GENERAL STANDARD

FOR

GAS DETECTORS

ORIGINAL EDITION

MAY 1997

This standard specification is reviewed and updated by the relevant technical committee on Nov. 2002(1) and Dec. 2012(2). The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

Standards and Research department

No.17, Street14, North kheradmand

Karimkhan Avenue, Tehran, Iran .

Postal Code- 1585886851

Tel: 88810459-60 & 66153055

Fax: 88810462

Email: Standards@ nioc.ir

GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the “Company" where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

CONTENTS : PAGE No.

0. INTRODUCTION

This Standard gives details of construction, safety performance and testing requirements of portable and transportable gas detecting instruments. These instruments can be used for detection of:

- Combustible gases;
- toxic gases;
- oxygen deficiency and excess;

And are constructed to sense the presence of combustible, toxic and concentrations of gas or vapor reading in PPM (for toxic gases) and lower explosive limit (for explosive gases and vapors) and are in the following groups:

1) Monitoring System

Provides early warning of the incipient accumulation of combustible and/or toxic gases. Gas Monitoring Systems are multi channel gas detecting with remotely installed sensors which provide automatic alarm and control system. Monitoring Systems can also provide oxygen deficiency or excess detections.

2) Transportable and/or Portable

Monitoring of combustible or hazardous gases which can be used for leak seeking or continuous monitoring of areas which maintenance work such as hot works are in progress in gas free areas.

3) Chemical Sensing Detector Tubes.

For measurement of atmospheric contaminants.

Portable gas detecting instruments are also used to protect employees who are working in dangerous locations such as process units, storage vessels, sewer system and any plant handling oil, gas or chemicals.

Note:

Contaminants at concentration of occupational; exposure limit (OEL).

1. SCOPE

This Standard covers the minimum requirements for material and equipment of three types of portable or transportable gas detecting instrument for sensing the presence of combustible and common toxic gas and vapor concentration and does not cover gas detection instruments of the laboratory used for analysis of measurement or continuous gas monitoring fixed systems.

The Standard gives also guidance on the use, care and maintenance of:

1) Battery operated transportable or portable apparatus that indicate the presence of a combustible 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 a visual or audible preset alarms.

2) Portable combination gas (Hydrogen Sulphide or Hydrocarbon Oxygen deficiency or excess).

3) Toxic gas testing detector by chemical sensing tubes.

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Nov. 2002. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 188 on Nov. 2002. These modifications are included in the present issue of IPS.

Note 2:

This standard specification is reviewed and updated by the relevant technical committee on Dec. 2012. The approved modifications by T.C. were sent to IPS users as amendment No. 2 by circular No. 361 on Dec. 2012. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-GN-100	“Engineering Standard for Units”
IPS-E-SF-860	“Engineering Standard for Air Pollution Control”

BSI (BRITISH STANDARD INSTITUTION)

BS EN 60079-1	“Explosive Atmosphere-part 1: Equipment Protection by Flameproof Enclosures "d" “
BS EN 50019	“Electrical Apparatus for Potentially Explosive Atmosphere Increased Safety "e" ”
BS EN 60079-11	“Explosive Atmosphere – Part 11: Equipment Protection by Intrinsic Safety " i " “
BS EN 60079-0	“Explosive Atmosphere Part 0: Equipment–General Equipments”
BS EN 60079-7	“Explosive Atmospheres – Part 7: Equipment Protection by Increased Safety "e " “

BS EN 60079-29-1	“Explosive Atmospheres-Part 29-1: Gas Detectors – Performance Requirements of Detectors for Flammable Gases”
BS EN 1231	"Short Term Detector tube measurement"

3. DEFINITIONS AND TERMINOLOGY

For the purposes of this Standard the following definitions apply.

3.1 Alarm Set Point

The concentration of gas to which an alarm is set.

3.2 Ambient Air

The normal atmosphere surrounding the instrument.

3.3 Aspirated Instrument

Combustible gas detecting instrument which obtain the gas by drawing it to the gas sensor by means of a hand operated or electric pump.

3.4 Diffusion Instrument

An instrument in which the transfer of gas from the atmosphere to gas sensor take place by diffusion. There is no aspirated flow.

3.5 Explosion Protected Apparatus

Any form of apparatus with recognized type of protection.

3.6 Explosive Range

The range of gas or vapor mixture with air between the explosive (flammable) limits over which the gas mixture is explosive.

3.7 Lower Explosive Limit (LEL)

The concentration of combustible (flammable) gas, vapor or mist in air below which an explosive gas/atmosphere will not be formed.

3.8 Upper Explosive Limit (UEL)

The concentration of combustible (flammable) gas, vapor or mist in air above which an explosive gas/atmosphere will not be formed.

Note :

The lower and the upper explosive limits for number of chemicals are given in Table 1 (See Appendix).

3.9 Group I Instrument

Portable, transportable and fixed instrument for sensing the presence of combustible gas concentration with air. The instrument or part thereof may be used or installed in mines susceptible to fire damp.

3.10 Group II Instrument

Apparatus for use in potentially explosive atmosphere other than mines susceptible of fire damp.

3.11 Portable Apparatus

Apparatus that is designed to be readily carried by the user from place to place as required.

3.12 Transportable Apparatus

Apparatus that is not intended to be portable, but which can be readily moved from one place to another.

3.13 Fire Damp

A combustible gas formed in coal mines.

3.14 Spot Reading Apparatus

Apparatus that is intended to be used for short period of time as required.

3.15 Sensing Element

That part of a sensor that reacts in the presence of a flammable gas mixture to produce some physical change that can be used to activate a measuring or alarm function or both.

3.16 Catalytic Sensor

A sensor that the operation of which depends upon the oxidation of gases on an electrically heat catalytic element.

