

# Fact Sheet

## Gas Monitoring

Supplement to «Richtlinie Laborbauten» and «Guideline for gas cylinders with compressed and liquefied gases»

### Scope of application

Gas warning systems are installed in all rooms at ETH in which there are local gas networks and/or in which gas cylinders or cryogenic liquefied gases are stored or handled and where the escape of these gases could pose a hazard to persons or animals. This applies, for example, to laboratories, workshops, liquid nitrogen filling and storage rooms, animal facilities, refrigeration plants. Special rooms where large quantities of flammable liquids are handled (e.g. solvent storage tanks, solvent disposal rooms, solvent filling stations) may also require a gas warning system.

For central nitrogen or argon gas supply in buildings, gas monitoring is usually not necessary in the rooms connected to the central system (except in the room where the tank is located). However, the connected rooms must have sufficient artificial ventilation and the functionality of the corresponding ventilation system must be monitored accordingly. If the ventilation system is not functioning, no work may be performed in the rooms concerned. Under these conditions, it is assumed that in the event of a leak at an extraction point, the residual risk of personal injury due to oxygen deficiency is very low.

For the central supply of carbon dioxide gas in buildings, however, planners must provide calculations to show that if there is a leak at an extraction point, the CO<sub>2</sub> content of the room air cannot rise above 2.0%vol with minimum ventilation, e.g. by means of permanently installed flow control regulators. If this proof cannot be provided, CO<sub>2</sub> gas monitoring is necessary in the connected rooms.

### Assessing the need for gas monitoring

To assess the risk, the following «worst-case» scenario is assumed:

- The entire content of the largest container in the room leaks out
- Gas / vapor escapes abruptly
- The gas / vapor spreads evenly throughout the entire room volume
- Mechanical exhaust ventilation is not taken into account (exception: it is designed redundantly and also available in case of power failure)

For each single gas/vapor available in the room, the following must be considered:

- Can a potentially explosive mixture be created ?  
Reference value: the Lower Explosion Limit (LEL) is reached
- Is there a risk of damage to the health of persons or animals ?  
Reference value: MAK value (maximum workplace concentration)
- Can the oxygen content in the room fall below 18% vol. ?

If at least one of these three questions is answered with "yes" for one gas, gas monitoring becomes necessary for the gas in question. At the ETH gas monitoring is generally realized by means of permanently installed gas warning systems. Should the installation of such a gas warning system be waived, it is mandatory that an exemption be authorized by SSHE CABS.

### Structural requirements

A gas warning system includes the technical components listed under Tab.1.

Tab.1: Technical components of a gas detection system

Components	Location
Shut-off valve(s)	<ul style="list-style-type: none"> <li>– basic rule: as close as possible to the cylinder</li> <li>– for very toxic/corrosive gases (pre-alarm <math>\leq 1</math> ppm) an electro-pneumatic valve is installed on the high-pressure side of the gas installation</li> <li>– for other monitored gases a solenoid / magnetic valve is installed on the low-pressure side of the gas installation (directly after the pressure regulator)</li> <li>– safe valve control<sup>[1]</sup></li> </ul>
Gas sensor(s)	<ul style="list-style-type: none"> <li>– in the gas cylinder cabinet: in the upper part (gases lighter than air) or 20 cm above ground (gases heavier than air); depending on the sensor model also possible in the exhaust air duct of the gas cylinder cabinet</li> <li>– in the room: on the ceiling (gases lighter than air), 150 cm above ground for oxygen or carbon monoxide sensors or 20 cm above ground (gases heavier than air, vapors, cryogenic liquefied gases) for carbon dioxide sensors</li> <li>– in fume hood (for gas networks in a fume hood)</li> <li>– several sensors may be necessary for each room</li> </ul>
Visual alarm e.g. flashing light, warning light, illuminated sign	<ul style="list-style-type: none"> <li>– in the room on the ceiling (clearly visible; if the room is larger or has many angles, several may be required)</li> <li>– outside the room at each door</li> </ul>
Acoustic alarm e.g. horn	<ul style="list-style-type: none"> <li>– in the room on the ceiling</li> <li>– if indicated, also outside the room (depending on volume level<sup>[2]</sup>)</li> </ul>
Display to show all measurement values	<ul style="list-style-type: none"> <li>– clearly visible and accessible outside of room/danger zone, e.g. in the corridor by the door</li> <li>– the location of the display must be indicated on all the doors (e.g. plan)</li> </ul>
Central control unit	<ul style="list-style-type: none"> <li>– if possible, outside the room/danger zone</li> </ul>

[1] Designed according to SN EN ISO 13849-1. [2] Reference value per EN ISO 7731: min. 65 dB(A), as well as 15db(A) above the background noise level.

Gas sensors in adjacent rooms can also be combined into a joint gas alarm system.

If several rooms are linked to the same gas monitoring system, it should be ensured that only the visual and acoustic alarms linked to the sensors are triggered and not all in the entire system.

If the rooms are occupied by different users, different data points for the main alarm must be set up for each user group. An example is shown in Fig. 1.

