Certified Sustainable Cable Maintenance

Cable Maintenance Guide
for implementation in a life extension program




MANAGEMENT SYSTEM CERTIFICATION
DNV
ISO 9001 · ISO 14001
ISO 45001

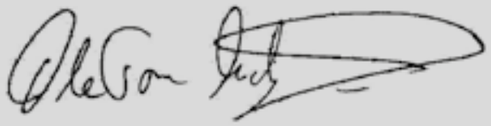
FIRE SECURITY

Fire Security has over 30 years of experience in the fire protection and lifetime extension of cables. During this time, we have encountered many different cable sheath conditions caused by numerous contributing factors. The pictures and descriptions that follow present an assessment of these conditions on a graded scale.

This guide is intended as a tool for electrical engineers, maintenance superintendents & asset managers to assist with grading the condition and expected lifetime of their cables and to consider if Fire Security could offer a cost-effective solution compared to cable replacement.

We work almost exclusively on live cables with no interruption to operations. Fire Security has also carried out projects on new cables where the installed cables were of a lower specification then the design tolerance called for.

Our coating solutions are approved by the major international classification societies. They have been utilized by major players in the oil & gas, power generation, smelter, heavy industrial & civil engineering projects, shipping & cruise liner industries.



Ole Tom Eidjord
Principal, CEO and President

Insulation Fundamentals

The fundamental understanding of cable insulation properties forms the foundation for assessment of cable operability. These same fundamentals provide the basis for evaluating whether various electrical and physical tests and measurements are meaningful, cost-effective, and warranted.

They are a basis for evaluation of present or conventional cable test practices against the critical properties of concern for:

- Cable operability
- Life extension
- Retention of the original environmental qualification, and
- The adequacy of environmental qualification

General Properties of Insulation

The electrical properties of concern for cable insulations are dielectric loss properties (resistivity, insulation resistance, dielectric constant and permittivity) and dielectric endurance properties (dielectric strength, breakdown strength, and ability to withstand corona discharge).

Although these properties are important for higher voltage and other specialty applications, many of them lose their importance for the low-voltage cabling used in most units. It is proven that the significance of mechanical and thermal properties depends upon the application of the cable, as such it may not be a concern for your unit.

Insulation resistance measurements are commonly used to evaluate insulation systems. For shielded cable, insulation resistance is directly related to the volume resistivity of the cable. For unshielded cable, the insulation resistance has a complex relationship to volume and surface resistivity because there is no shield for a return path.

Good Cable Insulation

When voltage is impressed across any insulation system, some current leaks into, through, and around the insulation. When testing with DC high-voltage, capacitive charging current, insulation absorption current, insulation leakage current, and by-pass current are all present to some degree.

For shielded cable, insulation is used to limit current leakage between the phase conductor and ground or between two conductors of differing potential. As long as the leakage current does not exceed a specific design limit, the cable is judged good and is able to deliver electrical energy to a load efficiently.

Cable insulation may be considered good when leakage current is negligible, but since there is no perfect insulator even good insulation allows some small amount of leakage current measured in microamperes.

When is a Cable Insulation Bad?

When the magnitude of the leakage current exceeds the design limit, the cable will no longer deliver energy efficiently.

Why A Cable Becomes Bad?

All insulation deteriorates naturally with age, especially when exposed to elevated temperature due to high loading and even when it is not physically damaged. In this case, there is a distributed flow of leakage current during a test or while energized.

Many substances such as water, oil, and chemicals may contaminate and shorten the life of insulation and cause serious problems. Exposure to UV, elevated ozone concentration will also shorten the life of cables.

Cross-linked polyethylene (XLPE) insulation is subject to a condition termed treeing. It has been found that the presence of moisture containing contaminants, irregular surfaces, or protrusions into the insulation plus electrical stress provides the proper environment for inception and growth of these trees within the polyethylene material.

Testing indicates that the breakdown strength of these treed cables is dramatically reduced. Damage caused by lightning, fire, or overheating may require repair, upgrading, or replacement of the cable to maintain or restore service.

