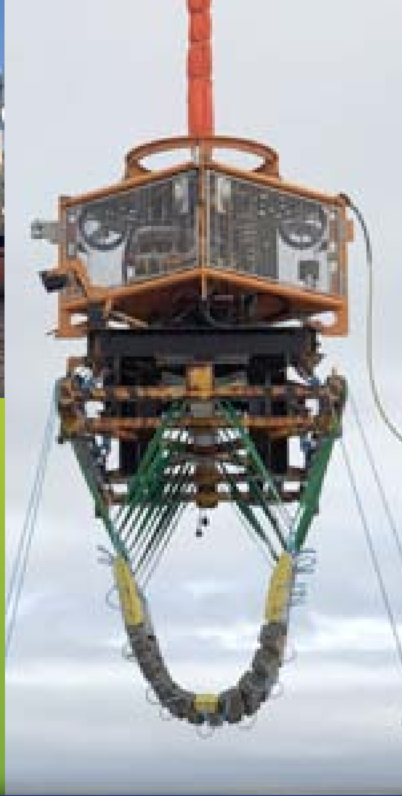

Scottish & Southern Electricity Networks

How we manage our

Submarine Electricity Cables

Overview

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Scottish & Southern Electricity Networks

About us

Scottish and Southern Electricity Networks (SSEN), operating under licence as Scottish Hydro Electric Power Distribution plc (SHEPD), delivers electricity to some 760,000 customers in the north of Scotland which covers a quarter of the UK landmass.

As well as the major towns and cities of Aberdeen, Dundee, Inverness and Perth, we connect to most Scottish islands with over 100 submarine electricity cable links, including the Inner and Outer Hebrides, Arran and the Orkney Islands. We also serve the Shetland Islands, which runs as a separate electrical system without a connection to the mainland.

As a natural monopoly, the amount of money charged for this service is regulated by Ofgem and shared between all electricity consumers across the north of Scotland as part of their energy bills. We have an obligation to do the right thing and keep the electricity distribution element of bills low whilst providing value for money.

We are embarking on a significant programme of investment to ensure that the fifty-nine Scottish islands who depend on us continue to receive a safe, reliable and secure supply of electricity. This document describes how we manage submarine electricity cables.

Our replacement programme

We decided, in collaboration with our regulators, customers and stakeholders to make this replacement programme one which was sustainable and puts the communities we serve and work amongst at the centre of decision making.

The journey to being truly sustainable began in 2015. Partnership working has been ongoing ever since to understand the complexities and sophistication required to achieve this.

To help us account for the impacts that our operations have on society, the environment and the economy; we have developed an innovative cost benefit analysis methodology.

This has moved SHEPD from an engineering based decision making model to a holistic risk based approach.

By applying the methodology, we can model scenarios which consider the full implications that our submarine electricity cable installation, protection and decommissioning proposals will have socially, environmentally and economically.

Communities have been consulted to determine if the resulting scenario is deliverable and fully considers local circumstances and represents best societal value. As a responsible developer, we must ensure that our decisions continue to protect the well-being of current and future generations.

Methods used to protect cables in the water

Jetting
High pressure water jets 'fluidise' the seabed allowing the cable to 'sink' into the seabed.

Mass flow excavation
A method of burial that clears sediment from underneath the cable.

Ploughing
A narrow trench is cut in the seabed in which to lay the cable.

Mattressing
A concrete 'mattress', typically 3m x 6m, is used to protect the cable at key points.

Horizontal directional drilling
Land-based solution of drilling under short passages of water.

Rock placement
Covering the cable with rock of a suitable size and type.

Rock filter bags
A filter bag filled with rocks is used to protect and secure the cable at key points for stability.

Surface laying
Submarine electricity cable is laid directly on the seabed with no additional protection.

Deciding what to do

Cable Health Assessment

We are responsible for around 454km of submarine electricity cables. These cables are regularly inspected throughout their operational lives.

After each inspection, our engineers assess the viability and efficiency of each cable. The cables are then given a Health and Criticality rating which determines the programme of work to be undertaken.

Health Rating Index

The Health of a cable is graded on a scale of HI1 to HI5, where 1 is a new cable and 5 is a cable nearing the end of its operational life. The assessment is based on;

1. The outward appearance and condition of the cable armour
2. Any changes to the cables position on the sea bed or physical protection
3. Any signs of third party activity in or around the cable.