3.17 Thermal semi Conductivity Sensor

A sensor that the operation of which depends upon the condition of gases on an electrically heated catalytic element.

3.18 Thermal Conductivity Sensor

A sensor that the operation of which depends upon the changes of heat loss by conduction of an electrically heated element located in the gas to be measured compared with that of similar element located in a reference gas cell.

3.19 Infera-Red Sensor

A sensor that the operation of which depends upon the absorbtion of infera-red radiation by the gas being detected.

3.20 Multi Function

A detecting instrument which detects 0-100% LEL, 0-25 Oxygen, 0-25% ppm Hydrogen Sulphide and 0-50 ppm Carbon Monoxide.

3.21 Explosion Proofing

Any electrical equipment used in hazardous area including gas detection equipment must be tested and approved to ensure that even under fault condition it can not initiate an explosion.

3.22 Intrinsically Safe

Any electrical equipment which can be used in Zones "0", "1" or "2" being designed as such, that even if two faults develop, an explosion will not happen.

Note:

Type 1a can be used in Zones "0", "1" or "2" type 1b can be used in zones "1" or "2"only.

3.23 Fault Signal

An audible, visible or other indication that instrument is not working satisfactorily.

3.24 Sampling Probe

A separate sample line which is attached to the instrument as required. It is usually short (1 meter) and rigid but may be connected by a flexible tube to the instrument.

3.25 Open Path Infra-Red Sensor

A sensor that is capable of detecting gas at any location along an open path traversed by an infrared beam.

3.26 Semiconductor Sensor

A sensor, which the operation of which depends upon changes of electrical conductance of a semiconductor due to chemical absorption of the gas being detected at its surface.

3.27 Aspirated Apparatus

Apparatus in which the transfer of gas from the atmosphere to the gas-sensing element is by means of hand or powered pump.

3.28 Diffusion Apparatus

An apparatus in which the transfer of gas from the atmosphere to the gas sensing element takes place by diffusion, i.e., there is no aspirated flow.

3.29 Short Term Detector Tubes

Tubes and associating aspirating pumps used for evaluating atmospheric contaminants at concentration in the range (OEL) Occupational Exposure Limit. It covers color tubes which are designed to give indication of concentration over a short period of time.

4. UNITS

This Standard is based on International System of Units (SI), as per IPS-E-GN-100 except where otherwise specified.

5. GAS DETECTORS - MATERIALS

5.1 General

5.1.1 Gas detection instruments which are intended to detect gas or vapor present in the area shall be suitable for use in zone 1 hazardous locations. Gas detection instrument specially intended for

use in presence of corrosive vapors or gases which may produce corrosive by products as a result of a catalytic oxidation or other chemical process shall be constructed of materials known to be resistant to corrosion by such substances. All instruments shall be provided with means for facilitating regular accuracy checks.

5.1.2 Electrical assemblies and components shall comply with the construction and test requirement, in addition, all parts of combustible gas detection instrument shall employ material and construction suitable for continuous operation within an ambient temperature range or as specified in the following clauses:

a) Flameproof enclosures shall comply with the requirements of BS EN 60079-1 or BS EN 60079-0

b) Intrinsically safe and associated apparatus shall comply with the requirements of BS EN 60079-11.

c) Increased safety electrical apparatus shall comply with the requirements of BS EN 50019 or BS EN 60079 part 0 and 7.

5.1.3 The design of a combustible gas detection instrument shall be such that all material used in the construction and components including electrical and electronic parts shall be used within manufacturers rating, or the limits specified by them.

5.1.4 The instrument shall show, in a location on or adjacent to the meter or other indicator, the gas with which it has been caliberated.

5.1.5 Hand held spot reading (portable) instruments shall not exceed 1 kg in mass.

5.1.6 An indication shall be provided to show that the instrument is switched on.

5.1.7 If individual indicating lights are fitted they shall be colored as follows:

a) Alarm indicating the presence of gas in potentially dangerous concentrations shall be colored "RED".

b) Equipment fault indicator shall be colored "YELLOW".

c) Power supply indicator light shall be colored "GREEN".

In addition to the color requirements, the indicator lights shall be adequately labeled to show their function.

5.1.8 Alarm devices provided as part of portable gas detection instrument reading up to 100% LEL only shall be set to operate at a gas concentration not higher than 60% of the LEL.

5.1.9 Alarm levels for multi gas detector shall be set to 20% LEL 19% and 24% oxygen, 10 ppm Hydrogen Sulphide and 50 ppm Carbon Monoxide.

5.1.10 Fault signals in transportable gas detection instruments shall provide a fault signal in the event of failure of power to the instrument, short circuit in one or more of the wires or loss of continuity of any gas sensing system. This fault signal shall be distinguishable from any other alarm. Instruments powered with integral batteries shall be provided with an indication of low battery condition and the nature and purpose of this indication shall be clearly explained in the instruction manual.

5.2 Batteries

5.2.1 Portable continuous duty

Instruments with fresh or fully charged batteries shall be capable of continuous non alarm operation for a period of at least 10 hours without replacement of recharged batteries.

5.2.2 Portable spot reading instruments

Instruments with fresh or fully charged batteries shall be capable of operation at a duty cycle of 10 min. ON 10 min. OFF for a period of 8 hours (total accumulative "ON" time of 4 hours) without replacement or recharging batteries.

5.3 Carrying Case

Portable instrument shall be provided with a carrying case to protect it against severe shock and to store the detector probe when not in use.

5.4 Panel

The panel shall have the following controls:

a) Zero control.

b) Alarm set potentiometer, ON-OFF battery check range switch.