Key elements of restoring and upgrading cables

The key elements of restoring and upgrading aging and deteriorating cables can be described as:

- Increased Insulation value
- Increased Dielectric strength
- Added UV resistance
- Added Ozone resistance
- Added Fire Protective properties
- Added Water resistance
- Added Chemical resistance
- Maintaining a flexible outer sheath

We grade cable condition into the following main categories

A-B New / Good appearance.
C Chemically affected cables.
UV UV affected cables.
QC Issue of sheath material at manufacture leading to early aging.
M Mechanically damaged cable.
H Heat / Fire damaged cables.

Examples of cable condition as per FS grading system

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A-B NEW / GOOD APPEARANCE

A1 New / good condition cable unbleached, dust covered for internal areas

Cables in this condition do not require any maintenance. Fire protection properties and lifetime extension would be increased by application of FS coating systems at this stage.

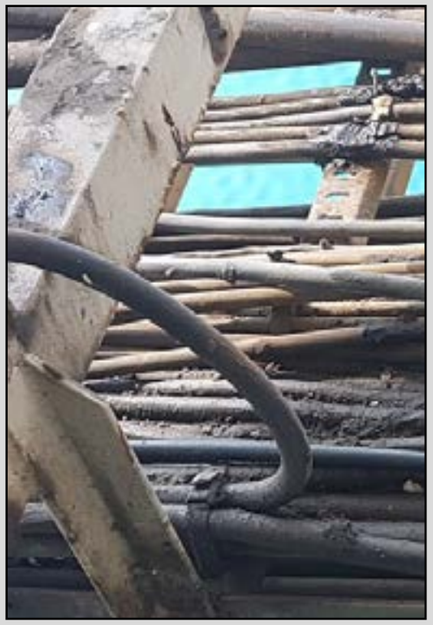
B1 Good appearance but with surface contaminates; Guano, moss, cement water-based drilling mud

Cables in this condition do not need to have any maintenance, however HP water blasting could be considered if contaminates build up in thickness possibly affecting the cooling properties of the sheath. Some cables could be bleached by Guano.

C CHEMICALLY AFFECTED CABLES

C1 Good appearance but with surface contaminates that may degrade the sheath: Acids, Oil based drilling Mud's, Hydraulic fluid, Gas Turbine / Compressor oil, grease & oil based paints

Many hydrocarbon-based chemicals could react with the cable to soften the outer sheath hydraulic fluid & compressor oil being of particular concern. It is advised to clean the cables using HP water and a degreaser like rig wash.

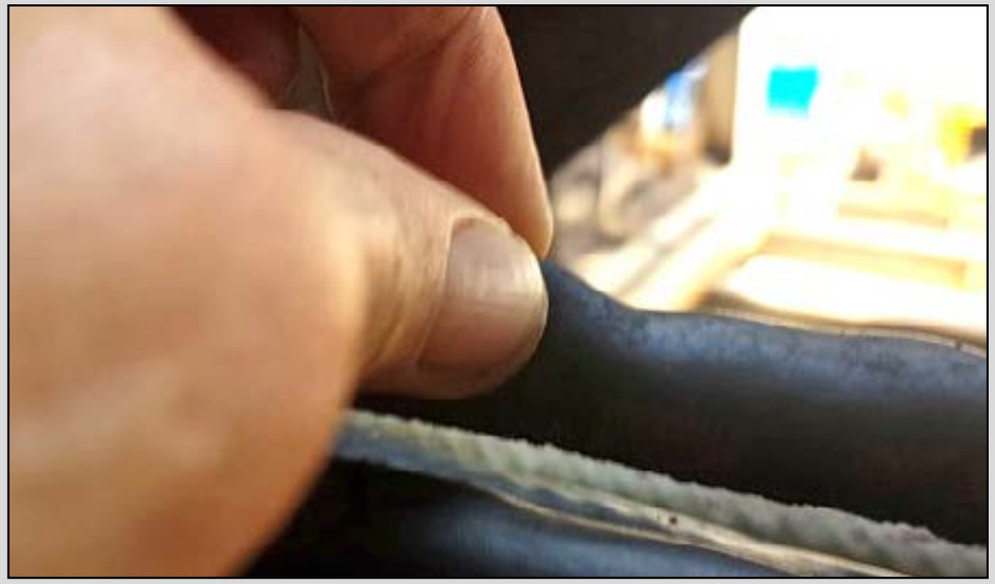


Attempt to pinch the sheath, if you can move it from the core, then chemical softening has already started. Washing and degreasing the cable may halt this process but the cable has already lost a high percentage of its protective capabilities: I.e. Low Smoke emission, insulation value, dielectric strength.

