INVESTMENT STRATEGY FOR DECOMMISSIONING FLUID-FILLED CABLES

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ABSTRACT

EDF Energy Networks operates the largest aggregate length of fluid-filled cable of any Network Operator in the UK. There is an ongoing leakage problem across the industry which is further compounded where circuits are located in environmentally sensitive areas and areas of restricted access.
The operational issues are especially challenging in the London distribution network, where over 50% of the EHV network is fluid-filled cable.
The Regulator has requested improved evidence of the specific challenges relating to fluid-filled cables in order to consider our future investment plans.
EDF Energy Networks' investment strategy is derived from ETR 135 'Guidance for the Operation and Management of Fluid-Filled Cables' and has the following objectives:

- *to ensure that EDF Energy Networks effectively manages the risk of fluid loss from cables,*
- *to ensure that the security of the network is maintained,*
- *to comply with environmental legislation,*
- *to set the criteria for prioritising the repair, refurbishment and decommissioning of fluid-filled cable (including asset replacement on a non like-for-like basis),*
- *to affirm fluid-filled cable decommissioning as a long-term capital expenditure programme.*

The information required to support our investment strategy includes the use of environmental mapping and revisions to the asset data structure. A scoring methodology has been devised to support a consistent risk-managed approach to investment in the asset, to balance asset condition with environmental risk.

INTRODUCTION

EDF Energy Networks is the licensed Distribution Networks Operator (DNO) for three network areas in the UK. Its principal objective is to provide and maintain a secure supply of electricity to approximately 25% of the UK population living in London, the East and South East of England.
EDF Energy Networks has a stated ambition to be a safe and responsible company regarding our people, the environment and the communities we serve.

Part of this ambition can be realised by reducing the amount of fluid lost to the environment through leakage from fluid-filled cables (FFC). EDF Energy Networks operates approximately 2,500 circuit km of FFC out of a national asset of approximately 7,800 circuit km. This is the largest aggregate length of FFC of any Network Operator in the UK. Nationally, the majority of this asset type was installed in the 1960s. On average, cables 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, it is expected that the life expectancy should greatly exceed this 40 year period. The remaining lifetime of the FFC out on the network is however, difficult to determine. Whilst the majority of cables have not failed electrically, it is recognised that there is an ongoing leakage problem across the industry which is further compounded where circuits are located in environmentally sensitive areas and areas of restricted access.
EDF Energy Networks' Leak Management Strategy has been developed from nationally-agreed guidelines. It describes how our existing FFC will be operated and managed in a sustainable manner through to final decommissioning (new FFC will be installed only in exceptional circumstances). Whilst there will be limited opportunities for decommissioning as a consequence of new business, reinforcement and investment in network reconfiguration, it is expected that the majority of decommissioning will be achieved through capital expenditure to replace the FFC assets.

ENVIRONMENTAL CONSIDERATIONS

The Environment Agency (EA) is responsible for water pollution control in England and Wales and has unlimited powers of prosecution for the pollution of watercourses. EDF Energy Networks and the other Network Operators have worked with the EA to produce the Operating Code for Fluid-Filled Cables (referred to as 'the Operating Code').
The Operating Code provides a framework for effective cooperation between the EA and Network Operators in dealing with incidents that have the potential to pollute the water environment. It does, however acknowledge the fact that FFC will be a feature of the electricity infrastructure for the medium to long term future.

The main obligations on Network Operators under the Operating Code are:

- to determine which parts, if any, of each route pass through Sensitive Areas;
- to report, on a monthly basis, any leakage exceeding 100 litres/month (or 40 litres/month in Sensitive Areas);
- to expedite leak location and repair;
- to take responsibility for remedial actions if pollution occurs;
- to endeavour to reduce leakage rates using Best Available Techniques (BAT) within the industry.

"Sensitive Areas" are defined as those areas where a cable is within 50m of a watercourse or known to be in close proximity to a vulnerable aquifer. Source Protection Zones around public supply abstractions and other sensitive targets are included.

ENGINEERING TECHNICAL REPORT 135

All of the Network Operators have collaborated to produce Engineering Technical Report (ETR) 135, Guidance for the Operation and Management of Fluid Filled Cables.
This is a Best Practice Guide, representing industry consensus over the need for active life-cycle management of FFC, and of collaboration in the development of BAT.

