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Engineering Recommendation C135

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Guidance for the operation and management of fluid filled cables

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PUBLISHING AND COPYRIGHT INFORMATION

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Amendments since publication

Issue	Date	Amendment
Issue 1	November, 2016	This issue includes the following principal technical changes. Engineering Technical Report 135 converted to Engineering Recommendation C135, Issue 1. Major revision of ETR 135 Issue 1: (i) to reflect latest best practice regarding management of FFC (ii) to update the information in the Annexes and replace with reference to ENA documents where appropriate. Foreword: Revised to include reference to the superseded Issue 1 of ETR 135. Paragraph relating to background of FFC has been moved to a new 'Introduction' clause. Reference to lifecycle removed and reference to maintenance added via EREC C84/2. Clause 2: Normative references: New Clause added to capture the list of relevant references. The list is derived from those detailed in ETR 135 Issue 1 Clause 6.3 and those referred to in the document text. Clause 3: Terms and definitions: New Clause added to capture terms and definitions. New definition for Environmental Regulator added. Clause 5: The descriptions for the classifications, SPZ1 - SPZ3, have been replaced with updated descriptions. Clause 6.10: The term 'sandy soils' has been replaced by 'coarsely granular soils'. The wording 'i.e. it is not too sandy' has been deleted.

		Clause 6.11: Clause 10.5 has been inserted and the wording 'being developed and tested' and associated sentence, has been deleted as these bioremediation techniques are commercially available. Clause 7.3.2: The Clause has been amended to reflect that PFT is an established method used by many Network Operators, and not a developing solution. Added 2 new paragraphs to describe the 'Proactive Method' and 'Reactive method'. Clause 7.3.4, 'Other leak location development': New clause added to describe the 'ground radar' developments, taken from Clause 7.3.2. Clause 8.4: New bullet added to include 'organic absorbent' as a means of cable fluid recovery. Clause 9.2: Description of health scores added. Clause 9.3: Added reference to Ofgem document, "DNO Common Network Asset Indices Methodology – Health & Criticality – Draft Version 4, 15/12/2015 [N7]. Clause 9.5: Deleted original risk assessment and added new wording to explain that the current risk assessment is now carried out as part of the calculation of health scores and Criticality Indices as per the Common Framework Methodology, as per RIIO ED1. Previous Clause 9.6 'Net Present Value' deleted as NPV is not used as a prioritisation method and has been replaced by the common framework methodology (i.e. prioritisation based on risk and not cost). Clause 10.5: New paragraphs 2, 3 and 4 added to describe the hydrogel purging and bioremediation techniques available for the draining of FFC. The hazards of these methods has also been highlighted as per the project NIA_NGET0116. Clause A.1 Paragraph 2 – the wording 'conductor of copper or aluminium is stranded and compacted around a central fluid duct' has been replaced with 'the conductor of copper or aluminium is generally either of segmental (referred to as 'keystone' in IEC Standards) or Milliken construction (see Figure A1) with a central fluid duct'. Table A1: Note 1 added to Table A1 to include typical minimum pressure for Pirelli cable. Note 3 added to Table A1 to explain the alarm scenarios for cable pressure limits. Clauses A.3, A.4 and A.5 have been subject to a major revision to avoid duplication/confliction with the guidance in ENA EREC C55. Clause A.6: This Clause describing TOPMOS has been subject to minor amendments so as to generalise the description and ensure there is no inference of National Grid's internal policies. A new paragraph has been added to the end of the paragraph describing alternative solutions to TOPMOS, i.e. 'Drallim' product. Annex B: This Annex has been subject to a major amendment. It is considered inappropriate that safety information for specific cable fluids should be published in an ENA document. Rather, such safety information should be acquired from an appropriate source i.e. fluid manufacturer/supplier. Instead, Annex B now describes the legislative background to SDS information and the purpose of having the information. Details of all other technical, general and editorial amendments are included in the associated Document Amendment Summary for this Issue (available on request from the Operations Directorate of ENA).

Contents

Figures

Tables

Foreword

This Engineering Recommendation (EREC) is published by the Energy Networks Association (ENA) and comes into effect from the date of publication. It has been prepared under the authority of the ENA Engineering Policy and Standards Manager and has been approved for publication by the ENA Electricity Networks and Futures Group (ENFG). The approved abbreviated title of this engineering document is "EREC C135".

This issue supersedes and replaces Engineering Technical Report (ETR) 135, Issue 1 published 2006. The document has been revised in conjunction with the ENA Fluid Filled Cables Liaison Group and the Cable and Accessories Panel. The revision includes alignment with the latest fluid filled management practices and insertion of appropriate normative references.