It is advised to coat the cable with FS5 at this stage to restore / enhance the lost properties of the sheath and to protect the sheath from further chemical degradation.

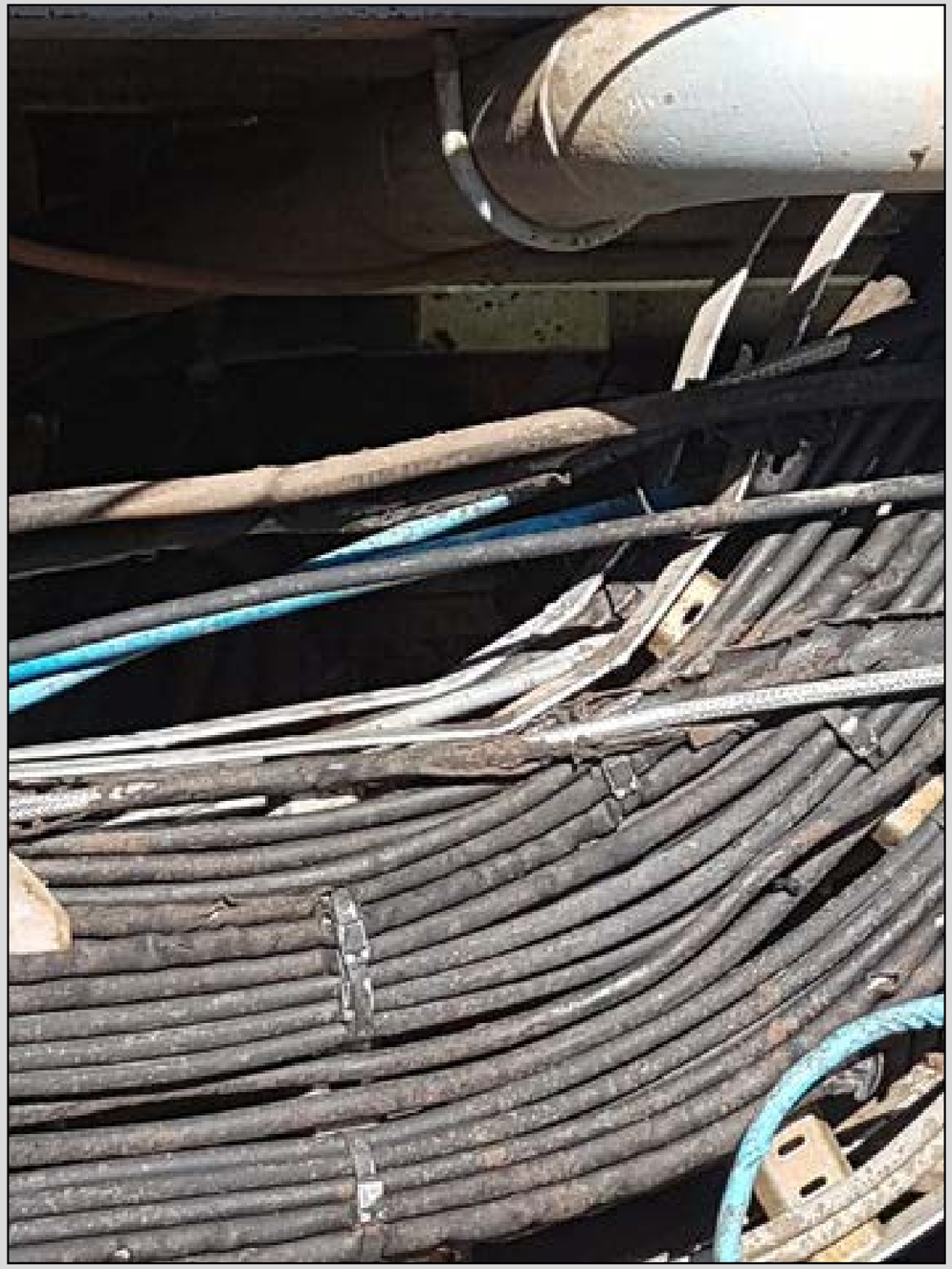
C2 Damaged sheath softened or even wrinkled sheath due to contaminates