5.5 Selection

5.5.1 Transportable apparatus shall normally be selected for such purposes as monitoring work areas (hot work) and areas where flammable liquid, vapor or gas is present in process units.

5.5.2 Portable apparatus shall normally be selected for such purposes as leak checking, verification of gas free conditions, safety checks and similar applications.

5.5.3 Factors that are important in selecting portable or transportable apparatus include its size, mass, robustness, power supply requirement, the type of indication required and the visibility or audibility of alarm.

5.5.4 Portable and transportable gas detecting instruments are used for short periods of time in almost any environments, outdoors or indoors. They may be subject to contamination, dirt, wind, rain, dust and handling. Adequate robustness and weather proofness should be considered in the selection of the apparatus. Weather condition should be borne in mind to ensure if the apparatus is to be subject to rapid temperature changes and rapid air flow, particularly where accuracy is important. Gas detecting instruments shall be sealed to IP 65 to ensure that the Electronic Systems are safe from corrosion and dust particles and also protected from suffering accidental dropping onto hard surfaces.

5.6 Labeling and Instructions

5.6.1 Identification

Each instrument shall carry a label stating the manufacturer’s name, the instrument type identification and serial number together with the number of the appropriate part of official accepted standard.

The word "caution" shall be attached on label in capital letters at least 3 mm high and other wordings shall be in capital letters 2.5 mm high.

The label shall be visible, legible and permanently attached on each portable or transportable gas detection instrument.

The labeling required shall appear on a surface of the instrument and or carrying case and be exposed when instrument is in use.

5.6.2 Caliberation gas

Portable and transportable instrument shall carry a label indicating the gas with which the instrument has been calibrated by the manufacturer. This label may be on the meter, if provided or on the surface of the instrument (adjacent to the meter).

5.6.3 Instruction manual

Each gas detection instrument or group of instruments shall be provided with a suitable instruction manual. The instruction manual shall contain complete, clear, and accurate instructions for safe and

proper operation, installation and servicing of the instrument. It shall include the following informations.

a) Initial start up operation.

b) Operating instructions and adjustments.

c) Instructions for checking and/or calibration on a routine bases.

d) Detail of operational limitations including the following items where applicable:

- Range of gases for which the instrument is suitable.
- Ambient temperature limits.
- Humidity range.
- Battery life.
- Maximum and minimum storage temperature limits.
- Sample velocity limits.

e) Applications, information on the adverse effects of contaminating gases or substances and oxygen enriched or deficient atmosphere on the proper performance of the instrument. In the case of oxygen enriched atmosphere the safety of electrical components of the instrument.

f) For instruments of the aspirated type, wording to indicate the minimum and/or maximum flow rate or range of flow rates, pressure and tubing type and size of proper operation.

h) Clear statements of the nature and significance of all alarms and fault signals, the duration of such alarms and signals (if they are time-limited or self restoring) and any provision which may be made for silencing or resetting of such alarms and signals as applicable.

i) Detail of any method for determination of the possible sources of malfunctioning and any corrective procedures.

j) A statement that alarm devices, outputs or contacts are of the non-latching types, where applicable.

k) For portable continuous duty instruments of the aspirated type that are provided with an integral flow indicating device, detected instructions regarding one or more suitable techniques which the user may employ to ensure that sample lines are intact and a proper flow is established.

l) For battery operated instruments, installation and maintenance instructions for the batteries.

m) A recommended replacement part list.

n) The storage life and recommended storage conditions for replacement parts, which are critical.

o) Where the special nature of the instrument requires additional instructions and/or special information which are alternative to, or in addition to the requirements, the instructions/information shall be provided.

p) Detail of certification to the relevant accepted standard and any special condition of service.

5.7 Test Requirement

The manufacturer shall supply test certification for each instrument dispatched. The instruments excluding all optional or accessory parts shall be subjected to the entire test applicable to that type of instrument in accordance with BS EN 50059 or any other tests methods accepted by the Company.

6. GAS DETECTOR TUBES

6.1 General

This section specifies requirements for short term detector tubes and associated aspirating pumps

used at normal atmospheric pressure and temperature for evaluating atmospheric contaminants at concentration in the range of Occupational Exposure Limit (OEL) values. It covers length of stain tubes and color-match tubes which are designed to give an indication of concentration over a short period of time.

6.2 Performance Requirements

6.2.1 The accuracy of aspirating pump used with a given detector tube shall be certified by the manufacturer of the tube.

As supplied, the pump shall aspirate a volume of air within ±5% of the volume stated by the manufacturer. Means of indicating the completion of each aspiration shall be provided.

Note:

Aspirating pumps should be checked for leakage in accordance with the manufacturer's instructions before each use, and checked for accuracy at least every three months. A suitable method of pump calibration which may also be used for subsequent performance testing is given in Appendix A. Pumps should be maintained in accordance with the manufacturer's instructions and should not be used if their accuracy falls outside 10% of the nominal capacity.

6.2.2 Length-of-stain short term gas detector tubes

6.2.2.1 Graduation

Tubes shall either be graduated in volume or mass per unit volume of air or shall be accompanied by a calibration graph in the same units. The graduation of the tubes shall permit the measurement of concentrations of half the OEL and twice the OEL.

6.2.2.2 Length of end point of stain

The length of stain shall not be less than 15 mm after aspiration of the recommended volume of the gas mixture at the concentration of the OEL of the gas being detected.

The maximum variation of stain length around the circumference of the tube at the interface between the stained and unstained indicator layer shall not exceed 20% of the stain length when measured at its points of maximum length at concentrations of half the OEL and above of the gas being detected.

6.2.2.3 Boundary between indicator layer and packing

The boundary between the indicator layer and any inert packing or cleansing layers shall be such that the difference between the longest and shortest length of packing or cleansing layers around the circumference of the tube does not exceed 1 mm.