Criticality Index Rating

The criticality rating of a cable is defined as the ability of the network to maintain supplies should the submarine electricity cable fail in service. The ability to provide a safe and reliable supply of electricity is directly affected by the impact the cable has on both the distribution and transmission networks.

The Criticality Index is rated on a scale of CI1 to CI4 where 1 has low impact; and 4 high impact on the safety and reliability of electricity supply received by customers.

Both the Criticality and Health rating scores are placed in our asset management matrix as shown below to help decide whether to repair, maintain or replace a submarine electricity cable.

Submarine Asset Health Selection Matrix

Criticality Rating	Asset Health Rating				
	HI1	HI2	HI3	HI4	HI5
CI1	Green	Green	Green	Yellow	Red
CI2	Green	Green	Yellow	Orange	Red
CI3	Green	Yellow	Orange	Orange	Red
CI4	Yellow	Orange	Orange	Red	Red

Key
- Green: Operating as expected
- Yellow: May need to carry out some maintenance or repairs
- Orange: Regular monitoring
- Red: Need to consider replacing the cable

Cross section of a submarine cable

1. **Armour** - Protects the conductors and gives the cable its physical strength. It also shields the cable during installation works and once in place, protects it from impacts within the marine environment.
2. **Insulation** - Prevents current flowing outside of the conductor. When insulation fails the cable faults.
3. **Conductor** - Carries the electrical current.

Cable Health Assessment

HI1

Health Scale Point - HI1

Cable Condition
New or as New.

Description
- There are no concerns over asset health
- The submarine electricity cable outer serving has no visible damage
- There is no exposed armour
- There is no exposed insulation.

Intervention in non-fault situation
No maintenance or repairs required.

Intervention in a fault situation
The cable has faulted but is in relatively good condition so repair may be an economic and efficient engineering solution (dependent on water depth and fault location).

