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Fixed Ultrasonic Gas Leak Detectors (UGLD) — General requirements and test methods

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Ortsfeste Ultraschall-Gasleckage-Detektoren (UGLD) - Allgemeine Anforderungen und Prüfverfahren

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European foreword

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Introduction

Ultrasonic Gas Leak Detectors (UGLDs) are being increasingly appointed to quickly detect gas leaks from pressurized systems to complement the use of point or line of sight detectors. The UGLD detects the acoustic emission generated by the leak, which propagates omni-directionally at the speed of sound. The leak can be detected at some distance without the gas itself needing to reach the position of the sensor. The main reason for implementing UGLDs is to improve the response time to detect dangerous gas leaks and to improve the gas leak detection coverage with the addition of a complementary detection method that is not affected by air flow.

In general terms, an UGLD functions by detecting the ultrasonic noise generated by gas escapes from a high-pressure area to a low-pressure area through a small aperture (leak). In practice the technique is of value for detecting leaks from tank/pipelines, etc running at pressures greater than 2 bar. The intensity of this airborne ultrasound generated by a gas leak is due to a number of factors including but not limited to gas type, gas pressure, leak size and gas temperature.

An UGLD does not detect specific gas types, measure percentage LFL or ppm concentration level, but instead responds to the specific ultrasonic sound generated by a pressurized gas leak. The reliable range coverage of an UGLD is mainly determined by the leak rate of the gas leak, the atmospheric transmission of the ultrasound, and the potential acoustic background noise that can interfere with the UGLD. The leak rate is mainly determined by gas pressure and leak size, but molecular weight and gas temperature also plays a role. The leak rate determines how fast a potentially dangerous gas cloud will be generated. In addition, physical obstructions between the location of the leak, and the UGLD will also have an influence on the detection range of the detector.

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1 Scope

This document refers to UGLDs (ultrasonic gas leak detectors) that work in a frequency beyond the audible range. This document is applicable to fixed ultrasonic gas leak detection equipment intended to provide an indication, alarm or other output function for the purpose of initiating automatic or manual protective action(s).

This document specifies general requirements for design, testing and performance, and describes test methods that apply to UGLD. The following items are considered in this document:

— Leak rates to be used to verify the detection range of UGLD,

— Test gas to be used (nitrogen or compressed air),

— Nozzle shape and size used at all tests leak rate tests,

— Gas pressure used at all leak rate tests,

— Time duration of each leak rate test,

— Test leak nozzle height from solid ground,

— Test leak nozzle angling relative to test UGLD,

— UGLD angle relative to the leak (field of coverage of the UGLD),

— Wind speed and direction, air temperature and humidity at day of test,

— Minimum distance to solid structures (walls, etc.) at test site,

— Installation height relative to the ground,

— Texture of solid ground between leak and UGLD,

— Background noise sources, known to interfere with UGLDs,

— Specification of detection radius in 3 dimensions,

— Operational requirements such as temperature, vibration, etc.

This document is also applicable when an equipment manufacturer makes any claims regarding any special features of construction or superior performance that exceed the minimum requirements of this document. This document prescribes that all such claims are verified, and that the test procedures are extended or supplemented, where necessary, to verify the claimed performance. The additional tests are agreed between the manufacturer and test laboratory and identified and described in the test report.

This document does not apply to portable gas detectors using ultrasonic measurements nor to gas detectors using non-ultrasonic measurements to detect a gas leak.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN IEC 61326-1, *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements*

EN 50271:2018, *Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen - Requirements and tests for apparatus using software and/or digital technologies*

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IEC 60068-2-6, *Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Glossary

3.1.1
UGLD
Ultrasonic Gas Leak Detector
equipment that work normally in a frequency beyond the audible range (> 16 kHz)

3.1.2
leak rate
mass flow rate from the gas leak

3.2 Types of equipment

3.2.1
alarm-only equipment
equipment having an alarm but not having a proportional indication of sound pressure level

3.2.2
continuous duty equipment
equipment that is powered for long periods of time, but may have either continuous or intermittent sensing

3.2.3
fixed **equipment**
equipment that is intended to have all parts permanently installed

3.2.4
stand-alone leak detection equipment
fixed leak detection equipment that provides a conditioned electronic signal or output indication to a generally accepted industry standard (such as 4-20 mA), intended to be utilized with stand-alone control units, or signal processing data acquisition, central monitoring and similar systems which typically process information from various locations and sources including, but not limited to, leak detection equipment