6.2.2.4 Direction of gas flow

Tubes shall be marked to indicate the direction of gas flow.

6.3 Color-Match Short Term Gas Detector Tubes

6.3.1 Accuracy

Tubes shall be calibrated against standard atmospheres see 6.2.2.1 in accordance with the

manufacturer's instructions. There shall be a distinct difference in color produced by concentrations 20% below and 20% above that of the OEL when operated according to the manufacturer's instructions.

The tubes shall meet these requirements at all temperatures between 5°C and 35°C.

Note:

Color-match tubes are generally less accurate than length-of-stain tubes because of the subjective nature of color comparison.

6.3.2 Assessment of results

Tubes shall be accompanied by a color chart, a table or a mathematical formula for evaluating the concentration in units of volume or mass per unit volume of air. Tubes shall permit the measurement of concentrations of half the OEL and twice the OEL.

6.4 Life of Tubes

Short term detector tubes shall be used for a period of not more than 2 years from the date of batch testing provided they are stored in accordance with the manufacturer's recommended storage temperatures.

6.5 Recommendations for Use

See Appendix B.

6.6 Instructions

6.6.1 Aspirating pumps

Manufacturer's instructions shall be supplied with each aspirating pump and shall include the following:

a) A warning stating that because pumps made by different manufacturers may not operate at the same rate even when they draw the same volume, they should not be used interchangeably;

b) instructions for testing for leakage before each use;

c) maintenance instructions.

6.6.2 Short-term detector tubes

Manufacturer's instructions shall be supplied with each box of detector tubes and shall include the following:

a) Directions stating that aspiration pumps shall be tested for leakage before each use;

b) information on the general reactions involved in the system and the levels at which other gases and vapors, including water vapor, are likely to interfere to the extent of reducing the accuracy below the level;

c) where the contents of tubes are hazardous, a warning to this effect together with disposal instructions;

d) where special requirements for lighting are needed to ensure reliable reading of color-match and length-ofstain tubes, details of such requirements;

e) for color-match tubes, instructions for evaluating the color change;

f) the time required for the completion of one aspiration and the limits on this time;

g) a statement about the limitations of re-use.

6.7 Marking

6.7.1 Boxes

Each box of short term detector tubes shall be marked with the following information:

a) the manufacturer's name, trademark or other means of identification;

b) the number and date of the Standard used;

c) the names of the gases or vapors for which the short term detector tubes may be used and the concentration ranges;

d) the manufacturer's batch numbers and date of batch testing;

e) the expiry date;

f) recommended storage temperatures.

6.7.2 Tubes

Each tube shall be marked with the following information:

a) The manufacturer's name, trademark or other means of identification;

b) an indication of the gases and vapors for which the tubes are intended to be used.

7. INSTRUCTION MANUAL

7.1 Each gas detection instrument shall be provided with an instruction manual containing complete, clear, and accurate instructions for safe and proper operation. It shall include the following information:

a) Operating instructions and adjustment.

b) Instructions for checking and/or calibration.

c) Detail of operational limitations including, where applicable the following:

1) Range of gases for which the instrument is suitable.

2) Ambient temperature limits.

3) Humidity range.

4) Battery life.

5) Maximum and minimum storage temperature limit.

6) Sample velocity limit.

d) Information on the adverse effects of contaminating gases and substances and oxygen enriched or deficient atmosphere on the proper performance of the instrument.

8. COMBUSTION GAS DATA SHEET

Design of form is included in Appendix C.

9. RANGE OF FLAMMABLE GAS AND VAPOR

See Table 1 in Appendices.

10. PRINCIPLE OF OPERATION, COMBUSTIBLE GAS DETECTORS

10.1 Catalytic Sensor

The principle of operation of the catalytic sensor depends upon the oxidation of flammable gas at the surface of an electrically heated catalytic element (i.e., filament or bead). This oxidation causes the temperature of the sensing element to change as a function of the concentration of gas so detected. The change of electrical resistance is determined in a bridge circuit and the apparatus is calibrated to provide indication of gas concentrations and alarms.

Since oxidation depends upon the presence of oxygen, detection apparatus using this type of sensor should only be used for gas/air concentrations up to the lower explosive limit.

By their very nature, catalytic sensors will positively detect the presence of any combustible gas mixture. The other types of sensors infer the presence of combustible gases by relating the response to the gas detected to the calibration of the detection apparatus.

The catalytic sensor is the most widely type of gas detector, used in either diffusion mode or in aspirating or sampling systems.

10.2 Thermal Conductivity Sensor

The principle of operation of the thermal conductivity sensor depends upon the heat loss by conduction of an electrically heated resistance element (i.e., filament or bead, located in a gas sample stream of fixed velocity).

The resulting change of electrical resistance is compared with that of a similar sensing element located in a reference cell,both electrical elements forming part of an electrical bridge or other measuring circuit, and the apparatus is calibrated in any suitable range up to 100% gas to provide indications of gas concentrations and alarms.

This type of sensor is best used for the detection of specified single gases of relatively high thermal conductivity with respect to air, e.g. hydrogen, methane, etc., at concentration above the LEL.

By their very nature, thermal conductivity detectors normally function within some form of sampling systems and not by diffusion.

10.3 Infra-Red Sensor

The principle of operation of the infra-red sensor depends upon the absorption of a beam of infra-red radiation by the gas being detected. Detection apparatus with infra-red sensors may take various forms but may be categorized as:

a) Specifically adapted analysers with sampling systems; or

b) Single point, self-contained infra-red detection apparatus suitable for installation in potentially explosive atmospheres; or

c) Open path detection apparatus, which protect an infra-red beam alone an open path through the area being monitored.