Washing and then coating the cable with FS5 may be considered if wrinkled is still minor however, we would advise that FS carry out a survey and advise the correct course of action at this stage. The sheath can be fully stripped off and a new one installed utilizing our FS17 repair tape and FS5 coating system.



C2 Damaged sheath softened or even wrinkled sheath due to contaminates

C3 Failed sheath due to contaminates



Cables with fully failed outer sheaths can have the sheaths replaced by using FS17 repair tape and FS5 coating, armour (if present) may need to be replaced, this we can do with FS18 shielding tape. The condition of the inner sheath(s) to be assessed first.

UV UV AFFECTED CABLES

UV1 Colour faded (bleached) but not chalking

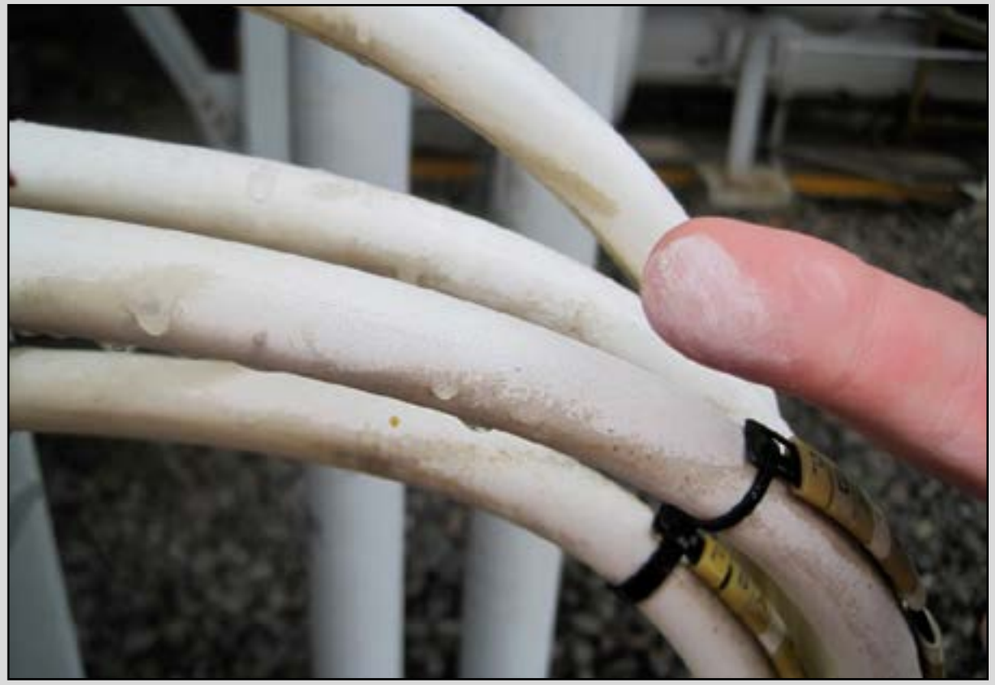
Red, yellow and blue cables tend to be affected by UV exposure worse than black or grey coloured cables. The first sign of UV degradation is loss of colour. This could indicate that the sheath material is at the first stage of UV affected breakdown.

UV2 Colour faded & chalking

Rub your gloved finger over the cable, if it comes away with a chalk like residue and the area that you have just rubbed is slightly shiny then chalking has started. This is a sure sign that the sheath material is beginning to break down. Life expectancy of the sheath at this stage is dependent upon thickness and quality of the remaining sheath. Erecting shade to cover cable runs may be considered or covering cable tray runs with covers. Application of FS5 at this stage will totally halt the UV aging of the cable.

