Contents

1 Scope 15

2 ~~Normative r~~References 16

3 Terms and definitions 16

4 Basic information on the properties, behaviour, and detection of gases and vapours 22

4.1 Detecting gases and vapours – General 23

4.1.1 Safety when monitoring for flammable gases where personnel could be present 23

4.2 Some common properties of gases and vapours 24

4.3 The differences between detecting gases and vapours 25

4.3.1 Detection of gases 25

4.3.2 Detection of vapours 26

4.4 Oxygen deficiency 29

4.4.1 Chemical reaction of oxygen, with solid products 30

4.4.2 Chemical reaction of oxygen, with gaseous products 30

4.4.3 Dilution of the air by displacement by some other gas or vapour 30

5 Measuring principles 31

5.1 Catalytic sensors 33

5.1.1 Common applications 33

5.1.2 Limitations 33

5.1.3 Interferences 34

5.1.4 Poisoning 34

5.2 Thermal conductivity sensors 34

5.2.1 Common applications 35

5.2.2 Limitations 35

5.2.3 Interferences 36

5.2.4 Poisoning 36

5.3 Infrared sensors 36

5.3.1 Common applications 36

5.3.2 Limitations 36

5.3.3 Interferences 37

5.3.4 Poisoning 37

5.4 Semiconductor sensors 37

5.4.1 Common applications 37

5.4.2 Limitations 37

5.4.3 Interferences 38

5.4.4 Poisoning 38

5.5 Electrochemical sensors 38

5.5.1 Common applications 38

5.5.2 Limitations 39

5.5.3 Interferences 39

5.5.4 Poisoning 39

5.6 Flame ionization detectors (FID) ... 40
5.6.1 Common applications ... 40
5.6.2 Limitations ... 40
5.6.3 Interferences ... 40
5.6.4 Poisoning ... 41
5.7 Flame temperature analysers (FTA) ... 41
5.7.1 Common applications ... 41
5.7.2 Limitations ... 41
5.7.3 Interferences ... 41
5.7.4 Poisoning ... 41
5.8 Photo ionisation detector (PID) ... 41
5.8.1 Common applications ... 41
5.8.2 Limitations ... 42
5.8.3 Interferences ... 42
5.8.4 Poisoning ... 42
5.9 Paramagnetic oxygen detector ... 42
5.9.1 Common applications ... 42
5.9.2 Limitations ... 43
5.9.3 Interference ... 43
5.9.4 Poisoning ... 43
6 Selection of apparatus ... 43
6.1 General ... 43
6.2 Selection criteria ... 44
6.2.1 General criteria ... 44
6.2.2 Gases to be detected by the apparatus ... 45
6.2.3 Intended application of the apparatus ... 46
6.2.4 Transportable apparatus ... 47
6.3 Miscellaneous factors affecting selection of apparatus ... 48
6.3.1 Electromagnetic immunity ... 48
6.3.2 Intended location(s) ~~zone(s)~~ of use ... 48
7 Behaviour of gas releases ... 48
7.1 Nature of a release ... 48
7.1.1 General ... 48
7.1.2 Release rate of gas or vapour ... 48
7.1.3 Flammable limits ... 49
7.1.4 Ventilation ... 49
7.1.5 Relative density of the released gas or vapour ... 50
7.1.6 Temperature and/or pressure ... 50
7.1.7 Other parameters to be considered ... 50
7.1.8 Outdoor sites and open structures ... 50
7.2 Buildings and enclosures ... 51
7.2.1 General ... 51
7.3 Unventilated buildings and enclosures ... 51
7.4 Ventilated buildings and enclosures ... 51

