EI Research report

Investigation into the ignition risks due to the ageing effects of Ex electrical equipment

EI RESEARCH REPORT

INVESTIGATION INTO THE IGNITION RISKS DUE TO THE AGEING EFFECTS OF EX ELECTRICAL EQUIPMENT

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FOREWORD

The presence of ageing explosion-protected (Ex) electrical equipment in hazardous areas related to potentially explosive atmospheres, onshore and offshore, causes serious concern for those responsible for its operation and maintenance. It is essential that operations continue without planned interruption, but when equipment is 30, 40, or more years old, for how long can it be expected to operate effectively and safely? Its integrity will end sometime. The danger to life, adverse environmental effects and loss of production resulting from equipment failure and ignition can result in swingeing penalties.

In order to create some practical guidance for plant operators, the Electrical Committee of the Energy Institute (EI) commissioned Intertek Testing and Certification Ltd. to carry out an investigation and report on ageing Ex electrical equipment.

The work detailed in this report was carried out in three sections: site-based questionnaire to EI member companies; site surveys by an Intertek engineer, and laboratory testing of selected/available equipment. Whilst it was not possible to carry out internal examination of equipment in operation, external examination of a range of equipment was undertaken and is documented in the report. Some member companies supplied samples of equipment, withdrawn from service, for detailed laboratory examination and testing.

The conclusion in the report states that '*…. there does not seem to be much evidence that ageing of hazardous area electrical equipment introduces an inherent additional ignition hazard risk*'. However, this is tempered by the statement '*it must be recognised that the scope of this work could not examine all types of equipment and caution must be exercised in applying these conclusions outside of the range of equipment types tested*'.

Whilst sample numbers of each type of equipment were small and the range of equipment types was limited, significant common detrimental effects were identified, confirming the experience of engineers in the field. The report illustrates and highlights four main modes of degradation that lead to eventual failure of Ex electrical equipment to meet certification requirements and possible catastrophic failure:

- corrosion;
- water ingress and inadequate gaskets/seals protection;
- degradation of plastics (e.g. glass reinforced plastic (GRP)) enclosures and components, due to ultraviolet (UV) or other environmental factors, and
- absence of adequate labelling/ID of equipment to confirm its type of Ex protection related to its location.

A major negative factor in determining the ongoing integrity of ageing Ex electrical equipment is the inability to identify the certified Ex characteristics of equipment because of the degradation or absence of the original labelling showing the necessary characteristics. Evidence shows that generally only data that are substantially embossed or engraved on equipment, or securely attached labels that survive into decades of use. Some EI member companies have overcome this problem by securing well engraved and securely attached site ID tags to equipment and maintaining site records of the related data for the equipment.

The report does not give recommendations as to the frequency of inspections for ageing Ex equipment, but acknowledges that the frequency and degree of inspection will depend on a number of factors, including the age of the equipment and severity of environmental conditions. It is logical that as equipment ages into decades, it should be inspected with increasing frequency. Whereas early in its life, for example, equipment may be closely inspected every three years, it will reach an age or condition when it should be inspected more frequently. Some member companies have reported that they carry out annual inspections, with vulnerable equipment receiving detailed inspection. Clearly the legal responsibility for maintenance lies with the relevant Duty Holder and it would be prudent to afford an appropriate degree of attention to the possible outcome of not providing adequate surveillance of ageing Ex electrical equipment.

Testing of enclosures which visibly appeared to be degraded for impact resistance and water ingress did not show that the integrity of the enclosures had been affected. Greater clarification is necessary to help personnel inspecting this type of equipment make correct judgement as to condition and suitability for continued use. Further research is therefore justified to establish what level of degradation is unacceptable before a plastic enclosure can no longer reliably fulfil its protective function. Such research could offer some guidance as to the appropriate frequency of inspection as equipment ages.

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The EI wishes to thank those who contributed to the research by completing questionnaires, those who provided Ex-electrical equipment for testing and those who catered for site visits to enable visual inspections to be conducted.

The work was coordinated by Toni Needham (EI), Technical Manager.

