SAFETY ALERT

HSE Safety alert – Failure to detect dangerous gas/vapour due to incorrect specification of sample tube

Health and Safety Executive - Safety alert	
Department Name:	Chemicals, Explosives and Microbiological Hazards Division (CEMHD)
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Target Audience:	Personnel specifying and selecting devices for measuring concentrations of flammable and toxic gases Chemical processing and production
Key Issues:	This safety alert highlights the risk of misleading gas detection readings associated with the use of sampling tubes with pumped gas detectors. Sampling tubes are sometimes used to extend the reach of the detection device and/or to allow detection at an increased distance from the user. In a recent incident a gas detector failed to detect the presence of a flammable vapour. Hot work proceeded in the belief that there was no flammable vapour present. The subsequent explosion resulted in a fatal injury. The investigation found that a significant contributor to the failure to detect the flammable vapour was it being adsorbed on the inner surface of the sample tube. This meant that no flammable vapour reached the detector before the test was completed and a false conclusion that the work area was free of flammable vapour. This incident has highlighted the importance of selecting the correct systems for gas detection and verifying the effectiveness of the detection system. The purpose of this safety alert is to highlight the risk of adsorption if an unsuitable sample tube is used.

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Introduction

- Gas detection may be used in support of a risk assessment associated with, for example, hot work or confined space entry. It is important that the gas detection system used is suitable for the intended purpose and gives a sufficiently accurate and reliable indication of the presence of the hazardous material. Pumped gas detectors can be used to sample locations at a distance from the detector via a sampling tube.
- In a recent incident, a gas detector failed to detect a flammable atmosphere. Hot work proceeded based on the false reading. The hot work resulted in ignition of a flammable atmosphere and a fatal injury.
- While there were errors in the selection and set-up of the gas detector, the most significant contributor to the failure of the gas detector was the adsorption of the flammable vapour on the surface of the sample tube before it could reach the gas detector.
- This safety alert is to remind operators of the need to ensure the suitability of gas detection system for its intended purpose.

Background:

- The gas detector involved in the incident performed in accordance with the manufacturer's specification.
- The manufacturer's technical performance information reported that it was not suitable for the detection of the substance to be measured. The detector was being used for a substance other than its calibration gas but had not been configured to include a correction factor. Each of these issues would have resulted in an incorrect reading. On this occasion, if these had been the only faults the reading would still have been sufficient to result in a decision not to proceed with the hot work.
- The most significant contributor to the failure was the adsorption of the substance of interest on the inner surface of the sample tube. During laboratory testing of the gas detector and at a concentration of 50%LEL (lower explosion limit) of the substance involved, the sample tube extended the time to achieve a non-zero reading by more than 1 minute. This extension was considerably longer than the time taken to test at any particular location with a recommended sample tube fitted. At 50%LEL of the substance involved, the time to achieve 90% of the final reading was over 15 minutes.
- The same gas detector and sample tube had a response time of less than 5 seconds to the calibration gas (methane).

- The phenomenon of adsorption of some substances on sample tubes is known. It is mentioned in each of the references to this safety alert and has been studied in previous HSE research (eg Research Report RR635).
- Review of manuals for gas detectors from a range of manufacturers has identified that most manuals include little or no information on the importance of selecting a sample system of a suitable material.
- While the incident to which this safety alert refers involved a highly flammable substance and measurement of LEL, similar issues may apply to some other gases, particularly reactive gases such as H2S and NOx

Action required:

- Operating instructions for most gas detectors recommend a function check (often referred to as a 'bump test') before each day's use. This is additional to the requirement for periodic calibration. It is recommended in the case of gas detectors that will be used with a sample tube, at least the first function check ('bump test') for a new intended use and/or a new sampling configuration be conducted using the combination of the gas detector and its sample tube and the substance of interest, where practicable. This is of particular importance if the substance of interest is not the substance used to calibrate.
- For example, the head space in a sample jar containing a liquid sample of the substance of interest at a temperature above its flashpoint would be expected to give an output representing greater than 100%LEL.
- Sample tubes should be as short as possible. The increase in response time should not exceed the response time of the gas detector without a sample tube plus the delay time specified in the gas detector manual or, where no time is specified in the manual, 3 seconds per metre (eg BS EN 60079-29-1:2016, section 5.4.15). The combination of gas detector and sample tube should be considered unsuitable where this time is exceeded.
- Particularly for spot testing, users should be aware of the response time of the combination of the gas detector and its sample tube.

Relevant legal documents:

- Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and guidance. L22 (4th edition) HSE November 2014
- Dangerous Substances and Explosive Atmospheres Regulations. 2002 Approved Code of Practice and guidance. L138 (2nd edition) 2013

- A guide to the Control of Major Accident Hazards Regulations (COMAH) 2015. L111 (3rd edition) HSE June 2015

References:

- BS EN 45544-4:2016 Workplace atmospheres — Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours Part 4: Guide for selection, installation, use and maintenance
- BS EN 60079-29-1:2016 Explosive atmospheres Part 29-1: Gas detectors —Performance requirements of detectors for flammable gases
- BS EN 60079-29-2:2015 Explosive atmospheres Part 29-2: Gas detectors — Selection, installation, use and maintenance of detectors for flammable gases and oxygen
- The selection and use of flammable gas detectors (PDF) - Portable Document Format
- Research Report RR635 Effect of tubing type on gas detector sampling systems

Further information:

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General note:

Please pass this information to a colleague who may have this product/equipment or operate this type of system/process.