3.2.5
stand-alone control unit
fixed leak detection control units intended to provide meter indication, alarm functions, output contacts and/or alarm signal outputs when utilized with stand-alone leak detection equipment

3.3 Sensors

3.3.1
integral sensor
sensor which is integral to the main body of the equipment

3.3.2
remote sensor
sensor which is not integral to the main body of the equipment

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3.3.3
sensor
assembly in which the sensing element is housed and which may also contain associated circuit components

3.3.4
sensing element
part of the sensor which is sensitive to the noise to be measured

3.4 Signals and alarms

3.4.1
sound pressure level
SPL
level measured in dB defined as:

$$SPL = 10 \cdot \log_{10}\left[\frac{POW_{SIG}}{POW_{ref}}\right] = 20 \cdot \log_{10}\left[\frac{P_{SIG}}{P_{ref}}\right]$$

with the sound pressure P_{SIG}, the reference sound pressure P_{ref} = 20µPa, the reference signal power POW_{ref}, and the signal power POW_{SIG} calculated from a time domain signal of N digits:

$$POW_{SIG} = \sum_{i=1}^{N/2}\left[abs\left(FFT_i\left(N\right)\right)\right]^2 \sim P_{SIG}{}^2$$

Note 1 to entry: FFT_i represents the signal within the i_{th} frequency bin generated by a Fast Fourier Transformation. No weighting filter is applied (like A, C or Z). The FFT window shall be chosen in a way that best represents the power of the ultrasonic signal.

Note 2 to entry: The reference signal power POW_{ref}, necessary to fixate the dB-scale to an absolute reference, is extremely difficult to measure, especially since the ultrasonic bandwidth ranges of UGLDs differ among each other. Therefore, the absolute calibration is traced back to the existing calibration in the audible range, the hearing threshold. A practical method and calibration set up is described in Annex E.

To generate a consistent dB-scale between the vendor devices, the calibration bandwidth is fixed from 16kHz to 64kHz, representing two full octave frequency bands.

3.4.2
reference noise
small leak of air close to the UGLD – typically round nozzle, 300 µm, mass flow 0,06 g/s, 25 cm from the sensor, used for some specific small-scale tests

Note 1 to entry: The nozzle drawing is provided in Annex D.

3.4.3
reference leak
25 g/s leak of test gas generated though a 2 mm nozzle using e.g. a mass flow controller

Note 1 to entry: An upstream pressure of 38-bar at 20°C may be necessary.

Note 2 to entry: The nozzle drawing is provided in Annex D.

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3.4.4
low noise condition
no external stimulus beyond 50 dB, measured with an external dedicated measurement equipment in the frequency range defined

3.4.5
measuring range
measuring range that represents the interval between the lowest measured value (in dB) and the highest measured value

3.4.6
alarm set point
fixed or adjustable setting of the equipment that is intended to pre-set the level of ultrasonic sound pressure level at which the equipment will automatically initiate an indication, alarm or other output function

3.4.7
fault signal
audible, visible or other type of output, different from the alarm signal, permitting, directly or indirectly, a warning or indication that the equipment is not working faultless

3.4.8
latching alarm
alarm that, once activated, requires deliberate action to be deactivated

3.4.9
repeatability
level of agreement between the results of measurements of the same ultrasound noise level, carried out by the same method and conditions, on the same UGLD instrument type

3.4.10
drift
variation in the equipment indication with time, at any fixed ultrasound noise level under constant ambient conditions

3.4.11
final indication
indication given by the equipment after stabilisation

3.4.12
stabilisation
state when three successive readings of an equipment, taken at 5 s intervals, indicate no changes greater than ± 1 dB

3.4.13
time to alarm
time interval, with the equipment in a warmed-up condition, between the time when an instantaneous release is produced in the equipment surrounding and the time when the alarm is triggered

4 General requirements

4.1 Introduction

The equipment shall comply with the requirements of this document.

Electrical assemblies and components shall comply with the construction and test requirements of 4.2, where applicable. In addition, parts of the UGLD intended for use in potentially explosive atmospheres are expected to employ materials and comply with the construction and explosion protection as specified in the appropriate regulations for explosion protection.

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