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Edition 1

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**Guide for Combustible Gas
Detection as a Method of
Protection**

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Combustible Gas Detection as a Method of Protection

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Foreword

The primary reasons for development of this recommended practice is to support the existing allowance for combustible gas detectors as a method of protection as recognized within ANSI/NFPA 70, National Electrical Code (NEC), Articles 500 and 505. Combustible gas detectors as a method of protection have been applied for many years within the American Petroleum Institute (ref. API 14C, 500 and 505) and the Canadian Electrical Code C22.1 (CEC).

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Introduction

Flammable gas detection apparatus may be used whenever there is the possibility of a hazard to life or property caused by the accumulation of a flammable gas-air mixture. Such apparatus can provide a means of reducing the hazard by detecting the presence of the flammable gas and issuing suitable audible or visual warnings. Gas detectors may also be used to initiate specific precautions (for example plant shutdown, evacuation, and operation of fire extinguishing procedures).

Apparatus may be used to monitor a gas atmosphere below the lower flammable limit in circumstances where accumulation of gas may result in a concentration of the gas/air mixture to potentially explosive levels.

Performance requirements for gas detecting apparatus are set out in ANSI/ISA-12.13.01-2003 (IEC 61779-1 to 5 Mod).

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1 General

1.1 Scope

1.1.1 ISA-TR12.13.03 gives guidance on the use of combustible gas detection as a method of protection for equipment necessary to be placed within hazardous (classified) locations without adequate certification markings for the location. A prerequisite for applying this method of protection for equipment in hazardous (classified) locations is combustible gas detection equipment conformance to ANSI/ISA-12.13.01-2003 (IEC 61779-1 to 5 Mod). The recommended practice is a compilation of practical knowledge to assist the user, and applies to apparatus, instruments and systems that indicate the presence of a flammable or potentially explosive mixture of gas or vapor with air by using an electrical signal from a gas sensor to produce a meter reading, to activate an audible and visual pre-set alarm or other device, or any combination of these. This method of protection applies to normal use or operation. Maintenance requires deenergized equipment or localized monitoring for flammable gases.

NOTE — When in classified areas, the apparatus should be so installed and used that it is not capable of itself igniting a flammable gas-air mixture. It should therefore comply with the requirements of ANSI/NFPA 70, Articles 500-505.

For the purpose of this document flammable gases shall include flammable vapors.

1.1.2 This document applies only to group II (non-mining) apparatus intended for use in industrial and commercial safety applications, involving areas classified in accordance with ANSI/NFPA 70, Articles 500-505.

For the purpose of this document, apparatus includes

- a) fixed apparatus;
- b) portable apparatus;
- c) transportable apparatus.

1.1.3 This document is not intended to cover the following:

- a) open path gas detection apparatus;
- b) apparatus intended only for the detection of non-flammable toxic gases;
- c) apparatus of laboratory or scientific type intended only for analysis or measurement purposes;
- d) apparatus intended for mining applications;
- e) apparatus intended for applications in explosives processing and manufacture;
- f) apparatus intended only for process control applications;
- g) apparatus intended for the detection of a potentially flammable atmosphere resulting from dust or mist in air.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards. ANSI maintains registers of currently valid US National Standards.

ANSI/ISA-60079-0 (12.00.01)-2005: Electrical apparatus for Use in Class I, Zones 0, 1 & 2 Hazardous (Classified) Locations: General Requirements

ANSI/ISA-TR12.24.01-1998 (IEC 60079-10 Mod): Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2

IEC 60079-19:1993, Electrical apparatus for explosive gas atmospheres - Part 19: Repair and overhaul for apparatus used in explosive atmospheres (other than mines or explosives)

NFPA 497-1997, Recommended Practice for the Classification of Flammable Liquids, Gases, Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.

