Guidelines for managing inspection of Ex electrical equipment ignition risk in support of IEC 60079-17
GUIDELINES FOR MANAGING INSPECTION OF EX ELECTRICAL EQUIPMENT
IGNITION RISK IN SUPPORT OF IEC 60079-17

First edition

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# CONTENTS

## Acknowledgements  ................................................................................................................. vii

## Foreword ................................................................................................................................. viii

## Overview .................................................................................................................................... x

### 1 Introduction, scope and application

1.1 Introduction .................................................................................................................. 1  
1.1.1 Objective ........................................................................................................ 3  
1.1.2 Ex sampling strategy ....................................................................................... 3  
1.2 Scope ..................................................................................................................... 4  
1.3 Application ........................................................................................................... 5  
1.3.1 Managing inspection of Ex electrical equipment ignition risk by applying gap analysis .................................................................................................... 6

### 2 Legislation, regulations and standards ............................................................................ 7

2.1 Introduction .............................................................................................................. 7  
2.2 The Health and Safety at Work etc. Act and Management of Health and Safety at Work Regulations ................................................................. 7  
2.4 Provision and Use of Work Equipment Regulations ...................................................... 8  
2.5 Offshore installations (Prevention of Fire and Explosion, and Emergency Response) Regulations ................................................................. 8  
2.6 Offshore Installations (Safety Case) Regulations ........................................................... 8  
2.7 The Electricity at Work Regulations ........................................................................... 8  
2.8 The Construction (Design and Management) Regulations ............................................ 9  
2.9 IEC 60079-17 .............................................................................................................. 9  
2.9.1 Maintenance .................................................................................................. 9  
2.9.2 Inspection ....................................................................................................... 9  
2.9.3 Skilled personnel (electrical technicians) ........................................................ 10  
2.9.4 Technical person with executive function ...................................................... 10  
2.10 ISO 2859-1 ............................................................................................................... 10

### 3 Applying SMS principles to managing the inspection of Ex electrical equipment  

3.1 Introduction .............................................................................................................. 12  
3.2 Policy ...................................................................................................................... 12  
3.2.1 Initial inspection ............................................................................................ 12  
3.2.2 Periodic inspections ...................................................................................... 13  
3.2.3 Sample inspections ....................................................................................... 14  
3.2.4 Ex risk-based inspection .............................................................................. 16  
3.2.5 Summary of coupling the sampling strategy with an RBI strategy ................. 17  
3.2.6 Audit and review of Ex inspection strategy ...................................................... 20  
3.3 Organisation .............................................................................................................. 20  
3.3.1 Roles and responsibilities .............................................................................. 20  
3.3.2 Competence ................................................................................................... 21
Contents Cont...

3.4 Planning and implementation ................................................................. 22
   3.4.1 Phase 1 of implementation plan ....................................................... 22
   3.4.2 Phase 2 of implementation plan ....................................................... 23
   3.4.3 Phase 3 of implementation plan ....................................................... 24

3.5 Measuring performance ........................................................................ 25
   3.5.1 Initial Ex inspection target levels ...................................................... 25
   3.5.2 Faults ............................................................................................... 25

3.6 Audit and review of performance ............................................................ 25
   3.6.1 Reviewing performance .................................................................... 25
   3.6.2 Auditing ........................................................................................... 31

4 Managing inspection of Ex electrical equipment throughout its life cycle phases .... 32
   4.1 Introduction ......................................................................................... 32
   4.2 Design and construction ...................................................................... 32
      4.2.1 Equipment selection and implications for inspection and maintenance ... 32
   4.3 Installation/commissioning/handover ..................................................... 33
      4.3.1 Handover of data ........................................................................... 33
      4.3.2 Equipment register ......................................................................... 33
      4.3.3 Initial inspection ............................................................................. 34
   4.4 Operation ............................................................................................... 35
      4.4.1 Equipment location ......................................................................... 35
   4.5 Maintenance and inspection .................................................................. 36
      4.5.1 Functional maintenance ................................................................. 36
      4.5.2 Inspection of systems ...................................................................... 36
      4.5.3 Efficiency in inspections ................................................................. 37
   4.6 Modification and decommissioning ......................................................... 37