In cases (a) and (b), the absorption of infra-red radiation by the gas is detected by photoelectric means and produces an electrical signal to provide indication of gas concentration and alarms.

In case (c), the absorption of infra-red radiation by gas anywhere along the open path is detected by photoelectric means and also produces an electrical signal to provide alarms and indications of the concentration of gas integrated along the path.

Open path infra-red detection apparatus differs from the other types mentioned, in that it does not measure the concentration of gas at a particular point location, but rather measures the path integral of gas concentration along an investigative beam. It is therefore capable of detecting the presence of gas over a wider area than other types. However, it is inherently not capable of distinguishing between a high concentration of gas occupying a short section of the open path, and a low concentration of gas occupying a long section of the path.

As in the case of thermal conductivity sensors, infra-red sensors may be used for the detection of

specified combustible gas(es) in any specified range of concentrations up to 100% gas.

10.4 Semiconductor Sensor

The principle of operation of the semiconductor sensor depends upon changes of electrical conductance that occur by chemisorption when the heated semiconductor sensing element is exposed to gas. The changes of conduction are then determined in an appropriate electrical circuit and the apparatus is calibrated in any suitable range to provide indications of gas concentrations and alarms.

This type of sensor is normally only used for the detection of a specified gas in a nominated range of concentrations.

Semiconductor sensors may be used in either diffusion mode or in a sampling system.

10.5 Intended Application of Apparatus

10.5.1 Transportable apparatus

Transportable apparatus should normally be selected for such purposes as monitoring temporary work areas "hot work" and areas where combustible liquids, vapors or gases may be transferred.

10.5.2 Portable apparatus

Portable apparatus should normally be selected for such purposes as leak seeking, verification of gas-free conditions, safety checks and similar applications.

Portable apparatus is normally used in diffusion mode, but where leak seeking is involved or where the apparatus is used for the detection of gas in confined spaces beyond the normal reach of the user, either a static sample probe or a hand or mechanically aspirated sample probe will be necessary.

Where a portable apparatus is, from time to time, likely to be exposed to gas concentrations greater than the lower explosive limit, care should be taken to select apparatus suitable for that purpose.

10.5.3 Portability of the apparatus

Factors that are important in selecting portable or transportable apparatus include its size, mass, and robustness, its power supply requirements, the type of indication required, and the visibility or audibility of any alarms.

11. USE OF PORTABLE AND TRANSPORTABLE COMBUSTIBLE GAS DETECTION APPARATUS

11.1 General

The various types of portable and transportable gas detection apparatus may be used in a variety of ways according to their particular design and specification.

Small, hand-held apparatus may be used for leak seeking or spot checks, while larger portables, some with visual and/or audible alarms, may be used in multi-role mode so as to include leak seeking, spot checking, and local area monitoring function, according to the particular needs of the user.

Transportable apparatus is intended for use as temporary area monitors in locations where the operations involved are potentially hazardous and are of a temporary nature, e.g. during the loading or unloading of fuel or chemical tankers or where temporary ’hot work’ (in connection with maintenance activities) may be in progress in classified hazardous areas under the authority of a gas-free certificate.

Transportable apparatus is not intended to be hand carried for long periods of time, but is intended to be in place for hours, days or weeks.

While both portable and transportable types of apparatus are likely to be exposed to adverse climatic and handling conditions from time to time, transportable apparatus is more likely to be exposed to these conditions due to the nature of its use, whether indoors or outdoors, and particular attention should be paid to its protection from climatic or handling damage.

Anybody required to use portable or transportable gas detection apparatus should have been properly trained in its use and have ready access to the operating instructions.

11.2 Guidance on the Use of Portable and Transportable Apparatus

11.2.1 In areas being surveyed with portable apparatus where gases or vapors may form a layer rather than uniformly mixed, spot checks may be made at different levels using an extension probe.

11.2.2 When sampling vapor above a liquid, care should be taken to avoid the sample line or sensor from coming into contact with the liquid, since this may block the gas entry to the apparatus.

Note:

Only sample lines recommended by the manufacturer should be used.

11.2.3 When taking a portable apparatus from a cool environment to a warm environment, it is important that time is taken to allow the apparatus temperature to rise sufficiently to avoid vapor condensation which may otherwise interfere with its correct operation.

11.2.4 Combustible gas detection apparatus is not normally designed to detect the presence of combustible materials that are not in a volatile state under the conditions that measurements are made.

11.2.5 Combustible gas detection apparatus is not intended to be used to indicate the presence of either combustible dusts or fibers.

11.2.6 Many types of combustible gas detection apparatus are not sensitive to a specific gas. The presence of other gases than that for which the apparatus is calibrated may adversely influence its indications.

11.2.7 Erratic indications may indicate apparatus malfunction or some atmospheric disturbance. Where doubt exists a check should be made with a second apparatus of the same type and/or the apparatus should be checked under controlled conditions before its continued use.

11.2.8 The presence of very low concentrations of combustible gas can produce indications that may be mistaken for zero drifts. In the case of doubt, the apparatus should be removed to a clean air environment and rechecked.

11.2.9 Saturated steam may physically block the flame arrestors of certain types of gas sensor, so as to make them inoperative, and care should be exercised accordingly.

11.2.10 Where an apparatus is to be used to detect the presence of more than one gas it should be calibrated accordingly. The calibration may be with several gases or with the gas to which the apparatus is least sensitive. However, gas detection apparatus of this kind should not be regarded as being suitable for gas analysis.

11.2.11 Where off-scale indications occur (in either direction), this may indicate the presence of a potentially explosive atmosphere. It may then be necessary to flush the sensor with clean air and to cross-check for the presence of gas by taking the reading again or by using another type of gas detection apparatus. In any event, in such cases, the presence of a potentially explosive atmosphere should be assumed until proven otherwise.