ANSI/ISA-12.13.01-2003 (IEC 61779-1 to 5 Mod): Electrical apparatus for the detection and measurement of flammable gases

ANSI/ISA-RP12.13.02-2003 (IEC 61779-6 Mod): Installation, Operation, and Maintenance of Combustible Gas Detection Instruments

2 Definitions

For the purpose of this document, the following definitions apply.

2.1 catalytic sensor:

sensor, the operation of which depends upon the oxidation of gases on an electrically heated catalytic element.

2.2 clean air:

air that is free of flammable gases and interfering or contaminating substances.

2.3 continuous duty apparatus:

apparatus that is powered for long periods of time, but may have continuous or intermittent sensing.

2.4 continuous sensing:

mode of operation in which power is applied continuously to the sensing element and readings are taken continuously.

2.5 diffusion apparatus:

apparatus in which the transfer of gas from the atmosphere to the gas sensing element takes place by random molecular movement, i.e., under conditions in which there is no aspirated flow.

2.6 explosion protected apparatus:

apparatus incorporating a type of protection listed in ANSI/ISA-60079-0.

2.7 explosive gas atmosphere:

mixture with air, under normal atmospheric conditions, of flammable material in the form of gas or vapor, in which, after ignition, combustion spreads throughout the unconsumed mixture.

NOTE 1 — This definition specifically excludes dusts and fibers in suspension air. Mists are not covered by this standard.

NOTE 2 — Although a mixture that has a concentration above the upper explosive limit (2.15) is not an explosive atmosphere, in certain cases for area classification purposes, it is advisable to consider it as an explosive gas atmosphere.

NOTE 3 — Normal atmospheric conditions include variations above and below reference levels of 101.3kPa and 20 C provided the variations have a negligible effect on the explosive properties of the flammable materials.

2.8 explosive range:

range of gas or vapor mixtures with air between the explosive (flammable) limits.

2.9 fixed apparatus:

apparatus which is intended to have all its parts permanently installed.

2.10 flashpoint:

lowest liquid temperature at which, under certain standardized conditions, a liquid gives off vapors in a quantity such as to be capable of forming an ignitable vapor/air mixture.

2.11 group II apparatus:

electrical apparatus for places with a potentially explosive atmosphere, other than mines susceptible to firedamp.

2.12 lower flammable limit (LFL):

volume ratio of flammable gas or vapor in air below which an explosive gas atmosphere does not form, expressed as a percentage (see Annex A).

NOTE This is also known as lower explosive limit (LEL).

2.13 portable apparatus:

spot reading or continuous duty apparatus that has been designed to be readily carried from place to place and to be used while it is being carried. Portable apparatus is battery operated and includes, but is not limited to.

- a) hand-held apparatus, typically less than 1 kg, suitable for single-handed operation;
- b) personal monitors, similar in size and mass to the hand-held apparatus, that are continuously operating (but not necessarily continuously sensing) while they are attached to the user; and
- c) larger apparatus ~~up to 5 kg~~ that can be operated by the user while it is suspended by hand, by a shoulder strap or by a carrying harness; it may or may not have a hand directed probe

2.14 source of release:

point or location from which a flammable gas, vapor or liquid may be released into the atmosphere such that an explosive gas atmosphere could be formed. [IEV 426-03-06, modified].

2.15 upper flammable limit (UFL):

volume ratio of flammable gas or vapor in air above which an explosive gas atmosphere does not form, expressed as a percentage (see Annex A).

NOTE This is also known as upper explosive limit (UEL).

2.16 ventilation:

movements of air and replacement with fresh air due to the effects of wind, temperature gradients or artificial means (for example fans or extractors).

2.17 failsafe:

circuitry of a system so designed such that the electrical failure of a component which is critical will result in de-energizing the equipment of which it is a part.

3 Live Equipment Maintenance

3.1 General

Portable gas detection equipment used for an equipment protection means must be suitably marked for use in the hazardous (classified) location. The gas detection equipment should be listed or labeled by a nationally recognized testing laboratory (NRTL) in accordance with ANSI/ISA-12.13.01-2003, Performance Requirements for Combustible Gas Detectors.