LEAK MANAGEMENT STRATEGY

EDF Energy Networks has produced its own Leak Management Strategy, based on the principles of ETR 135. It describes the process by which FFC is selected for refurbishment or decommissioning. This process balances asset condition and business risk to produce a flexible investment programme which will facilitate the decommissioning of cables in a poor condition (regardless of route) and those in high risk locations. A weighted scoring methodology has been developed for the selection. The selection will be reviewed as part of the annual investment planning process. It will also be reviewed in response to unplanned incidents involving FFC, such as damages and requests for diversions.

FFC INFORMATION

EDF Energy Networks' asset management information system has been enhanced to facilitate a risk-based strategic approach to the management of the FFC asset base, and the creation of network investment plans to support it. This includes, insofar as practicable:

- A comprehensive asset register,
- Knowledge of current and predicted asset condition and performance,
- Comprehensive knowledge of the cable condition recorded in the asset register,
- Pumping history to record the fluid lost from each cable section,
- Discovered cause of reported leaks,
- Repair history for each cable section,
- The CAPEX and OPEX costs related to network investment activities.
- Route Sensitive Area information,
- Network security/compliance issues,
- Physical access issues.

LEAK REPAIR

The Operating Code sets minimum performance standards for responding to and reporting leaks.
Where it is evident that a repair is required, the approach should include an assessment of:

- cable condition, as evidenced by leak and repair history, and analysis of the cable at the work site. For instance, degraded lead sheath is frequently discovered only when a repair is undertaken;
- environmental sensitivity, as determined by an environmental risk assessment for the route;
- operational difficulty, arising from:
  - analysis of the lead time to gain access to the cable;
  - restrictions on working hours (weekend-only working is frequently demanded in central London and unsociable hours working is often required in order to use the periods when roads are made available);
  - the network risk associated with circuit outage;
  - exceptional physical obstacles preventing access to the cable;
  - tramways, light rail and rail systems;
  - site-specific health and safety issues;
  - availability of spares;
- present (and projected) cost of operation, resulting from the above factors;
- traffic management restrictions on lead time, number and size of excavations.

REFURBISHMENT AND DECOMMISSIONING

Beyond the leak repair activity, on a more strategic level, there are five principal investment drivers to avoid future fluid loss:

- The Operating Code states that the DNO "…will take all reasonably practicable steps to prevent pollution of controlled waters, taking advice from the EA as required."
- The identification of circuits which pass through Sensitive Areas.
- Operational considerations such as network security.
- Obsolescence.
- Diversions due to third party activities on existing routes

Prioritisation for condition

Cable condition must be determined from leak and repair history and any diagnostic or physical evidence.
Joints, terminations and tanks/pipework can all usually be replaced or refurbished to serviceable condition. However, crystalline or porous lead sheath and phosphor bronze tape corrosion is irreparable and is usually not a localised condition. Replacement (or decommissioning) is the only practicable investment option for cable with degraded lead sheath. Approximately 90% of the FFC in the LPN networks is lead sheathed.
Crystalline or porous lead sheath is found only by physical examination of the cable, so it is important that condition information is determined during leak locations and repairs are recorded on the asset register.
Certain obsolete cable designs may have attendant problems with shortages of correct materials and relevant expertise, e.g. Mollerhoj cable. The lack of materials to carry out repairs can lead to extended repair times which will mean that network security is at risk in the event of failure or third party damage.
EDF Energy Networks believes that it is now the only operator of Mollerhoj cable in the UK supply industry, with approximately 25km still in service.

Prioritisation for environmental sensitivity

If an FFC circuit passes through a Sensitive Area, the probability of it polluting the area must be assessed.
There are three categories of Sensitive Area, each of which has its own hierarchy of needs;

- Source Protection Zone,
- Major and Minor Aquifer,
- Surface water or watercourse.

The overview of the three categories combined will help determine the prioritisation of environmental route risk.
Approximately 300 circuit km of EDF Energy Networks' FFC passes through 'Very High Risk' environmental areas.