Annex A: Managing inspection of Ex electrical equipment ignition risk gap analysis checklist .... 38
   A.1 Managing inspection of Ex electrical equipment ignition risk gap analysis checklist .... 38

Annex B: Developing sampling plans by applying the RBI sampling methodology .......... 44
   B.1 Introduction ......................................................................................... 44
   B.2 Overview of developing a sampling plan by applying the RBI sampling strategy to manage Ex electrical equipment ignition risks ................................................ 44
   B.3 Steps in developing a sampling plan by applying the sampling methodology .......... 45
      B.3.1 Define lots ....................................................................................... 45
      B.3.2 Define grade of inspection ............................................................... 50
      B.3.3 Define sample size ......................................................................... 51
      B.3.4 Define rejection criterion ............................................................... 55
      B.3.5 Define frequency of inspection ...................................................... 55
      B.3.6 Select a random sample from a lot ............................................... 59
      B.3.7 Inspect sample ............................................................................... 60
      B.3.8 Record inspection data ................................................................. 60
      B.3.9 Define scoring and rules for handling faulty equipment .................. 61
      B.3.10 Audit and review of sampling plans ......................................... 69

Annex C: Technical basis of RBI sampling methodology ........................................ 70
   C.1 Introduction ......................................................................................... 70
   C.2 Limitations of inspection by sampling .................................................. 70
      C.2.1 Varying ASLs and applying Pa(10%) and Pr(5%) for an example lot .... 70
C.3 Define key sampling parameters ................................................................. 71
  C.3.1 Calculation of $P(X=d)$ using hypergeometric law .......................... 71
  C.3.2 Calculation of $P(a(X=Re-1))$ using hypergeometric law .............. 72
  C.3.3 Calculation of $P(X=d)$ and $P(a(X=Re))$ using binomial law .......... 72
C.4 Determination of $P(a(10\%))$ ................................................................. 73
  C.4.1 Determination of $P(a(10\%))$ where $n/N \geq 0.15$ ......................... 73
  C.4.2 Determination of $P(a(10\%))$ where $n/N < 0.15$ ......................... 75
C.5 Determination of $P(r(5\%))$ ................................................................. 75
  C.5.1 Determination of $P(r(5\%))$ where $n/N \geq 0.15$ ......................... 75
  C.5.2 Determination of $P(r(5\%))$ where $n/N < 0.15$ ......................... 75
C.6 Example graphical determination of $P(a(10\%))$ and $P(r(5\%))$ .......... 76
C.7 Sampling tables for various ASLs ........................................................... 77
C.8 Determination of ALARP ASLs for various lot sizes ............................. 86
C.9 Lot quality for various sample sizes and rejection numbers .................. 94

Annex D: Inspection schedules for Ex 'd', 'e', 'n', 'i' and 'p' electrical equipment 95
D.1 Introduction .............................................................................................. 95

Annex E: Glossaries ....................................................................................... 99
E.1 Introduction .............................................................................................. 99
E.2 Glossary of terms ..................................................................................... 99
E.3 Glossary of abbreviations ....................................................................... 109

Annex F: References .................................................................................... 111

Tables:
Table 3.1: Ex electrical equipment risk graph – starting point for defining lots of Ex electrical equipment based on ignition risk ................................................................. 18
Table 3.2: Example application of RBI with or without sampling to Ex ignition risk in an Ex electrical equipment strategy by applying frequency of inspection multipliers .......... 19
Table 3.3: Example application of RBI to Ex ignition risk in an Ex electrical equipment sampling strategy by varying ASL ......................................................... 19
Table 3.4: Simple set of fault codes based upon the type of faults typically encountered .......... 30
Table A.1: Managing inspection of Ex electrical equipment ignition risk gap analysis checklist ................................................................................................. 38
Table B.1: Simplified approach to defining lots using a matrix for an offshore installation .......... 50
Table B.2: Sampling data for ASL = 1% .......................................................... 54
Table B.3: ALARP ASLs for various lot sizes ............................................... 54
Table B.4: Ignition risk .................................................................................. 57
Table B.5: Severity of the environment .......................................................... 58
Table B.6: Ignition risk .................................................................................. 62
Table B.7: Results of inspection by sampling for equipment in a Zone 1 hazardous area .......... 63
Table B.8: Results of inspection by sampling for equipment in a Zone 2 hazardous area .......... 64
Table C.1: Example calculation of $P(a(10\%))$ where $n/N \geq 0.15$ ............. 74
Table C.2: Example calculation of $P(a(10\%))$ where $n/N < 0.15$ ............. 74
Table C.3: Example calculation of $P(a(10\%))$ where $n/N < 0.15$ ............. 76
Table C.4: Sampling data for ASL = 0.25% .................................................. 78
Table C.5: Sampling data for ASL = 0.40% .................................................. 79
Table C.6: Sampling data for ASL = 0.65% .................................................. 80
Table C.7: Sampling data for ASL = 1% ...................................................... 81
Table C.8: Sampling data for ASL = 1.5% .................................................... 82
Table C.9: Sampling data for ASL = 2.5% .................................................... 83
Contents Cont...