In the UK & Ireland, each Network Operator has a requirement to be a safe and responsible company regarding its people, the environment and the communities served. In England, the *Operating Code for the management of fluid filled cable systems* [N1] requires Network Operators to "take all reasonably practicable steps to prevent pollution of Controlled Waters" and to "endeavour to reduce leakage rates using best available techniques" whilst "taking environmental risks associated with fluid filled cables into account in cable asset investment programmes." The Environment Agency's Director of Operations has stated previously that, "Ofgem and the EA [Environment Agency] agree that each electricity company should make leaks a thing of the past."

This document considers the management and operation of the fluid filled cable asset which should ultimately lead to their decommissioning. Guidance for the maintenance of FFCs can be found in ENA EREC C84/2, *Code of Practice for the maintenance of self-contained fluid-filled pressure-assisted cable systems up to 400kV operating voltage* [N6].

Where the term "shall" or "must" is used in this document it means the provision is mandatory. Where the term "should" is used in this document it means the provision is a recommendation. The term "may" is used to express permission.

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

Introduction

Energy Networks Association Member Companies (ENAMCs) own and operate fluid filled cable (FFC). The majority of this asset type was installed in the 1960s. Cables on average are designed to operate at maximum capacity for a period of 40 years. As the majority of cables are not operated at full load for their entire lifetime then it is expected that the life expectancy would greatly exceed this 40 year period. However, firm data does not exist to determine remaining useful life due to actual loading levels. Whilst the majority of cables have not failed electrically, it is recognised that there is an ongoing leakage issue across the industry which is further compounded where circuits are located in environmentally Sensitive Areas and areas of restricted access.

This document also provides guidance on the following points.

- The potential to install new FFC.
- Strategic investment decisions.
- An overview of the history of design and manufacture of FFC systems with regard to condition monitoring, leak location and repair.
- Detailed descriptions of design, construction, testing and fault location and repair (see Annex A to this document).

1 Scope

This document includes the techniques and processes by which existing fluid filled cables (FFC) may be operated and managed in a sustainable manner through to final decommissioning.

NOTE: Whilst there will be limited opportunities for decommissioning as a consequence of new business, reinforcement, and network reconfiguration investment, it is expected that the majority of decommissioning will be achieved through capital expenditure on replacement of the FFC asset.

2 Normative references

The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

IEC 60141-1, *Tests on oil-filled and gas-pressure cables and their accessories - Part 1: Oil-filled, paper or polypropylene paper laminate insulated, metal-sheathed cables and accessories for alternating voltages up to and including 500 kV.*

IEC 60141-2, *Tests on oil-filled and gas-pressure cables and their accessories - Part 2: Internal gas-pressure cables and accessories for alternating voltages up to 275 kV.*

IEC 60141-3, *Tests on oil-filled and gas-pressure cables and their accessories - Part 3: External gas-pressure (gas compression) cables and accessories for alternating voltages up to 275 kV.*

IEC 60141-4, *Tests on oil-filled and gas-pressure cables and their accessories - Part 4: Oil-impregnated paper-insulated high pressure oil-filled pipe-type cables and accessories for alternating voltages up to and including 400 kV.*

Other publications

[N1] *Operating Code on the Management of fluid filled cable systems*, Issue 3, 2013[1].

[N2] ENA TS 09-3, *33kV impregnated paper insulated oil-filled and gas-pressure type power cable systems.*

[N3] ENA TS 09-4, *66kV and 132kV impregnated paper insulated oil-filled and gas-pressure type power cable systems.*

[N4] ENA TS 09-5, *275 and 400kV impregnated paper insulated, oil-filled and gas compression type power cable systems.*

[N5] ENA EREC C55, *Insulated Sheath Power Cable Systems.*

[N6] ENA EREC C84/2, *Code of Practice for the maintenance of self-contained fluid-filled pressure-assisted cable systems up to 400kV operating voltage.*

[N7] Ofgem, *DNO Common Network Asset Indices Methodology – Health & Criticality – Draft Version 4, 15/12/2015*

[N8] Statutory Instrument 2015 No. 15, *The Construction (Design and Management) Regulations 2015*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
BAT
best available techniques

3.2
cable fluid
range of synthetic and mineral fluids used as impregnant for **fluid filled cables**.

3.3
CAPEX
capital expenditure

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[1] Joint agreement between ENA Member Companies and the Environment Agency, only applicable in England