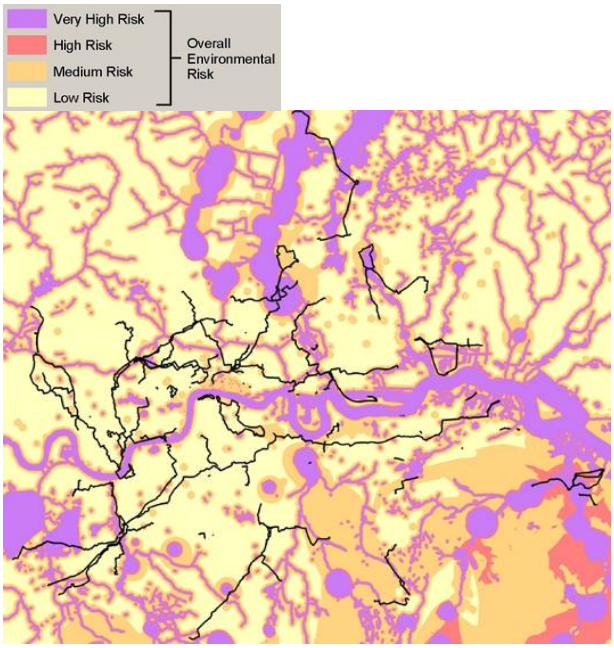

Figure 1: Fluid-filled cable routes in the London area, superimposed over environmental risk areas. The east-west route of the River Thames can be seen clearly.

Risk assessment on the cable route shall consider the vulnerability of joints and ancillary equipment within the Sensitive Area. Actions of mitigation may encompass the refurbishment and bunding of joints and equipment or their removal from the Sensitive Area. With regards to minimising the risk of third party damage, 'all reasonably practicable steps to prevent pollution' will include the provision of appropriate advice to Third Parties in order to avoid cable damage.

Operational Considerations

The factors which may determine the length of time taken to locate and repair leaks are discussed above. Over 50% of the EHV network in London is FFC.. This exacerbates the operational challenges, since leakage rate tends to vary with load. De-energising a circuit to locate a leak, may reduce the leak substantially on that circuit, whilst simultaneously causing leakage to increase on the supporting circuits.

WEIGHTED SCORING METHODOLOGY

A weighted scoring approach has been developed to quantify the different measurable factors which can be used to determine the potential impact of the operation of each fluid-filled cable section on the network.
The probability of a leak occurring is related to the condition of the cable and the number of potential leak sources in the circuit, the primary indicators of which are the amount of oil leaked and the cable repair history. The impact of the leak will be affected by the route of the cable through environmentally-sensitive areas and the potential time taken to trace and repair the leak.
Both probability and impact will be affected by a range of contributory factors, including operating pressure, type of cable sheath and the level of access to excavate and carry out leak locations and repairs.
Crystalline / porous lead sheath is irreparable and will therefore be a threshold criterion in determining which cables should be decommissioned rather than considered for refurbishment.

The scoring method scores each main criterion as follows:

Oil Pumping Rate, comprising:
Leak rate - from less than 40 litres/month (score 1) to 251-400 litres/month (score 20);
Aggregate leakage since leak detection - from less than 40 litres (score 0.1) to over 3000 litres (score 40)

Previous repair history - from over 5 years since last repair (score 1) to less than 180 days (score 15)
There is a further possible development to score the time elapsed from leak detection to leak location.

Environmental risk, based on the proportion of the cable length within Very High (score 60), High (score 40), Medium (score 20), Low risk (score 10) areas

Accessibility, based on presence of Traffic-managed routes and 'Red Routes' (score 10) to Arable Land (score 6)

Cable condition and source of leaks, from Third Party damage (score 3) to Crystallised lead sheath (score 20).

The results of the analyses so far have given a spread of overall assessment scores from 20 to 150. The methodology is tested for sensitivity to the values applied to the scores.

INVESTMENT PORTFOLIO

The revised analysis was applied to the circuits known to be the worst for leaks and to circuits in high risk environments. This exercise confirmed that our previous portfolio of investment proposals was reasonably prioritised. The portfolio has since been extended to include over 150 circuits. This has provided guidance to which circuits require further investigation. Ultimately, all fluid-filled cable sections will be risk-assessed and periodically reviewed for prioritised refurbishment or decommissioning. The improved analysis enables us to represent investment proposals for FFC decommissioning for condition or environmental reasons in a more objective manner than previously.

CONCLUSION

EDF Energy Networks has the greatest challenge of any UK network operator to manage its FFC asset. It has developed an objective risk-based process for assessing the investment needs relating to this asset which will form the basis for its long-term investment strategy.

REFERENCES

[1] Energy Networks Association, 2006, "ETR 135".

[2] ENA/Environment Agency, 2005, "Operating Code for Fluid-Filled Cables"