UV2 Colour faded & chalking

UV3 Perishing started



UV3 Perishing started

Perishing or micro cracking of the cable sheath can occur at anytime after chalking has been noted. This may not be visible to the naked eye; a digital photo of the sheath can be taken, and by zooming in, micro cracking, if present, will be noted. Life expectancy of the cable at this stage could be anywhere between 18-36 months before the sheath fully cracks. At this stage many of the cable sheaths properties; dielectric strength and insulation values, have lowered considerably. Application of FS5 at this stage will totally halt aging of the cable and restore its lost properties.

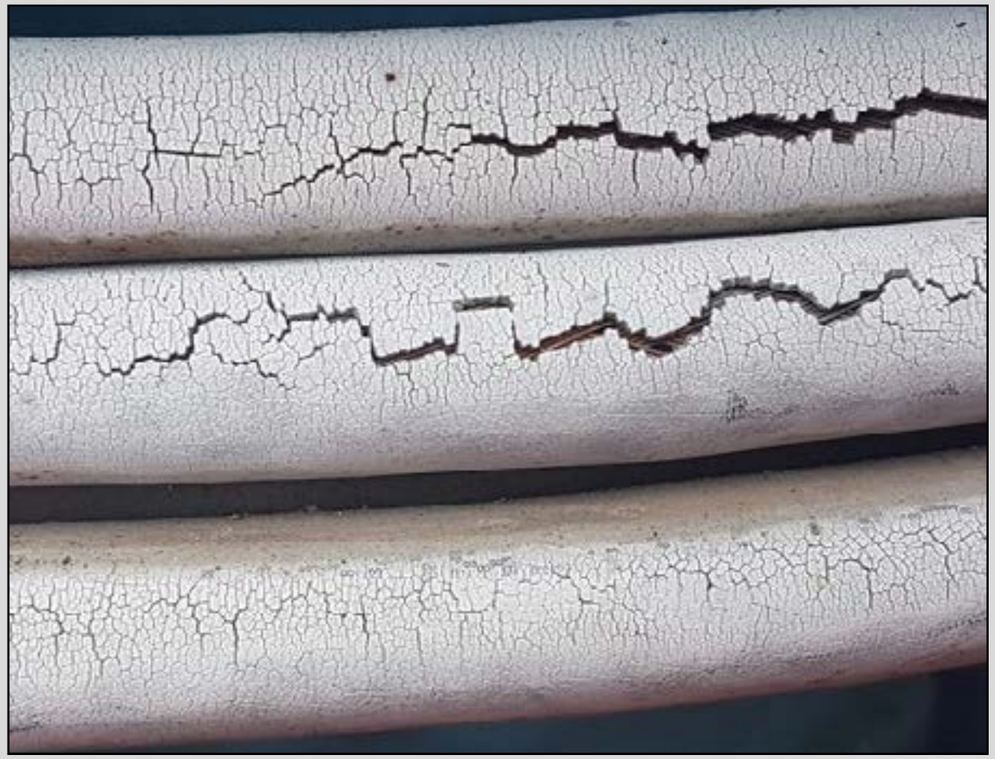
UV4 Heavily Perished

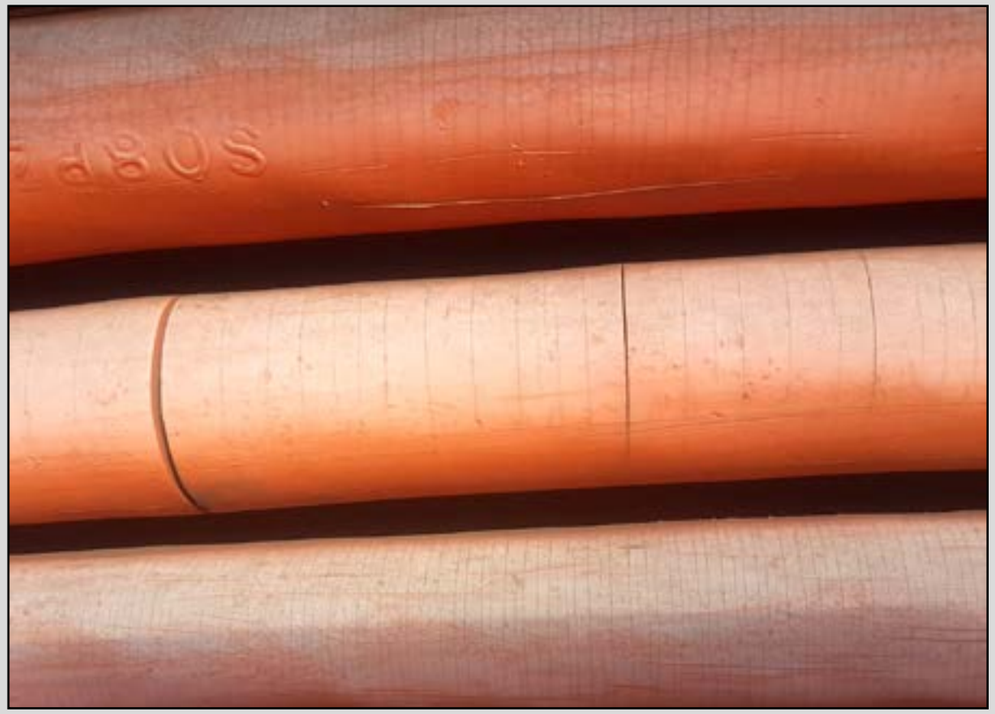
Cracks in the cable sheath will be fully visible to the naked eye but have not yet reached the armour or inner core. The sheath material may be very brittle and most of the cables dielectric strength and insulation value may have been lost. FS5 coating may need to be combined with an underlay of FS17 repair tape in places to restore the properties of the cables, depending upon how brittle the sheath material is.

UV5 Cracked sheath

Inner armour or inner sheath (if present) is now exposed, and the cable is now a major safety concern for hazardous (gas) areas. Fire Security offers various repair options at this stage, depending upon site conditions and operational constraints.

