



BSI Standards Publication

**Explosive and toxic atmospheres —
Hazard detection mapping — Guidance
on the placement of permanently
installed flame and gas detection
devices using software tools and
other techniques**

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2020

Published by BSI Standards Limited 2020

ISBN 978 0 59 02329 9

ICS 9.26.20

The following BSI references relate to the work on this document:

Committee reference EXL/31/1

Draft for comment 20/30383140 DC

Amendments/corrigenda issued since publication

| Date | Text affected |
|------|---------------|
|------|---------------|

Contents

| | Page |
|---|-----------|
| Foreword | iv |
| 0 Introduction | 1 |
| 0.1 General | 1 |
| 0.2 Document structure | 1 |
| <i>Figure 1 — Document structure</i> | 2 |
| 1 Scope | 2 |
| 2 Normative references | 3 |
| 3 Terms and definitions | 3 |
| 4 Hazard identification and risk assessment | 5 |
| <i>Figure 2 — Risk assessment process</i> | 6 |
| 5 Fire and gas (F&G) philosophy | 7 |
| 5.1 General | 7 |
| 5.2 Detector location – practical considerations | 8 |
| 5.3 Brownfield versus greenfield considerations | 8 |
| 6 Detection technology | 9 |
| 6.1 General | 9 |
| 6.2 Flame detection | 9 |
| <i>Figure 3 — Typical point of view (POV) alongside external view of the same envelope</i> | 10 |
| <i>Figure 4 — Example of a flame detector field of view</i> | 10 |
| 6.3 Heat detection | 12 |
| 6.4 Flammable gas detection | 12 |
| 6.5 Toxic gas detection | 13 |
| 6.6 Ultrasonic (acoustic) gas leak detectors | 14 |
| 7 F&G mapping techniques | 14 |
| 7.1 General | 14 |
| 7.2 Flame properties | 14 |
| 7.3 Flame detection | 16 |
| <i>Figure 5 — Example of a single flame detector map shown in 3D and 2D views</i> | 16 |
| <i>Figure 6 — Chessboard analogy and percentage coverage</i> | 20 |
| 7.4 Fluid states and dispersion | 21 |
| <i>Figure 7 — Jet entrainment</i> | 23 |
| 7.5 Flammable gas detection | 24 |
| <i>Figure 8 — Example detection output</i> | 31 |
| <i>Figure 9 — Detector contributions analysis</i> | 32 |
| <i>Figure 10 — Relationship between scenarios considered and percentage of scenarios detected</i> | 33 |
| 7.6 Toxic gas detection | 36 |
| <i>Figure 11 — Response time with a steady release of toxic gas</i> | 38 |
| <i>Table 1 — Factors in risk and mitigation</i> | 39 |
| 8 Detailed engineering | 47 |
| 8.1 General | 47 |
| 8.2 Schedule constraints | 47 |
| 8.3 Management of change | 48 |
| <i>Figure 12 — Example of ventilation analysis</i> | 49 |
| 8.4 Human factors and ergonomics | 49 |
| 9 Installation and commissioning (verification) | 49 |
| 9.1 Planning | 49 |
| 9.2 Execution | 50 |
| 10 System validation | 51 |