Table C.10: Sampling data for ASL = 4% .............................................................. 84
Table C.11: Sampling data for ASL = 6,5% .............................................................. 85
Table C.12: ALARP ASLs for various lot sizes ......................................................... 86
Table C.13: Discrimination ratio (Pa(10%)/Pr(5%)) for various ASLs for lot size 26-50 ........ 87
Table C.14: Discrimination ratio (Pa(10%)/Pr(5%)) for various ASLs for lot size 51-90 ........ 88
Table C.15: Discrimination ratio (Pa(10%)/Pr(5%)) for various ASLs for lot size 91-150 .... 89
Table C.16: Discrimination ratio (Pa(10%)/Pr(5%)) for various ASLs for lot size 151-280 ....... 90
Table C.17: Discrimination ratio (Pa(10%)/Pr(5%)) for various ASLs for lot size 281-500 ...... 91
Table C.18: Discrimination ratio (Pa(10%)/Pr(5%)) for various ASLs for lot size 501-1 200 .... 92
Table C.19: Discrimination ratio (Pa(10%)/Pr(5%)) for various ASLs for lot size 1 201-3 200 .... 93
Table C.20: Lot quality for various sample sizes and rejection numbers ..................... 94
Table D.1: Inspection schedule for Ex ‘d’, ‘e’ and ‘n’ equipment .................................... 96
Table D.2: Inspection schedule for Ex ‘i’ equipment .................................................. 97
Table D.3: Inspection schedule for Ex ‘p’ equipment (pressurisation or continuous dilution) .... 98

Figures:
Figure 1.1: Overview of various Ex electrical equipment inspection strategies .................. 2
Figure 1.2: Continuous improvement model .............................................................. 6
Figure B.1: Flowchart illustrating steps in developing a sampling plan by applying RBI sampling strategy to manage Ex electrical equipment ignition risks .................. 46
Figure B.2: Example of process for defining lots of Ex electrical equipment ................. 49
Figure B.3: Using change rules to determine category of inspection ............................. 68
Figure C.1: Example determination of Pa(10%) and Pr(5%) from a graph of probability of acceptance of the lot, Pa verses percentage of faulty equipment in the lot D/N ............. 76
Figure C.2: Discrimination ratio (Pa(10%)/Pr(5%)) versus ASL for lot size 26-50 ............... 87
Figure C.3: Discrimination ratio (Pa(10%)/Pr(5%)) versus ASL for lot size 51-90 ............... 88
Figure C.4: Discrimination ratio (Pa(10%)/Pr(5%)) versus ASL for lot size 91-150 ............. 89
Figure C.5: Discrimination ratio (Pa(10%)/Pr(5%)) versus ASL for lot size 151-280 .......... 90
Figure C.6: Discrimination ratio (Pa(10%)/Pr(5%)) versus ASL for lot size 281-500 .......... 91
Figure C.7: Discrimination ratio (Pa(10%)/Pr(5%)) versus ASL for lot size 501-1 200 ......... 92
Figure C.8: Discrimination ratio (Pa(10%)/Pr(5%)) versus ASL for lot size 1 201-3 200 ...... 93

Boxes:
Box 3.1: Example of using an Ex electrical equipment risk graph in an RBI inspection strategy .... 18
Box 3.2: Example of applying RBI principles to a sampling strategy ............................. 19
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FOREWORD