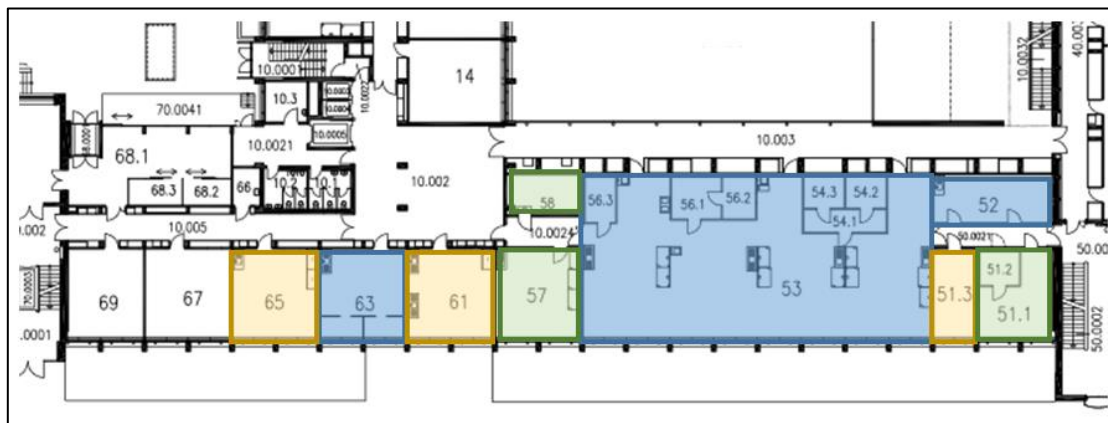


Fig. 1: Possible combination of several rooms with 3 different users (e.g. professorship «blue», professorship «yellow», professorship «green») in a joint gas monitoring system. The display and central control unit can be used jointly; for this system, however, 4 different building automation alarms are required: 1x technical malfunction, 1x main alarm for the rooms of professorship «blue», 1x main alarm for the rooms of professorship «yellow», 1x main alarm for the rooms of professorship «green».

### Connection/Alerting

The gas warning systems are connected to the building's automation system. Each gas warning system must detect three conditions under which an alarm is triggered:

- when the pre-alarm value is reached
- when the main alarm value is reached
- Technical malfunction of the system

As soon as one of these conditions is detected, the actions in Tab. 2 are triggered.

Tab.2: Alarm triggering

Action	Pre-alarm	Main alarm	Technical malfunction
Visual alarm	Yes	Yes	Yes
Acoustic alarm	No	Yes	No
Display indication	Yes	Yes	Yes
Activate emergency ventilation	Yes	Yes	No
Close shut-off valve on cylinder	Yes (for gas affected)	Yes (for gas affected)	Yes (all cylinders)
Building automation alarm	No	Yes, Cat. 1 with alarm help file on record <sup>[1]</sup>	Yes, Cat. 2 with alarm help file on record
Acknowledgeable	No	Yes, only horn (from outside the danger zone)	No

<sup>[1]</sup> release by SGU CABS required before triggering.

For ammonia refrigeration systems there is an additional intervention alarm (per EKAS directive) for which ventilation is deactivated.

The reference values in Tab. 3 apply to alarm values.

Tab.3: Reference values

Gas/Vapor	Pre-alarm	Main alarm
Flammable	10% LEL	20% LEL
Hazardous to health	MAK	KZGW
O <sub>2</sub> -displacing	19%vol O <sub>2</sub>	17%vol O <sub>2</sub>
CO <sub>2</sub>	1%vol CO <sub>2</sub>	2%vol CO <sub>2</sub>
NH <sub>3</sub> (in refrigeration systems)	40 ppm	< 200 ppm

If a gas has several hazardous properties (e.g. flammable and toxic), the lower value is used. Deviations from the reference values must be approved by SSHE CABS.

### System documentation

A system documentation must be created for every gas warning system and submitted to the Facility Services Department. A copy must also be filed in the control center/cabinet.

### User instruction

Before the installation can be handed over to the users, they must be instructed by the manufacturer or supplier on how to operate the system. The instruction must be documented (signature).

### System acceptance

Every installed gas warning system must be acceptance tested before it is handed over to users. A checklist is available for this purpose.

### Maintenance/Service

A service/maintenance contract must be made for all gas warning systems. During maintenance, the alarm values must also be checked to ensure that they are set correctly and comply with the currently valid limit values. This check is documented and the service log sent to the service/maintenance contract holder.

### Legal basis

- Verordnung über die Verhütung von Unfällen und Berufskrankheiten (VUV) (Ordinance on the Prevention of Accidents and Occupational Diseases)
- Wegleitung zu VO 3 und 4 zum Arbeitsgesetz (Commentary on Ordinance 3 and 4 of the Labor Law)
- SUVA publication 66122.d: «Gas cylinders – storage, ramps, gas distribution systems»
- SES Technical Guideline «Gas warning systems for toxic gases and oxygen» (SES = Swiss Association of Safety Systems Manufacturers)
- SES Technical Guideline «Gas warning systems for flammable gases and vapors»
- VKF Fire Regulation 21-03 «Gas detection systems» (VKF = Association of Cantonal Fire Insurances)
- VKF-Fire Regulation 27-03 «Hazardous substances»
- VKF Fire Regulation 28-03 «Flammable liquids»

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