11.2.12 Care should be taken to ensure that the materials from which the apparatus has been constructed are compatible with the gas or vapor to be detected.

For example, copper should not be contained in any apparatus likely to be used for the detection of

acetylene or its derivatives because of the possibility of the formation of potentially dangerous acetylides.

11.2.13 When using portable gas detection apparatus, it is necessary to be aware that some combustible gases and vapors are also toxic and may at least cause serious discomfort and at worst cause death.

11.2.14 Any portable or transportable gas detection apparatus that is used infrequently should be regularly inspected, maintained and calibrated, so that it may be available for immediate use when required.

11.2.15 If a portable or transportable gas detection apparatus is dropped or otherwise damaged, it should immediately be taken out of service for inspection, repair and recalibration as necessary, before reuse.

12. MAINTENANCE ROUTINE PROCEDURES AND GENERAL ADMINISTRATIVE CONTROL

12.1 General

Portable and transportable gas detecting apparatuses are units taken to sites where a mixture of gas/air atmospheres is expected to be present. Inadequate maintenance, incorrect zero adjustments, deteriorated batteries are all causes of gas detection errors. Errors and failures in apparatus may not be self-evident, therefore gas detectors should not be relied upon unless they are regularly and properly checked and maintained.

The accuracy of gas detection apparatus is particularly dependant upon the accuracy of the concentration of the test gas used for calibration. All types of gas detectors should be checked at regular intervals with the test gas recommended by the manufacturer.

When it is necessary to detect the presence of several gases mixed with air, the sensitivities to these gases should be checked periodically with appropriate test gases.

Any repair or maintenance should not invalidate the certification of the apparatus for use in potentially explosive atmospheres.

12.2 Repair

Portable and transportable gas detection apparatus shall be removed to a non-hazardous location for repair and testing under close supervision of a competent person.

12.3 Routine Test and Recalibration Procedures

All detection apparatuses, whether portable, or transportable, should be subjected to routine tests and recalibration procedures. These should be carried out in accordance with the instruction manual and using the recommended field test kit.

In general, gas detection apparatus should be:

a) Calibrated in accordance with the manufacturer's instructions, using the recommended test kit/equipment;

b) regularly inspected for possible malfunction, damage or other deterioration;

c) and if necessary recalibrated, immediately before each occasion of use.

12.4 Accuracy

When calibrated against atmospheres whose concentrations of appropriate gas or vapor in air have been standardized to within ±5% of the desired concentrations (standard atmosphere), tubes shall, when aspirated in accordance with the manufacturer's instructions at all temperatures between 5°C and 35°C, be accurate with a 95% confidence limit between:

+ 30% and - 20% at a concentration equal to the Occupational Exposure Limit OEL;

+ 50% and - 20% at a concentration of twice the OEL and half the OEL.

12.5 General Administrative Control

Portable and transportable apparatus should be marked with an indication of the calibration date and, according to the control system employed, the length of time to the next recalibration.

Apparatus awaiting recalibration or maintenance should be kept separately from apparatus awaiting return to service after such operations.

Spares may deteriorate in storage owing to mishandling or age and should always be tested before use.

13. COMBINATION EXPLOSIVE, TOXIC AND OXYGEN DEFICIENCY OR EXCESS DETECTORS (PORTABLE AND TRANSPORTABLE)

13.1 General

The gas detector unit can be used in the industrial environment from oil rigs to sewer system and designed for use in explosive or toxic atmosphere and powered from rechargeable Nickel cadmium batteries.

The unit can be used for leak seeking or for long period of time for static site monitoring, provided that the batteries are charged. The instrument can be safely used for 10 to 12 hours by fully charged batteries.

13.2 Design

13.2.1 The gas detector is designed to provide early warning of potentially hazardous leakage within the measuring ranges and within the alarm setting of the following table:

SENSOR TYPE	MEASURING RANGE	SENSOR LIFE (Mths)	ALARM SETTING
Oxygen	0-25	12	19-23
Flam. (% LEL)	0-100	24	20
H_2S (ppm)	0-25	24	10

13.2.2 Sensors

a) The sensor for flammable gases is usually of pellistor type calibrated for methane, pentane or other saturated Hydrocarbons.

b) Toxic Gas sensor for Hydrogen Sulphide is of electrochemical.

c) Detection of oxygen deficiency or excess is of oxygen sensor.

13.2.3 Alarms

13.2.3.1 The instrument shall be provided with control knob in the "TEST" mode to test that the battery is charged and three alarm lamps and siren are operative. The alarm levels selected for gas monitoring indicated as ready check.

13.2.3.2 To indicate normal operation, a green indicator light to pulse every 10 second followed by an audible click should be provided.

13.2.3.3 If the gas is escaped, the instrument should react regardless of control knob. The alarm latches can not be reset until the gas concentration drops back to the safe level.

13.2.3.4 A steady continuous note to sound warning when the battery needs recharging.

13.3 Safety Features

13.3.1 The instrument is made intrinsically safe and certified to be used in maximum safety in all potentially hazardous area of zones 0, 1 or 2.

The detector, in addition to its function as to monitor in open area should also test the air in confined area by using manual aspirator to suck the air into the unit for testing and checking where the gas may become trapped. The length of aspirator hose should be 2 meters.

13.3.2 Calibration adjustment for course and fine level. The preset control should be covered and locked and temper resistance to reduce the risk of accidental adjustment.

13.3.3 Case

The case should be built to work in tough environment and shall be of sealed stainless steel. Tailor made case is not proof with neck and waist straps and for maximum convenience should allow operator to work in comfort whilst using the unit.