Inspection of Ex electrical equipment is critical to assuring the continuing integrity of the types of protection that enable its use in potentially flammable atmospheres; yet such inspections are sometimes not carried out adequately both with regard to frequency of inspection, grade of inspection and completeness of the portfolio of Ex electrical equipment installed. This is due in part to the onerous requirements of IEC 60079-17 with respect to close inspection in three years of the several thousand pieces of Ex electrical equipment at a typical major hazards installation handling flammable fluids in the petroleum industry (both onshore and offshore) or allied process industries. In addition, inspection of Ex electrical equipment is often carried out at the same level of inspection (frequency of inspection, grade of inspection, etc.) without adjustment for the different ignition risks that might apply. Further, there is a lack of clarity in IEC 60079-17 regarding carrying out sample inspections, particularly with respect to detailed inspections.

EI Guidelines for managing inspection of Ex electrical equipment ignition risk in support of IEC 60079-17 provides guidance on managing the ignition risks of Ex electrical equipment located in hazardous areas arising from flammable fluids: this is mapped against a safety management system (SMS) framework which should be applied throughout its life cycle.

These Guidelines promote adoption of risk-based inspection (RBI) principles to inspection of Ex electrical equipment: this should result in high risk Ex electrical equipment being inspected to a more rigorous level of inspection (e.g. frequency of inspection) than lower risk items. These Guidelines set out an approach for establishing an RBI strategy which should be targeted, balanced and effective. Guidance is provided on implementing the strategy and ensuring that it is effective on a continuing basis. Therefore, these Guidelines constitute a benchmark of good practice.

These Guidelines further develop the RBI concept by providing an RBI sampling methodology that takes into account as low as reasonably practicable (ALARP) principles. The RBI sampling methodology draws from and bridges ISO 2859-1 and IEC 60079-17: it provides an audit trail to the established general sampling methodology of ISO 2859-1 and meets the Ex electrical equipment inspection requirements of IEC 60079-17. In order to adapt the general sampling methodology to the specific application of inspection of Ex electrical equipment, additional management, sampling methodology and Ex electrical equipment requirements have been added to the criteria considered in ISO 2859-1.

The RBI sampling methodology is intended for application to detailed inspections of Ex electrical equipment as defined in IEC 60079-17; however, it can be similarly applied to close inspections where a complete equipment register and records are available. The methodology applies random sampling to lots. Applying the RBI sampling methodology to the inspection of Ex electrical equipment should:

- Assure the continuing safety integrity of its types of protection.
- Enable compliance with pertinent legislation, regulations and standards.
- Reduce the possibility of introducing maintenance induced human failure due to intrusive inspection.
- Identify deficiencies such as corrosion, vibration, inadequate design, etc.
- Over time, help improve its performance.
- Be cost beneficial compared to the additional requirements on managing the process.

These Guidelines are based primarily on the GB legislative and regulatory framework and international standards; yet its guidance is globally applicable provided it is read, interpreted and applied in conjunction with relevant national and local statutory legislation and standards. Where the requirements differ, the more rigorous should be adopted.
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The Technical Department  
Energy Institute  
61 New Cavendish Street  
LONDON  
W1G 7AR  
e: technical@energyinst.org
OVERVIEW

Section 1 provides an introduction to the management of Ex electrical equipment ignition risks, defines the scope of these Guidelines, and describes how they should be applied.

Section 2 sets out the requirements of pertinent legislation, regulations and international standards pertinent to the inspection of Ex electrical equipment.

Section 3 sets out the safety management system (SMS) principles pertinent to managing the inspection of Ex electrical equipment. It is illustrated with pertinent examples.

Section 4 provides guidance on managing inspection of Ex electrical equipment throughout its life cycle phases after design and construction.

Annex A provides a gap analysis checklist for managing inspection of Ex electrical equipment ignition risk that aims to determine whether current practices and processes comply with pertinent legislation, regulations and standards.

Annex B sets out the steps in developing a sampling plan by applying the RBI sampling methodology. It defines key parameters and provides guidance on determining suitable values and reviewing the values based on the findings from inspections. The RBI sampling methodology is illustrated with examples and includes rules for applying a sampling plan.

Annex C provides the technical basis of the sampling methodology and includes the basis for assigning an as low as reasonably practicable (ALARP) principle threshold to rejection criteria using the RBI sampling methodology.