UV5 Cracked sheath





UV6 Cracked sheath, rusting armour

Inner armour or inner sheath (if present) is now exposed and the cable is now a major safety concern for hazardous (gas) areas. Rust streaking may be noted on the cable sheath and possible bulging of the sheath near cracks due to the rust expanding. Fire Security offers various repair options at this stage depending upon site conditions and operational constraints.

UV6 Cracked sheath, rusting armour

UV6 Cracked sheath, rusting armour

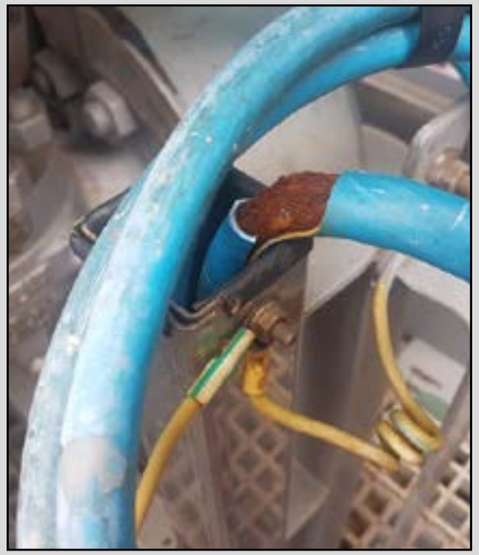
UV7 About to expose inner core

Fully failed outer sheath, stained with rust (if armour is present), and exposed inner core. At this stage, an HV cable should be considered beyond repair. If the client carries out megger testing and is happy with the results, then LV or Instrumentation/ control cables could be repaired (Not recommended for plant shut down or other critical operational cables).

QC ISSUE OF SHEATH MATERIAL AT MANUFACTURE LEADING TO EARLYSTAGING

QC1 Early ageing cable due to manufacture mishap, UV Exposed, may be graded on UV 1-7 scale

Fire Security offers various repair options for this, depending upon the extent of aging, site conditions and operational constraints.