1 INTRODUCTION, OBJECTIVES AND SCOPE

The Electrical Committee of the EI wished to investigate the potential safety risk of electrical equipment designed for use in hazardous areas as this equipment ages. This work was carried out by Intertek Testing and Certification in two parts. Firstly, whether degraded electrical equipment represents a real source of ignition, and secondly to comment on the viability of inspections to provide reassurance as to the continued integrity of Ex equipment. This report (produced by Intertek Testing and Certification Ltd.) forms part of this investigation. Intertek Testing and Certification is a wholly owned part of Intertek PLC, is a Notified Body for ATEX Directive, a certification body and test laboratory within the IEC Ex scheme.

In order that the aims of this project can be achieved, it was decided to limit the work in the following manner. These limitations were discussed and agreed with the Electrical Committee and detailed as follows. The investigation looked at hazardous area electrical equipment installed in areas as defined in IEC/EN 60079-14 and in the presence of flammable gases and vapours. Hazardous areas caused by the presence of dusts were excluded from this work. The environments to be considered are the oil and gas industries both on- and offshore. It was considered that these represent harsh operating conditions and so should give worst-case results.

The range of equipment and protection concepts (defined in the IEC/EN 60079 series of standards) is large. The concepts are identified by the use of the most recent standard designations. It was decided to initially limit the investigation to the most commonly used protection concepts for the reasons identified here:

IEC/EN 60079-1 Flameproof enclosure 'd'

Included in the investigation, due to the large number of installed units with the potential for very old equipment, as the protection concept has been used for over 90 years with the first publication of BS229 in 1929, and equipment tested before this by independent bodies. The characteristics of flameproof equipment make it susceptible to corrosion, wear and poor maintenance. Corrosion and wear of moving parts can affect the ability of the flameproof joints to prevent flame transmission. In extreme cases, the strength of the enclosure could be affected.

IEC/EN 60079-2 Pressurised enclosure 'p'

Excluded from this investigation due to the relatively small number of installed units and failsafe nature of the primary protection.

IEC/EN 60079-5 Powder filling 'q'

Excluded from this investigation due to the relatively small number of installed units.

IEC/EN 60079-6 Oil immersion 'o'

Excluded from this investigation due to the relatively small number of installed units.

IEC/EN 60079-7 Increased safety 'e'

Included in the investigation due to the large number of installed units. This protection concept is considered particularly susceptible to ageing. In general, this protection concept depends on the effective sealing of the equipment to prevent the ingress of dust and water that could contaminate internal equipment. This ingress could lead to the electrical breakdown of equipment and introduce the potential for incendive sparking.

IEC/EN 60079-11 Intrinsic safety

Initially, it was intended to include intrinsically safe (IS) equipment in the investigation. However, in discussion with the committee, it was decided to include this equipment in the survey but exclude it from further investigation. This was based on the view that IS equipment tends to be replaced more frequently than other types of equipment, due to the changes in technology requiring equipment updating, the reliability of electronic components, and the redundancy built in to this type of equipment. Also, the likelihood of any ageing effects being identified in this investigation are small as the basis for certification may not be apparent without access to the certification reports and detailed drawings.

IEC/EN 60079-15 Type of protection n

Included in the investigation due to the large number of installed units. In addition, equipment for Division 2 equipment specified in Code of Practice CP1003 (the forerunner of Zone 2) is still be in use, and could date from at least 1967. This protection concept is considered particularly susceptible to ageing. In general, this protection concept depends on the effective sealing of the equipment to prevent the ingress of dust and water that could contaminate internal components. This ingress could lead to the electrical breakdown of equipment and introduce the potential for incendive sparking.

IEC/60079-18 Encapsulation

Excluded from this investigation due to the relatively small number of installed units.

Table 1 lists the protection concepts included in this project.

Table 1: Summary of included protection concepts

IEC/EN 60079-1 Flameproof enclosure	'd'
IEC/EN 60079-7 Increased safety	'e'
IEC/EN 60079-11 Intrinsic safety	'i'
IEC/EN 60079-15 Type of protection	'n'