Annex D provides inspection schedules for various Ex electrical equipment types of protection.

Annex E provides glossaries of terms and abbreviations.

Annex F provides details of publications referenced.
1 INTRODUCTION, SCOPE AND APPLICATION

1.1 INTRODUCTION

These Guidelines were commissioned and partly developed by the EI Electrical Committee, which comprises senior electrical engineers from companies operating in the offshore and onshore petroleum industry, consultants and the Health and Safety Executive (HSE). They set out what is generally regarded in the industry as good practice and should assist those with responsibilities to meet the requirements of pertinent legislation, regulations and standards. They are not mandatory and different standards may be adopted in a particular situation where to do so would maintain an equivalent, or better, level of safety.

Currently, many inspections of Ex electrical equipment are carried out at the same level of inspection (frequency of inspection, grade of inspection, etc.) without adjustment for the different ignition risks that might apply. Yet the inventory of Ex electrical equipment is typically located in different hazardous areas (where the probability of a flammable atmosphere being present differs) and the various Ex electrical equipment type of protection concepts present different ignition risks. In addition, the equipment may have different ages or be located where the environmental conditions differ.

Detailed inspections are typically carried out as part of initial inspections, and not always as part of routine inspections. Such intrusive inspections are very resource intensive and might lead to maintenance-induced human failure (e.g. damage to gaskets and seals, or leaving out bolts on reinstatement). However, in order to ensure that the internal parts are fit for purpose and safe users should carry out Ex detailed (intrusive) inspections.

In addition to meeting requirements of relevant legislation, regulations and standards, there is a significant business driver to install and maintain Ex electrical equipment such that it does not provide a potential source of ignition. The impact on businesses of fires or explosions due to a failure to control sources of ignition in terms of personnel injury or fatality, repairs, loss margin or revenue, reputational damage and fines or other penalties, can be such as to pose a significant threat to the survival or profitability of the business. As all petroleum installations contain large numbers of sources of ignition such as instruments, lights, motors, junction boxes etc., any such business should ensure that they are installed and maintained properly so as to limit the risk of uncontrolled sources of ignition.

EI Guidelines for managing inspection of Ex electrical equipment ignition risk in support of IEC 60079-17 provides guidance on managing the ignition risks of Ex electrical equipment located in hazardous areas arising from flammable fluids: this is mapped against a safety management system (SMS) framework which should be applied throughout its life cycle.

These Guidelines promote adoption of risk-based inspection (RBI) principles to inspection of Ex electrical equipment; this should result in high risk Ex electrical equipment being inspected to a more rigorous level of inspection (e.g. frequency of inspection) than lower risk items.

These Guidelines further develop the RBI concept by providing an RBI sampling methodology that takes into account as low as reasonably practicable (ALARP) principles. The RBI sampling methodology draws from and bridges ISO 2859-1 and IEC 60079-17. Therefore, these Guidelines constitute a benchmark of good practice.

Application of RBI has the advantage of more efficient use and targeting of inspection resources.
Figure 1.1 provides an overview of the various Ex electrical equipment inspection strategies that are applied to managing ignition risks arising from Ex electrical equipment in potentially flammable atmospheres: in particular, it identifies whether they are risk-based and are likely to meet ALARP principles.

**Figure 1.1: Overview of various Ex electrical equipment inspection strategies**
1.1.1 **Objective**

The objective of these Guidelines is to provide guidance on establishing an Ex electrical equipment inspection strategy which accounts for ALARP principles. This should help in improving the continuing management of ignition risk by assuring the continuing integrity of Ex electrical equipment type of protection as inspection should identify faults such as corrosion, vibration, inadequate equipment selection, etc. It should also improve the quality of inspections of Ex electrical equipment and, over time, improve the in-service performance of Ex electrical equipment. These Guidelines should help to clarify the concepts and should facilitate compliance with the requirements of relevant legislation, regulations and standards.

Users are likely to seek answers to the following questions regarding managing the inspection of Ex electrical equipment:

- What legislation, regulations and standards do I have to comply with and are there other business benefits that might be accrued?
- What do these requirements imply in practice and how can I tell if what I already have is sufficient?
- How can I meet the requirements effectively (both in terms of cost and compliance) while at the same time leveraging the activity to provide added value/reduce risk for my business?