QC2 Stress cracking, mostly on tight bends (Usually Transverse)

Transverse cracking normally found on the outside of cables on tight bends.

For small diameter cables; Cover with FS17 Tape, coat with FS5.

For large diameter cables, Fill with FS21, repair with FS17 Tape, coat with FS5.

QC3 Sheath material turning to a soft ‘gum’ like consistency

Similar to chemically affected cable sheath, the material can be ‘pinched’ and even ‘picked’ off the sheath, and sticks like chewing gum to the fingers.
FS has so far only come across this type of breakdown on exposed inner core wire sheaths at termination points. Options include coating the area with FS5 or slipping a pre-prepared colour coded sheath over the affected section.

M MECHANICALLY DAMAGED CABLES

M1 Impact / Chaffing (mechanical damage) damaged outer sheath

Cable sheath is either split by impact or worn down by repeated rubbing (chaffing) of the cable against a hard surface. FS17 Tape repair of area and coating with FS5. Friction protection in the form of rubber mats or Teflon sheeting to be installed to prevent further chaffing.

M2 Impact / Chaffing (mechanical damage) fully thru the sheath into armour

Cable sheath is either split by impact or worn down by repeated rubbing (chaffing) of the cable against a hard surface, the damage has extended to the armour, but the inner core is still intact.
FS18 Shielding tape repair of armour, FS17 tape repair above this, and coating with FS5. Friction protection in the form of rubber mats or Teflon sheeting to be installed to prevent further chaffing.

M3 Impact / Chaffing (mechanical damage) into inner core

Cable sheath is either split by impact or worn down by repeated rubbing (chaffing) of the cable against a hard surface, and damage has extended past the armour and into the inner core.

If the client carries out megger testing of the cable and is happy with the results, then the repair of LV & instrumentation cables may be carried out as for M2 condition cables. This is not recommended for HV or Plant shut down / operationally critical cables.

FS18 Shielding tape repair of armour, FS17 tape repair above this, and coating with FS5. Friction protection in the form of rubber mats or Teflon sheeting to be installed to prevent further chaffing.

H HEAT / FIRE DAMAGED CABLES

H1 Heat affected cable, sheath is misshapen and / or brittle

Sheath material has partially melted and then re-hardened. If the client is convinced that the inner core is not affected, then repairs to the outer sheath can be carried out. FS17 tape repair and coating with FS5

H2 Heat affected cable, the sheath is charred, possibly with burn thru spots to armour

