Functional Bump Testing: A key to any Personal Gas Detection Safety Program

The only thing worse than a gas detector you know is not working properly, is the gas detector that you do not know is not working properly.

The Training and Safety Officer of a major Fire Department discovered by chance that a combustible gas sensor in one of the department's portable multi-gas detectors was not working, and the instrument gave them no indication at startup this sensor was faulty. Two firefighters were responding to a warehouse incident and while investigating, one firefighter's gas detector went into high combustible gas alarm and the other detector did not respond. Upon further testing at the fire station it was determined that the combustible sensor in the suspect instrument was not functioning properly.

The fire department was diligent in maintaining their gas detection equipment. They followed the gas detector manufacturers' recommendations and calibrated their detectors as often as recommended. How did a sensor pass the instrument self test at start up when it was not working? Unfortunately this question is raised far too often.

Everyday workers around the world trust their portable safety gas detector to warn them of possible life threatening atmospheric gas hazards, often with little, if any, understanding of how this important component of their safety equipment works. Serious injury or even death can be caused by exposure to toxic gases, oxygen deficient environments, or explosions caused by the presence of combustible gases. The use of a properly maintained gas detector is essential for protection. The gas detector that is about to be used today was calibrated according to the manufacturer's recommendations but that may have been months ago. Although it has been used each and every day since the last routine calibration service, it is possible that it is not functioning properly.

The only way to confirm that a gas detector is functioning and is capable of responding to gas is to expose the instrument to a concentration of target gas high enough to initiate an alarm situation while the instrument is in operating mode. This procedure is often referred to as performing a functional bump test and it is a key to the safe use of portable gas detection equipment.

In the evolution of safety gas detection instrumentation functional bump testing is a relatively new practice. There was a time when calibration was recommended frequently, even daily, but as sensor technology and sensor performance became better understood, the frequency began to lengthen. As calibration frequency decreased it was just assumed that a detector was operating properly between calibration intervals.

Today recommended calibration intervals vary considerably, but there is unanimous agreement amongst manufacturers that it is necessary to verify the function of portable safety gas detectors between calibrations. Again, there is no industry consistency in the wording of the functional bump testing recommendation found in gas detector manuals. Gas detector users can not be blamed if they are confused about what constitutes a functional bump test and how often it should be performed. Since many users do not understand why functional bump testing is necessary, the practice is often not adopted. In some areas of the world functional bump testing personal gas detectors between calibration intervals is virtually unheard of.

Why is function testing necessary?

Portable gas detectors can contain various types of sensor technologies with different detection principles.

Workplace environments can be harsh and gas detectors are subjected to all kinds of conditions that can affect their operation. Instruments can be physically damaged, sensor ports can become obstructed by dirt and oils, sensors can be damaged by exposure to gas concentrations that exceed their detectable limit, sensors can be exposed to compounds in the atmosphere that can degrade their performance, and, as with any product there is the possibility of a manufacturing defect.

The catalytic hot bead combustible sensor used in many safety gas detectors is particularly prone to damage by compounds that can be encountered daily in the work-place environment. This type of combustible gas sensor contains two coils of very fine platinum wire coated with a ceramic or porous alumina material to form refractory beads.

The beads are connected to opposing arms of a balanced Wheatstone Bridge electrical circuit. One bead (active) is additionally coated with platinum or palladium, which enables catalytic oxidation of combustible gases at concentrations below the lower explosive level (LEL) to occur. The opposing bead (reference) is identical in structure except that it is not coated with the catalyst material. Both beads are heated to a specific temperature and in normal air, the Wheatstone Bridge circuit remains balanced.

If a combustible gas is present, catalytic oxidation will heat the active bead to a higher temperature than the opposing reference bead, unbalancing the electrical resistance in the Wheatstone Bridge circuit. The difference in the electrical resistance of the active bead versus the reference bead is proportional to the concentration of combustible gas in the atmosphere.