| | | |
|----------------|---|-----------|
| 10.1 | Planning | 51 |
| 10.2 | System validation test | 51 |
| 11 | Operation, maintenance and modification | 52 |
| 11.1 | Evergreening | 52 |
| 11.2 | Planning | 52 |
| 11.3 | F&G detection system – execution | 53 |
| 11.4 | Maintenance | 53 |
| 11.5 | Modification (management of change) | 54 |
| 12 | Competence | 54 |
| Annex A | (informative) Oxygen enrichment and deficiency | 56 |
| Annex B | (informative) Flame detection – Example of volumetric-based mapping | 58 |
| | <i>Table B.1 — Flame detection performance targets</i> | 58 |
| | <i>Figure B.1 — Volume to be mapped</i> | 58 |
| | <i>Figure B.2 — Grademap volume</i> | 59 |
| | <i>Figure B.3 — Risk grade map</i> | 59 |
| | <i>Figure B.4 — Existing devices coverage map</i> | 60 |
| | <i>Figure B.5 — Existing flame detectors (coverage 1 of 2)</i> | 60 |
| | <i>Figure B.6 — Existing flame detectors (coverage 2 of 2)</i> | 61 |
| | <i>Figure B.7 — Proposed additional flame detector</i> | 61 |
| | <i>Figure B.8 — Updated assessment coverage map (1 of 2)</i> | 62 |
| | <i>Figure B.9 — Updated assessment coverage map (2 of 2)</i> | 62 |
| | <i>Figure B.10 — Example of basic 2D representation of one detector</i> | 63 |
| | <i>Figure B.11 — Example of 2D plane of one detector through a 3D model</i> | 64 |
| | <i>Figure B.12 — Example of basic 2D representation of two detectors</i> | 65 |
| | <i>Figure B.13 — Example of two detectors through a 3D model</i> | 66 |
| | <i>Figure B.14 — Example of basic 2D representation of three detectors</i> | 67 |
| | <i>Figure B.15 — Example of 2D plane of three detectors through a 3D model</i> | 68 |
| Annex C | (informative) Flammable gas detection – Volumetric-based mapping | 69 |
| | <i>Table C.1 — Estimated blockage ratio</i> | 69 |
| | <i>Table C.2 — Flammable gas detection performance targets</i> | 69 |
| | <i>Figure C.1 — Volume to be mapped</i> | 70 |
| | <i>Figure C.2 — Grademap volume</i> | 70 |
| | <i>Figure C.3 — Risk grade map</i> | 70 |
| | <i>Figure C.4 — Existing gas detectors</i> | 71 |
| | <i>Figure C.5 — Existing devices coverage map (1 of 2)</i> | 71 |
| | <i>Figure C.6 — Existing devices coverage map (2 of 2)</i> | 72 |
| | <i>Figure C.7 — Updated detection layout</i> | 72 |
| | <i>Figure C.8 — Updated assessment coverage map (1 of 2)</i> | 73 |
| | <i>Figure C.9 — Updated assessment coverage map (2 of 2)</i> | 73 |
| | <i>Figure C.10 — Example of OPGD placement in a 3D model</i> | 74 |
| Annex D | (informative) Risk and mitigation identification | 75 |
| | <i>Table D.1 — Example of facility information</i> | 75 |
| | <i>Table D.2 — Example performance targets</i> | 78 |
| | <i>Figure D.1 — Example of facility requirements grade map</i> | 79 |
| Annex E | (informative) Graphic symbols for fire and gas detection location drawings | 80 |
| | <i>Table E.1 — Graphical symbols</i> | 81 |
| | Bibliography | 84 |

Currently in preview, click buy full version

Summary of pages

This document comprises a front cover, and inside front cover, pages i to iv, pages 1 to 86, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 September 2020. It was prepared by subcommittee EXL/31/1, *Gas detectors*, under the authority of Technical Committee EXL/31, *Equipment for explosive atmospheres*. A list of organizations represented on these committees can be obtained on request to their committee managers.

Information about this document

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Use of this document

As a guide, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organisation” rather than “organization”).

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

0 Introduction

0.1 General

This British Standard is written in the form of guidance and supports flame and gas (F&G) detection standards across the industry.

One of the most challenging activities faced by a design engineer is deciding the quantity and location of gas detectors and/or flame detectors.

This British Standard refers to F&G coverage factors but does not specify target coverage factors for different applications. Coverage factors are only broad targets and are easily manipulated by changing device sensitivities, alarm trip levels, voting configurations, target gas concentrations, target flame size and other factors.

This British Standard also provides guidance on sensing technologies and the physical format of detectors which could greatly affect coverage (quantity and position). Irrespective of the quantity and positioning of detectors by a manual or software-related activity, the selection of incorrect sensing technologies leads to incidents not being detected or an increase in spurious trips.

This British Standard provides guidance on the full life cycle of a gas detection or flame detection system, emphasizing that mapping and/or modelling is an ongoing activity and not simply an activity that is carried out once in the design of a new facility. Routine surveillance of detector coverage during the full life cycle of a facility ensures that facility modification, changes in hazards, etc., are all addressed, and the management of change highlights any deficiencies or opportunities for improvement.

Detector coverage within this British Standard means permanently-installed devices, which are the only devices for which guidance is provided. The use of additional personal monitors, e.g. portable gas detectors, does theoretically increase the density of “detecting devices” when persons are actively working within a plant area or location.