7.5 Natural ventilation ... 51
7.5.1 Mechanical ventilation ... 52
7.5.2 Environmental considerations ... 52
8 Design and installation of fixed gas detection systems ... 52
8.1 Basic considerations for the installation of fixed systems ... 53
8.2 Location of detection points ... 54
8.2.1 General site considerations ... 54
8.2.2 Environmental conditions ... 55
8.3 Access for calibration and maintenance ... 57
8.4 Additional considerations for sample lines ... 57
8.5 Summary of considerations for the location of sensors or sampling points ... 57
8.6 Installation of sensors ... 58
8.7 Integrity and safety of fixed systems ... 59
8.7.1 General ... 59
8.7.2 Redundancy in fixed systems ... 59
8.7.3 Protection against loss of main power supply ... 59
8.8 Timing of installation during construction operations ... 60
8.9 Commissioning ... 60
8.9.1 Inspection ... 60
8.9.2 Initial gas calibration ... 60
8.9.3 Adjustment of alarm set points ... 61
8.10 Operating instructions, plans and records ... 61
9 Use of portable and transportable flammable gas detection apparatus ... 62
9.1 General ... 62
9.2 Initial and periodic check procedures for portable and transportable instrumentation ... 63
9.2.1 Inspection and field-check (response check) ... 63
9.2.2 Routine checks and recalibration ... 64
9.2.3 Maintenance and recalibration ... 65
9.3 Guidance on the use of portable and transportable apparatus ... 65
9.3.1 Electrical safety in hazardous atmospheres ... 65
9.3.2 Safety of personnel ... 65
9.3.3 Spot tests and sampling ... 66
9.3.4 Sampling above liquids ... 66
9.3.5 Avoidance of condensation ... 66
9.3.6 Poisoning of sensors ... 66
9.3.7 Changes of temperature ... 67
9.3.8 Accidental damage ... 67
9.3.9 Minimalist operation, the “Read and run” concept ... 67
10 Training of operational personnel ... 67
10.1 General ... 67
10.2 General training – Basic limitations and safety ... 68
10.3 Operator training ... 68
10.4 Maintenance training ... 69

11 Maintenance, routine procedures and general administrative control 69
11.1 General 69
11.2 Operational checks 71
11.2.1 Fixed systems 71
11.2.2 Portable and transportable gas detection apparatus 71
11.3 Maintenance 72
11.3.1 General 72
11.3.2 Fixed apparatus 72
11.3.3 Portable and transportable gas detection apparatus 72
11.3.4 Off-site maintenance, general 72
11.3.5 Maintenance procedures 73
11.4 Sensors 73
11.4.1 General 73
11.4.2 Flame arrestor 73
11.5 Flow systems 73
11.5.1 General 73
11.5.2 Filters, traps and flame arrestors 74
11.5.3 Flow system and sample chamber 74
11.5.4 Flow connections 74
11.5.5 Moving parts 74
11.5.6 Automatic sample-draw systems 74
11.5.7 Loss-of-flow ~~Trouble~~ signals 74
11.6 Readout devices 74
11.6.1 General 74
11.6.2 Other readouts 74
11.7 Alarms 74
11.8 Workshop calibration test and equipment 75
11.8.1 Calibration kits and test equipment 75
11.8.2 Conduct of workshop calibration testing 76
Annex A (informative ~~normative~~) Measuring principles 77
A.1 Catalytic sensors 78
A.1.1 Common applications 79
A.1.2 Limitations 79
A.1.3 Interferences 79
A.1.4 Poisoning 80
A.2 Thermal conductivity sensors 81
A.2.1 Common applications 81
A.2.2 Limitations 82
A.2.3 Interferences 82
A.2.4 Poisoning 82
A.3 Infrared sensors 82
A.3.1 Common applications 84
A.3.2 Limitations 84
A.3.3 Interferences 85

A.3.4 Poisoning 85
A.4 Semi-conductor sensors 85
A.4.1 Common applications 85
A.4.2 Limitations 86
A.4.3 Interferences 86
A.4.4 Poisoning 86
A.5 Electrochemical sensors 86
A.5.1 Common applications 87
A.5.2 Limitations 87
A.5.3 Interferences 88
A.5.4 Poisoning 88
A.6 Flame ionization detectors (FID) 89
A.6.1 Common applications 90
A.6.2 Limitations 90
A.6.3 Interferences 90
A.6.4 Poisoning 90
A.7 Flame temperature analysers (FTA) 90
A.7.1 Common applications 91
A.7.2 Limitations 91
A.7.3 Interferences 91
A.7.4 Poisoning 91
A.8 Photo ionisation detector (PID) 91
A.8.1 Common applications 92
A.8.2 Limitations 92
A.8.3 Interferences 93
A.8.4 Poisoning 93
A.9 Paramagnetic oxygen detector 93
A.9.1 Common applications 94
A.9.2 Limitations 94
A.9.3 Interference 94
A.9.4 Poisoning 94
Annex B (informative) Environmental parameters 95
Annex C (informative) Typical environmental and application check-list for flammable gas detectors 97
Annex D (informative) Typical instrument maintenance record for flammable gas detectors 99