3.2 Gas Free Work Permit

The gas detection method of protection must be applied in accordance with the documented management work process (known as the gas free work permit). Electrical equipment that uses an acceptable method of protection that must be temporarily bypassed for maintenance or trouble-shooting may be operated in a hazardous location with a method of protection bypassed while the gas detection method of protection is being used. In addition, any portable electronic product not suitable for the hazardous (classified) location may be operated while the gas detection method of protection is being used. As a minimum, this should incorporate the following:

- a) A measurement to confirm the absence of an ignitable concentration of any flammable gas
- b) Sampling to confirm the continued absence of a flammable gas or vapor
- c) Contingency plans for emergencies

Annex A provides an example of a Gas Free Work Permit process that incorporates these requirements and restrictions. A similar concept may also be applied to areas with combustible dusts or ignitable fibers although extensive analysis is not required. Visual analysis is usually sufficient.

4 Fixed Installation

ANSI/NFPA 70, The National Electrical Code (NEC), includes provision for the use of gas detection as a method of protection of electrical equipment that requires installation in a hazardous (classified) location for which the equipment is not suitability listed or labeled.

Article 500.7

Electrical equipment suitable for unclassified locations can be permitted to be installed in a Class I, Division 2 or Class I, Zone 2 hazardous (classified) locations. Electrical equipment suitable for Class I, Division 2 or Class I, Zone 2 hazardous (classified) locations can be permitted to be installed in a Class I, Division 1 or Class I, Zone 1 hazardous (classified) locations. In both cases the location must be continuously monitored by a stationary type, non-open path, permanently mounted combustible gas detector that is listed or labeled to meet the requirements of ANSI/ISA-12.13.01-2003 (IEC 61779-1 to 5 Mod), *Performance Requirements for Combustible Gas Detectors*.

Article 505.?

Clauses 4.1 – 4.4 provide general recommended practices for applying gas detection as a method of protection of electrical equipment pertinent to NEC Articles 500.7 and 505.?.

4.1 General

For fixed installations the use of gas detection as a method of protection should be applied only when no other suitable option is available for equipment area classification.

A containment system should provide primary protection from small liquid leaks that cannot be detected by the safety devices on a process component. Primary protection from small gas leaks that occur in an inadequately ventilated area and cannot be detected by component sensing devices should be provided by a combustible gas detection system.

Ignition of a combustible gas requires that the concentration of the gas mixed with air (oxygen) reaches the lower explosive limit (LEL). The safety system is designed to minimize the amount of hydrocarbon released by shutting off the hydrocarbon source on detecting an abnormal condition. Another method for preventing a combustible mixture is to provide a volume of air sufficient to maintain the hydrocarbon concentration below the LEL. To prevent the accumulation of combustible mixtures, process areas should be as open as practicable to allow the free movement of air. Enclosed areas containing hydrocarbon handling or fueled equipment should have adequate ventilation so that the gases or vapors will dissipate before reaching the LEL. If adequate ventilation is not provided for enclosed areas, a combustible gas detector (ASH) should be installed to initiate a signal at a preset concentration below the LEL to shut off the hydrocarbon source.

4.2 Criteria for use

The criteria for use of combustible gas detection equipment as a method of protection is the following:

- a) The gas detectors are of a stationary type, permanently mounted; non-open path; portable gas detectors will not satisfy this requirement;
- b) The gas detection equipment is of a type approved or listed by a nationally recognized testing laboratory (NRTL). It is recommended that equipment meet ANSI/ISA-12.13.01, Performance Requirements for Combustible Gas Detectors;
- c) An adequate number of sensors is installed to ensure the sensing of flammable gas or vapor in the building (or similar area) in all areas where such gas might accumulate;
- d) Sensing a gas concentration of 20 percent LFL (or less) should activate a local alarm (audible or visual, or both, as most appropriate for the location);

Note: It may be desirable to initiate remedial action at this level to avoid reaching the 40 percent LFL level, which requires power disconnection as detailed in (e).