13.4 Calibration

Regular functional checking of the instrument should be undertaken using gas test in accordance with the manufacturer's instruction manual.

13.5 Operation and Maintenance

Gas detectors should be supplied with operation and maintenance instructions which shall be followed. Repair and maintenance shall be carried out by a fully qualified engineer. Maintenance and general administrative control shall be in accordance with Clause 12.

14. CHEMICAL SENSING DETECTORS AND TUBES

14.1 General

This section specifies operating instructions of short-term and long-term detector tubes and associated aspiratory pumps used at normal atmosphere for evaluating atmospheric contaminants at concentration of occupational exposure-limit (OEL). It also covers color-match tubes which are designed to give an indication of concentration over a short period of time.

14.2 Detector Tubes

14.2.1 Applications

Detector tubes with direct reading colorimetric indication have many applications. Approximately 350 different substances can be measured with detector tubes.

Tubes are usually capable of only being used once; repeated measurement of the same substance can be performed with electrochemical sensor, which is more practical and economical.

When complex mixtures are present, only a laboratory analysis will suffice. Contaminant air is trapped in a sorbent sampling tube like silica gel or activated charcoal and analysis is performed in the laboratory. Since many of occupational exposure limits are in the range of 1 ppm measurement, the flexibility of detector tube method lends itself well to the diverse measurement applications encountered in the work place.

Before each measurement, an assessment of the situation should be made as to what contaminants are in question, at what location, at what time, then action is taken according to established safety requirements.

14.2.2 Classification

Detector tubes have different applications and are classified as follows:

a) Air investigation at work place, measurement in the range of the (OEL) occupational exposure limits;

b) technical gas analysis-detector tube measurement in the area of emission concentration;

c) compressed air for breathing apparatus.

Specially calibrated detector tubes should be used to determine the quality of compressed breathing air. The typical contaminants are CO, CO_2 water and oil.

14.2.3 Short-term detector tube

Short-term detector tubes are designed for on-the-spot measurement at a particular location over a relatively short time period from 10 seconds to 15 minutes or so, depending on the particular detector tube and sampling pump. Some applications for short-term tubes are the evaluation of concentration fluctuation in the workplace, the measurement of contaminants in the workers breathing zone, the investigation of confined spaces (e.g., Chemical, Hydrocarbon tanks, Sewers) prior to entry and additionally to check for gas leaks in process areas.

14.2.4 Detector pump

Detector pumps and short-term tubes are usually designed and calibrated as a unit and the use of other short-term detector tubes is not recommended. The difference in the flow characteristics of the pump and tube can result in considerable measurement errors.

14.2.5 Long-term tubes

Long-term tubes provide integrated measurement that presents the average concentration during the sampling time. The long-term tubes are used for measurements between one-and-eight hours. Long-term tubes can be used as personal monitors or area monitors to determine the time weighted average concentration. A constant flow pump is used for longterm tubes.

In addition to the long-term tubes, there are also direct reading diffusion tubes and badges for measurement.

14.3 Measurement

14.3.1 An assessment of the measurement for choosing the best detector tubes needs the following considerations:

a) The ambient condition;

b) limits of use.

14.3.2 Although the detector tube is an easily operated gas measurement method, it belongs to the hand of specialists or trained employees.

14.3.3 Manufacturers operating instructions in regards to the method of applications and IPS-E-SF-860 for air pollution control shall be followed.

Notes:

1) Threshold Limit Value, Time Weight Average (TLV-TWA)

The time-weighted average concentration for a normal 8 hour workday and 40 hour work week to which nearly all workers may be repeatedly exposed day after day, without adverse effect.

2) Threshold limit value, Short Term Exposure Limit (STEL)

The concentration to which workers can be exposed continuously for a short period of time without suffering from:

a) irritation;

b) chronic or irreversible tissue damage or;

c) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self rescue or materially reduce work efficiency should be considered.

3) Threshold limit value, Ceiling (C)

The concentration that should not be exceeded during any part of the working exposure. In conventional industrial hygiene practice, if instantaneous monitoring is not feasible, then the TLV-C can be assessed by sampling over 15 minutes period except for those substances that may cause immediate irritation when exposure is short.

14.4 Detector Tube Measurement System

14.4.1 Detector tube is a vial which contains a chemical component that reacts with the measured substance by changing color.

The normal shelf life of detector tube is 2 years and the tube tips are fused on both ends.

14.4.2 The system consists of a detector tube and a gas detector pump. The pump precisely matches the reaction of the reagent system in the tube. Therefore the gas detector pump delivering the correct volume must be used.

Short-term and long term measurement is distinguished between two different types of pumps namely, the short-term and the long-term pumps.

14.4.3 The detector tube pumps are four types:

1) Hand operated bellows pumps for leak detection.

2) Battery operated-after choosing the number of strokes necessary for measurement and pressing the stroke and stop button, the pump is automatically actuated. The pump must be Ex approved for the dangerous areas.

3) Microprocessor controlled automatic gas detector pump which can be programmed with number of strokes and features displays indicating the number of preselected and the actual number of strokes. This type also shall be Ex approved for the dangerous areas.

4) Long-term pump. The pump is constant flow type which droves a preset flow rate and the battery capacity ensures continuous operation for more than 8 hours. The pump shall be ex approved for the dangerous areas as specified.

14.5 Maintenance of Gas Detector Pumps

To ensure precise results, it is particularly important to confirm that the pump is operating properly. Short-term pumps shall be checked before each measurement for leaks and suction capacity according to manufacturers operating instructions. In addition, after a measurement, short-term pumps should be flushed with clean air by performing several strokes without a detector tube in the pump. This purges the pump of reaction products which enters the bellows due to reaction in the tube. The long-term pumps should be checked for flow volume according to the operating instructions.