Cable Health Assessment

HI2

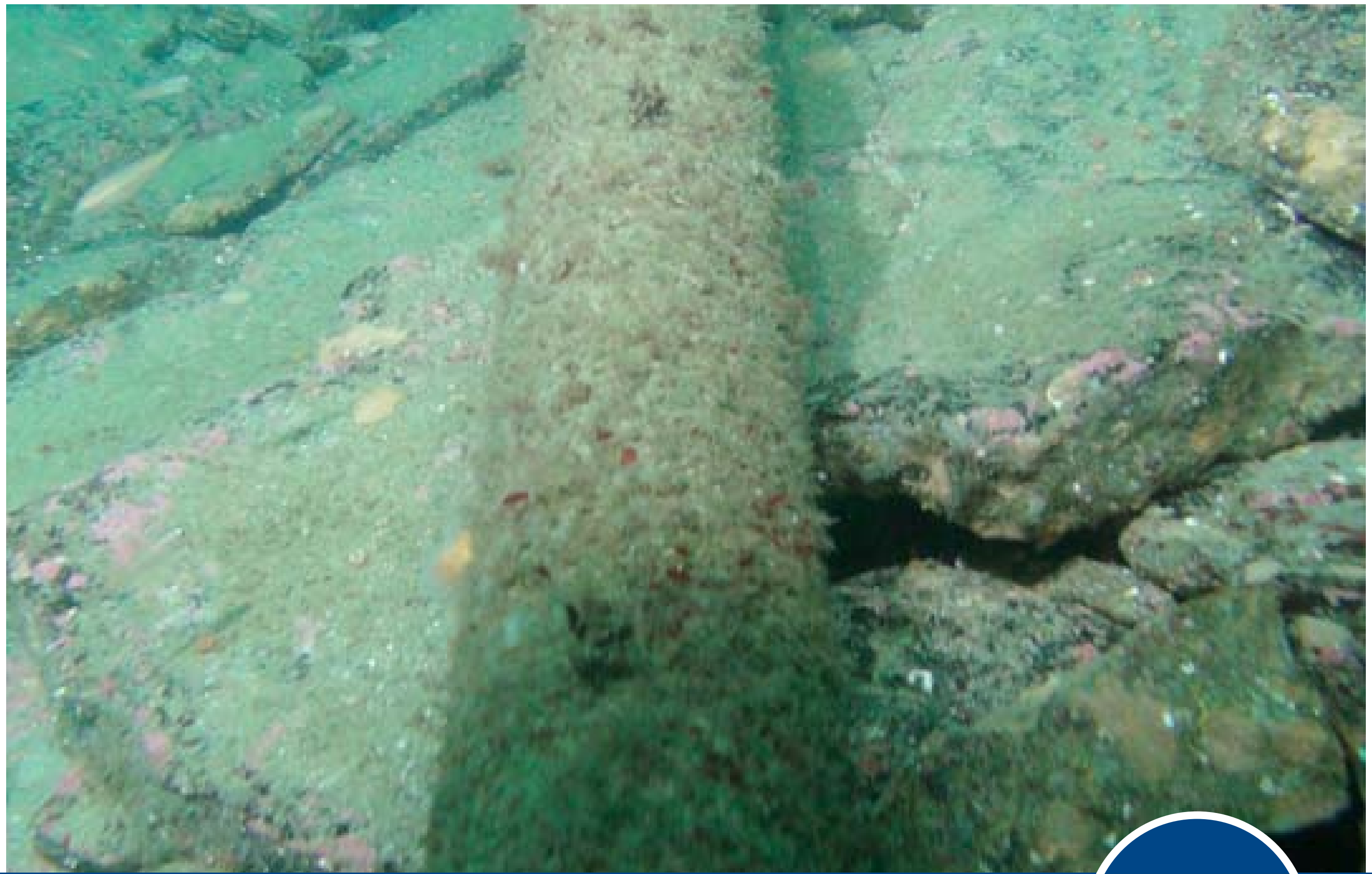
Health Scale Point - HI2

Cable Condition
Good or serviceable condition.

Description
- There are no concerns over asset health
- The submarine cable outer serving has visible damage
- There are small sections of exposed armour
- There is no exposed insulation.

Intervention in non-fault situation
No maintenance or repairs required.

Intervention in a fault situation
The cable has faulted but is in relatively good condition so repair may be an economic and efficient engineering solution (dependent on water depth and fault location).



Cable Health Assessment

HI3

Health Scale Point - HI3

Cable Condition
Deterioration requires assessment and monitoring.

Description
- Exhibiting signs that the submarine electricity cable is starting to age
- The submarine cable outer serving has visible damage
- There are small sections of exposed armour
- There is no exposed insulation.

Intervention in non-fault situation
It may be necessary to carry out maintenance works (but cable replacement is not required).

Maintenance is based on the addition of physical protection to extend the life of the submarine cable; or repair of existing protection measures.

Intervention in a fault situation
The cable has faulted but is in relatively good condition so repair may be an economic and efficient engineering solution (dependent on water depth and fault location).

HI4

Cable Health Assessment

Health Scale Point - HI4

Cable Condition
Material deterioration, intervention requires consideration.

Description
Significant sections of serving (outer layer of the armour) are missing. There are also significant lengths of erosion on the armours[1] in more than one area.

Intervention in non-fault situation
It is normally un-economic to consider any repair or maintenance works when the cable is in this condition, however this is considered on a case by case basis.

Therefore, replacement may be considered.

Intervention in a fault situation
Frequently, replacement is considered the most economic and efficient option.

The cable has faulted and its condition means that a repair is unlikely to be successful.

[1] If a submarine electricity cable has two layers of armour, it is acceptable to have a small number of outer armours damaged or missing but an increase in inspections would be necessary and is now in the window for either maintenance or replacement. Where inner armour is, damaged or corroded, this will constitute a minimum HI4.

HI5

Cable Health Assessment

Health Scale Point - HI5

Cable Condition
End of operational life, intervention required.

Description
- The submarine electricity cable is at risk from condition based failure
- The submarine cable outer serving has visible damage and has little or none left
- There are significant sections of exposed armour, with major corrosion to the armour
- Armour is likely to have lost mechanical strength
- There is exposed insulation.

Intervention in non-fault situation
Replacement is the only suitable option.

Intervention in a fault situation
Frequently, replacement is the most economic option.

The cable has faulted and its condition means that a repair is unlikely to be successful.

End of life cables

When a submarine electricity cable comes to the end of its operational life and is de-energised, there are three possible outcomes:

- Leave the cable within the marine environment
- Partial removal of the cable from the marine environment
- Remove the cable completely from the marine environment.

The preferred and most sustainable option is adopted following a decommissioning review which takes account of; health and safety, socio-economic, environmental, economic and engineering factors.

Scottish & Southern Electricity Networks

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