- e) Sensing a gas concentration of 40 percent LFL (maximum) or a gas detector system malfunction should both activate an alarm (audible or visual, or both, as most appropriate for the area) and initiate automatic disconnection of power from all electrical devices in the area that are not suitable for Division 2 (Zone 2). The power disconnecting device(s) should be suitable for Class I, Division 1 if located inside the building (or similar area); if the disconnecting device(s) is located outside the building (or similar area), it should be suitable for the area in which it is located. Redundant or duplicate components (such as sensors) may be installed to avoid disconnecting electrical power when single component malfunctions are indicated. When automatic shutdown could introduce additional or increased hazard, this technique of area classification reduction should not be used;

NOTE In the case of sensing 40 percent LFL or a gas detection system malfunction, corrective action to reduce the gas concentration should be initiated immediately.

- f) The gas detector calibration should be checked and adjusted as necessary in accordance with the manufacturer's recommendations, but at least once every three months. Calibration should be performed by actual exposure of the sensor to a known mixture (nominal 50 percent LFL recommended) of diluent and methane or other gas anticipated, in accordance with the manufacturer's recommendations;
- g) User-provided systems bypassing the disconnecting or other "corrective action" devices (but not audible or visual alarm devices) to allow calibration and maintenance are permitted, provided the bypass system is utilized only during calibration or maintenance operations, and only while the area is manned by personnel who are qualified to take corrective action should there be a malfunction in process, storage, transfer, or similar equipment that potentially might release flammable gas or vapor into the area. Any systems in the bypass mode must be made continuously obvious (audibly or visually) to facility personnel; and
- h) the building (or similar area) contains no electrically heated parts or components (not enclosed in explosionproof enclosures) that may operate at a temperature equal to or above 80 percent of the ignition temperature (expressed in degrees C) of the gas or vapor involved unless the component has been verified by a nationally recognized testing laboratory (NRTL) to operate below the ignition temperature of the gas or vapor.

NOTE : Electrically heated parts and components could remain at or above the ignition temperature for some time after de-energization.

4.3 Installation

For guidance on placement of gas detection sensors, reference ANSI/ISA-RP12.13.02, Clause 6.

The installation of combustible gas detection equipment can be a basis for the following:

- a) An inadequately ventilated area containing equipment that could release flammable gas or vapor can be designated as Division 2 (Zone 2).

NOTE If an area contains equipment that may release flammable gases or vapors within the area during normal operations, gas detectors are not a feasible alternative unless some degree of ventilation is provided since frequent alarms or equipment shutdowns, or both, are likely to occur.

- b) The interior of a building (or similar area) that does not contain a source of flammable gas or vapor can be considered unclassified, even though a door or similar pierced portion or all of the outside of the building is located in a Division 2 (Zone 2) area, provided the building is of a type construction that is essentially vaportight; that is, the building will not allow the entry of significant quantities of outside atmospheric pressure gas or vapor. Buildings made of fiberglass (molded fiberglass or fiberglass sprayed over wood) or seal welded steel plate normally are used to meet this criteria, but other construction methods may be equally satisfactory. Penetrations should be minimized—normally limited to a personnel entry door(s), electrical cable entries, air conditioning unit(s), and the like. The buildings should contain no windows that can be opened, and the personnel entry door(s) should be provided with adequate gaskets or weather stripping. Openings for air conditioning units and windows should be adequately caulked or otherwise made vaportight. Air conditioning equipment must not introduce outside air into the building. Entries for cables and other services should be made in a vaportight manner.

4.4 Maintenance Requirements

The gas detectors should be installed, operated, and maintained in accordance with ANSI/ISA-RP12.13.02-2003 (IEC 61779-6 Mod), *Installation Operation and Maintenance of Combustible Gas Detection Instruments*. The detector shall be calibrated according to the manufacturer's instructions at least annually for the gas or gases that are the basis for the classification.

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Annex A

{Need Gas Free Work Permit}

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