rohstoffe und chemische Industrie, Postfach 10 14 80, 69004 Heidelberg, mediencenter.bgrci.de

16 Occupational safety compendium as an online database (chargeable): regulations and rules, symbol library, programs for carrying out and documenting risk assessments (GefDok Pro demo version, GefDok SME and GefDok light). Information and free, time-limited test access at www.kompendium-as.de

Source of supply: www.maurischat.eu

17 Kompendium zur Gasmesstechnik Fassung 12/2016

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iStock.com/industryview, Jedermann Verlag

This document concentrates on essential points of individual regulations and rules. It therefore does not list all the measures required in individual cases. In addition, the state of the art and the legal basis may have changed since the publication of this document.

This document has been carefully prepared. This does not release you from the obligation and responsibility to check the information for completeness, topicality, and correctness yourself.

The German Occupational Health and Safety Act refers to the employer, while the German Social Code VII and the accident prevention regulations of the accident insurance institutions refer to the employer. The two terms are not completely identical because employers do not necessarily have employees. In the context of this topic, this does not result in any relevant differences, so “the employer” is used.

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This Code of Practice can be ordered online at **mediencenter.bgrci.de**.

Do you have any questions, suggestions or criticism?
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