These Guidelines provide guidance on answering those questions: they provide a pragmatic approach to achieving this by promoting a risk-based Ex inspection strategy; further they offer the option of adopting a robust sampling methodology that derives from IEC 60079-17 and ISO 2859-1, is balanced and should meet ALARP requirements.

The sampling methodology provides an opportunity to utilise qualitative and/or quantitative analytical techniques within a defined strategy. Use of robust statistical data derived from ISO 2859-1, in conjunction with a complete equipment register and competent personnel should optimise the potential of the methodology.

The success of an Ex electrical equipment inspection strategy is dependent on the complete life cycle of Ex electrical equipment being appropriately managed and inspected, having appropriate records, and being audited and reviewed (in accordance with the SMS principles of HSE *Successful health and safety management*) so as to ensure that all such Ex electrical equipment is fit for purpose and safe and can be demonstrated as being so.

These Guidelines set out an approach for establishing an RBI strategy, which in doing so provides a targeted, balanced and effective Ex inspection approach. This should result in high risk Ex electrical equipment being inspected to a more rigorous level of inspection than lower risk items. For detailed Ex inspections it prevents the need for the routine opening of all Ex enclosures. Annex B provides a comprehensive sampling strategy based on ISO 2859-1.

These Guidelines should encourage appropriate management of the complete Ex requirements of initial, visual, close and detailed inspections, as set out in IEC 60079-17, Figure A.1. In doing so, they should encourage a consistent approach in the petroleum and allied industries and consistency in its regulation and verification (where appropriate).

1.1.2 **Ex sampling strategy**

The Ex sampling strategy set out in these Guidelines is based on the following international standards:

- **ISO 2859-1** (which is technically identical to BS 6001-1) provides a recognised
sampling standard for general inspection requirements for manufacturing. This standard alone is not suitable for its direct application to inspection of Ex electrical equipment.

- IEC 60079-17 (which is technically identical to BS EN 60079-17) provides guidance on the following types of Ex inspections: initial inspection (commissioning); periodic inspection (visual and close); detailed inspection; and continuous supervision. This standard refers to Ex sample inspections; however, it does not provide specific guidance on what is expected of a sampling strategy.

These Guidelines provide a method of applying the sampling schemes set out in ISO 2859-1 (which then provides an audit trail to an established sampling method), together with the Ex electrical equipment inspection requirements set out in IEC 60079-17; therefore, these Guidelines bridge those standards. In order to achieve this, the following management, sampling methodology and Ex electrical equipment requirements have been added to the criteria considered in ISO 2859-1 so as to develop an RBI Ex electrical equipment sampling methodology:

- Management requirements:
  - Having a high quality SMS with a systematic approach and high quality of audit and review.
  - Having a complete equipment register and records.
  - Developing an RBI strategy.

- Sampling methodology requirements:
  - Defining lots and sample size.
  - Defining grade of inspection.
  - Defining frequency of inspection.
  - Defining rejection criterion including an ALARP principle threshold (i.e. a cliff-edge effect) in relation to the selection of acceptance safety levels (ASLs).
  - Defining rules for faulty equipment when the rejection criterion is exceeded.

- Ex electrical equipment requirements:
  - The probability of a flammable atmosphere being present, as indicated by the hazardous area classification (i.e. Zones 0, 1 and 2 (and non-hazardous)).
  - The probability of a source of ignition being present due to a fault.
  - Ignition risk due to the simultaneous presence of a flammable atmosphere and a potential source of ignition.
  - The effect of severity of the environment.
  - The effect of equipment age.

1.2 SCOPE

These Guidelines cover the inspection of Ex electrical equipment located in hazardous areas (other than mines) where the risk arises from flammable atmospheres. They apply to Ex electrical equipment supplied or put into service in accordance with the ATEX ‘Equipment Directive’ (see section 2.3) and electrical equipment that precedes that Directive (‘pre-ATEX’ electrical equipment). It is not intended for application to Ex electrical equipment used in hazardous areas arising from combustible dusts (including coal dust) as they are excluded from the scope of IEC 60079-17. It is applicable to petroleum production, storage and processing installations, both onshore and offshore e.g. offshore production installations, petroleum refineries, bulk storage installations,