One of the limitations of this catalytic bead technology is that the sensor is potentially prone to damage through exposure to airborne contaminants capable of impairing sensor performance, or permanently destroying the sensor. Some airborne substances called poisons can decompose on the active sensor bead catalyst and form a solid barrier over the catalyst bead surface. Silicone vapours are the most commonly encountered workplace substance capable of destroying catalytic bead sensors. Many commercially available lubricants, rust inhibitors, adhesives and cleaners contain silicone based compounds. Some other poisons to be aware of are compounds containing lead, sulphur or phosphates and high concentrations of combustible gases. A single exposure to a high concentration of a sensor poison can destroy the catalytic bead combustible sensor. Sensors can also lose detection sensitivity gradually.

Certain other compounds such as high concentrations of hydrogen sulphide, or halogenated compounds

are absorbed by the active sensor catalyst and the sensor response can be inhibited. Sensor inhibitors create a loss in sensitivity to combustible gases, however, exposure to these compounds is typically temporary and once the detector is removed from the contaminated environment the sensor will recover normal sensitivity. In some cases, chronic exposure to inhibitors will permanently damage the catalytic bead combustible sensor.

Electrochemical sensors used for the detection of toxic gases such as carbon monoxide (CO) and hydrogen sulphide (H2S) are not as prone to poisons as the catalytic bead sensor, but their performance can also be compromised by certain ambient contaminants. Many electrochemical sensors can be temporarily or sometimes permanently damaged by exposure to organic solvents and alcohols. Methanol, which is often widely used in many parts of the world during the cold winter months, can have a profound effect on CO and H2S sensors. Many insect propellants contain alcohol and use hydrocarbons such as propane or butane as an aerosol propellant. Both can affect personal gas detector sensors. Photoionizaton sensors can suffer a loss of sensitivity if internal components such as the ultraviolet lamp or sensing electrodes become dirty through everyday use.

Even though the gas detector performs diagnostic checks at start up and during operation it is often not possible to detect a problem with sensor response. The detector can not warn users that sensor ports are obstructed by dirt, oil, or some other substance, the capillary pore of an oxygen sensor is blocked, or the catalytic bead of a combustible sensor has been poisoned. Either way, if gas is not able to reach the gas detector sensor, the sensor is not able to detect its presence.

Functional bump testing gas detectors is essential to a safety program.

The only way to verify that a safety gas detector is actually capable of responding to the target gas is to perform a functional bump test. The concept of a functional bump test is to verify the detector sensors respond to a target gas and that the detector alarms activate. This is sufficient for many users, but others perform a calibration check, confirming the accuracy of sensor response while testing. The International Safety Equipment Association (ISEA) is an organization dedicated to protecting the health and safety of workers through education and the development of safe work practices. In May 1996, ISEA published a protocol to clarify the difference between functional bump testing and full calibration and to identify the frequency at which functional bump testing should be performed. In April 2007 ISEA held a meeting with gas detection manufacturers to discuss terminology and protocols that will clarify the terms functional bump test, full calibration and calibration check. Look for a revised recommendation from ISEA in the future.

Sensor calibration adjusts response accuracy and functional bump testing verifies sensor response between calibration intervals. The need for functional bump testing personal safety gas detectors is evident and the test is very easy to perform. It takes only seconds and provides gas detection users with confidence that the detector about to be used is working. Be sure to use test gas from a reliable source, and check the expiry date on the cylinder. If a detector does not pass the functional bump test protocol do not use it. Additional testing should be done to diagnose the cause.

With the development of automated calibration and functional bump test systems, the process can be as easy as pushing a button. Many automated systems keep a permanent record of each test performed so that in the event of an accident investigation detailed proof of proper maintenance and testing can be easily produced. Records of manual calibration and functional bump testing must also be kept. Remember, if it isn't recorded, it wasn't done!

Personal safety gas detectors are designed to help workers stay safe in potentially life threatening environments. At a minimum, follow the gas detector manufacturer recommendations on calibration and functional bump testing. If you have questions contact the manufacturer. It is essential that any gas detection safety program includes a functional bump test policy.

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