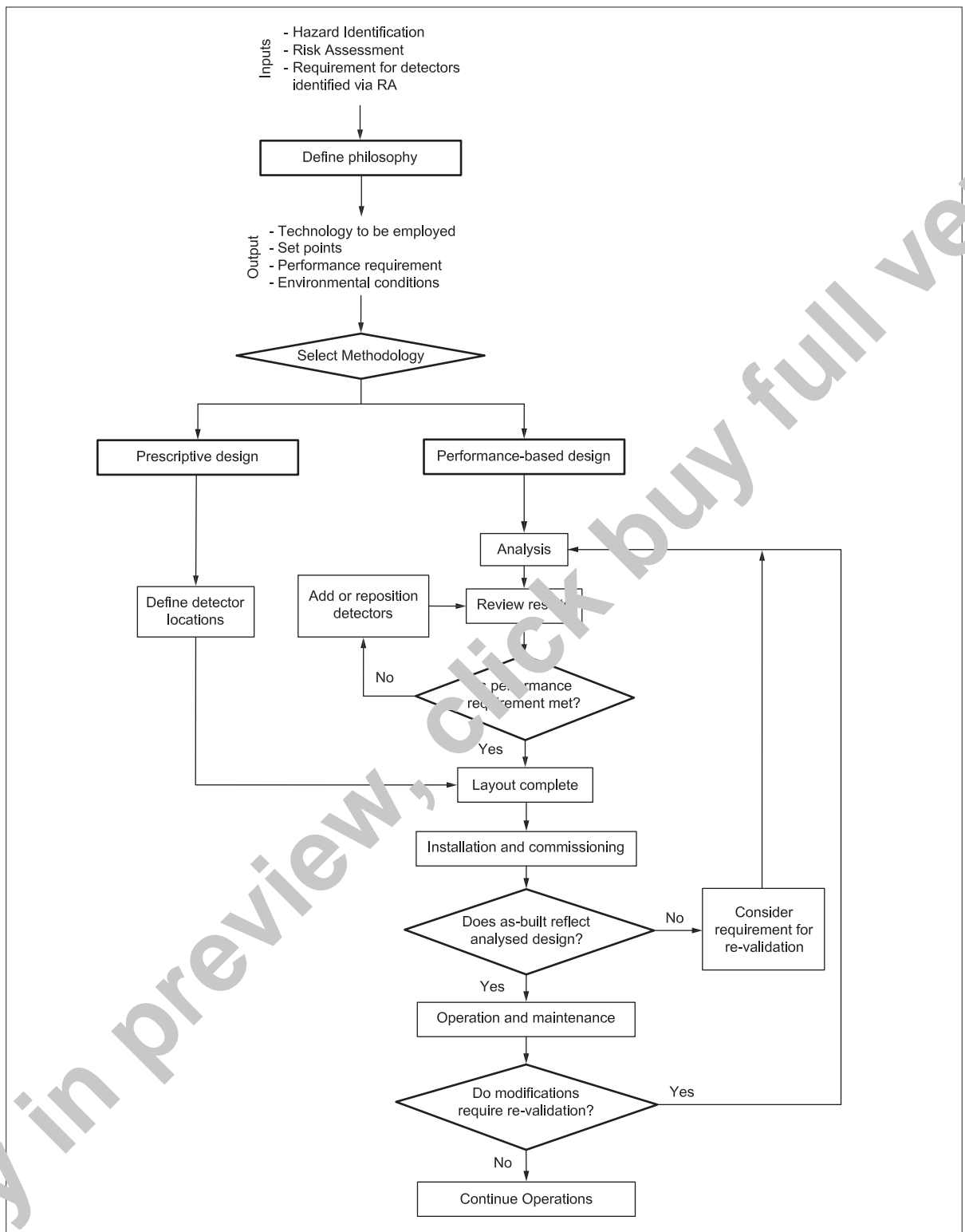
This British Standard is based on existing and established sensing and detector technologies and configurations. It is also based on many years of industrial experiences and lessons learned. This British Standard does not exclude emerging technologies or innovative ideas; however unless there is reasonable and practical evidence that these technologies or methodologies offer equal benefits, caution is advised.

This British Standard provides informative guidance on detection symbols (see [Annex E](#)), however this guidance does not preclude continued application of any established symbols applied by an operator or designer.

0.2 Document structure

The structure of the document and the process for F&G mapping is illustrated in [Figure 1](#), with detail provided in [Clause 4](#) to [Clause 12](#).

Figure 1 — Document structure



1 Scope

This British Standard provides guidance on the placement of permanently-installed F&G detectors, including coverage and technology selection.

NOTE 1 "Permanently-installed detection systems" include optical flame detection (including ultraviolet, infrared and imaging/visual), flammable gas/vapour detection and toxic gas detection.