14.6 Tubes for Short-Term Measurement

The design of the short-term tubes depends on the measurement task, particularly on the substances to be measured.

There are several types of short-term tubes:

- tubes with an indication layer;

- tubes with one or more prelayers plus an indication layer;
- combination of two tubes;
- tubes with connecting tube;
- tubes with a built-in reagent ampoule;
- tubes for simultaneous measurement.

14.7 Evaluation of Tubes

14.7.1 The evaluation of the indication on the detector tube is another important factor to be considered. The following are guidelines for interpreting the indication;

a) Continuously observe the tube during measurement;

b) evaluate the indication immediately following the measurement according to the instruction of use;

c) use sufficient lighting;

d) use a light colored back-ground;

e) compare with an unused tube.

14.7.2 Observing of tube during the measurement is particularly important to make sure that a complete discoloration of the tube has not happened without being realized. This complete discoloration can sometimes occur abruptly with high concentrations even during the course of first stroke.

A sufficient lighting source is necessary. Direct sun light shall be avoided-U.V. radiation of sun may cause a change in discoloration.

14.7.3 The reading of the tube shall be done immediately following the measurement and keeping the used tube as proof is not useful.

14.8 Expiration Date, Storage and Disposal

Detector tube contains reagent system designed to undergo a chemical reaction with the particular substance. Since chemicals and chemical reagents are not stable indefinitely, each box of detector tubes is stamped with an expiration date. Tubes used beyond the expiration date cannot be relied upon to give accurate result.

Tubes should be stored in the original package at room temperature of 25°C. Avoide excessive low (less than 2°C) or higher than 25°C and do not subject the tubes to light for prolong period.

Do not dispose the tubes in domestic waste.

APPENDICES

APPENDIX A

METHOD OF CALIBRATION FOR ASPIRATING PUMPS (SEE CLAUSE 6.2.1)

A.1 Principle

The aspirated volume when the aspirating pump is operated is measured against the calibrations of a hypodermic syringe.

A.2 Apparatus

A.2.1 100 mL graduated hypodermic syringe, additionally graduated at 110 mL, with a Luer fitting, sufficiently accurate to assess compliance with the requirements of BS EN 1231.

Note:

100 mL hypodermic syringes generally have sufficient barrel length to enable an extra graduation at 10 mL to be added. Normal hypodermic syringes are preferable to gas tight ones, since the formers are, in fact, sufficiently gas tight for the purpose of the test and their plungers have a much lower resistance to movement.

A.3 Procedure

Withdraw the plunger of the hypodermic syringe to the 110 mL graduation. Attach the aspirating pump to a freshly opened detector tube, and attach the tube to the hypodermic syringe, clamped in the horizontal position.

Operate the aspirating pump in accordance with the manufacturer’s instructions.

Read off the aspirated volume from the hypodermic syringe.

APPENDIX B

RECOMMENDATIONS FOR THE USE OF SHORT-TERM GAS DETECTOR TUBES

(SEE CLAUSE 6.5)

B.1 This Standard should be read in conjunction with the accepted international "Occupational Exposure Limits".

Particular attention is drawn to the definitions of Control Limits and Recommended Limits in the publication and to the fact that for many substances two limits are set, one relating to an 8 h time weighted exposure and the other relating to a 10 min. short term exposure period.

B.2 Gas detector tubes may be used for a number of purposes. When short term detector tubes are used to assess exposure against an OEL it is important to ensure that sufficient information is available on exposure throughout the relevant period for a valid time weighted average to be estimated. This may require sequential testing throughout the exposure period. OELs relate to personal exposure and tests should be carried out in the breathing zone, taken to be within 300 mm of the mouth or nose.

APPENDIX C

COMBUSTION GAS DATA SHEET

1	1	Type		**TO BE COMPLETED BY THE PURCHASER**
	2	Operating temperature		
	3	Relative humidity		
	4	Intended application		
	5	Aspirator		
2	6	Battery life	h	**TO BE COMPLETED BY THE MANUFACTURER**
	7	Battery charger rate	Slow h Fast h	
	8	Alarm level		
	9	Measuring range		
	10	Response time		
	11	Weight		
	12	Mode		
	13	Dimension		
	14	Visual alarm		
	15	Audible alarm		
	16	Meter		
	17	Expected sensor life		
	18	Case		
	19	Carrying case		
3	20	Safety certificate		
	21	Approved code		
	22	Standard used		
	23	Gas groups		

APPENDIX D

TABLE 1 - RANGE OF FLAMMABLE GASES AND VAPORS

GASES	EXPLOSIVE LIMITS (% BY VOLUME IN AIR)	
	LEL	UEL
Acetone	2.6	12.8
Acetylene	2.5	80.0
Ammonia	16.0	25.0
Benzene	1.4	8.0
Butane	1.6	6.5
Carbon disulphide	1.3	50.0
Carbon monoxide	12.5	74.2
Ethyl acetate	2.2	11.5
Ethyl alcohol	3.3	19.0
Ethylene	3.0	34.0
Ethyl ether	1.85	36.5
Ethyl nitrate	4.0	50.0
Hexane	1.2	6.9
Hydrogen	4.1	74.1
Methane	5.3	14.0
Methyl alcohol	6.0	36.5
Octane	1.0	3.2
Pentane	1.5	7.8
Gasoline	1.3	6.0
Propane	2.3	7.3
Toluene	1.27	7.0
Town gas	5.3	32.0
O - Xylene	1.1	7.0

Notes:

1) LEL = Lower Explosive Limits

2) UEL = Upper Explosive Limits

3) Source:

a) IPS-E-SF-100

b) Dangerous Properties (IRVING SAX)