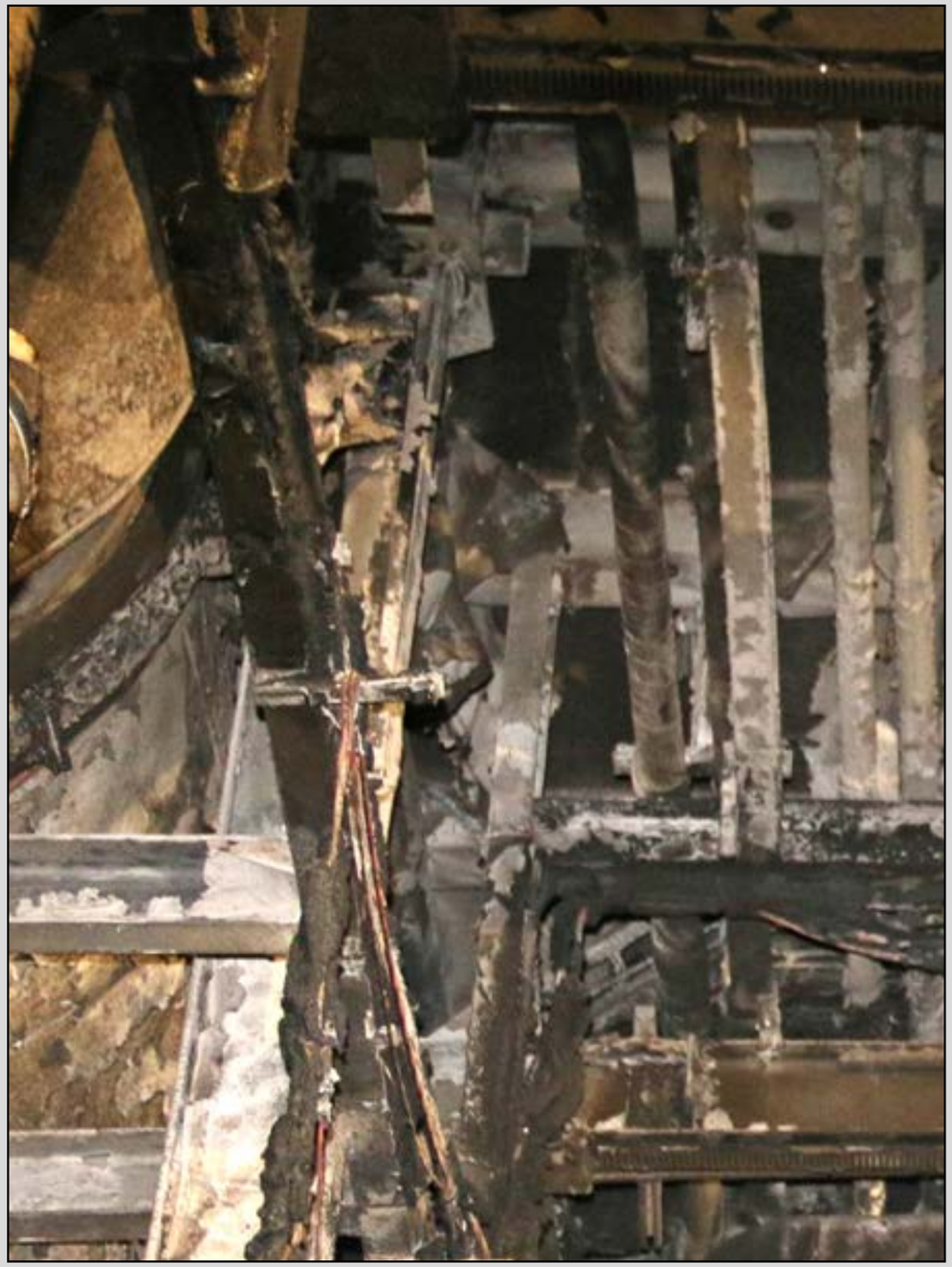
Cables that have been affected by fire but are still capable of operation.
FS17 tape repair and coating with FS5.

H3 Heat affected cable, the sheath is fully compromised, armour may be discoloured but is still intact, core unaffected

Cables that have been affected by fire but are still capable of operation.
FS17 tape repair and coating with FS5.

H3

H4 Heat affected cable, core exposed / fully failed sheath



Fully failed outer sheath, with exposed inner core due to external heat sources (for example cable near leaking exhaust). At this stage, an HV or instrumentation cable should be considered beyond repair. LV cables may be considered for repair. Various repair options are available depending upon site conditions and operational constraints.

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Sustainable Cable Maintenance

Protecting and prolonging the life span of electrical cables, FS has proven its worth for decades. We have an extensive reference list stretching from industrial plants, oil rigs and cruise ships to offshore wind farms. Our products are approved by leading classification societies and authorities. Our core activities are:

Using warranty backed applications only, FS repairs and upgrades damaged cables.

Cable life extension

The FS coating systems upgrade your cables and extend the lifetime by up to 3 times. No other fire protective cable coating is certified to be as resistant to UV, water, mud, oil, and a wide variety of damaging chemicals.

Cable repair

We repair cable sheaths that are damaged by UV, oil, mud, and mechanical stress. The coating restores the cable value, prevents future damage to cables and cable jackets, and eliminates the need for large-scale replacement. This is done with minimum shutdown time.

Fire protection

No other cable coating system has equal or better fire protection properties. Our coating provides superior fire protection compared to standard cables and can upgrade existing cables to the highest fire technical standard.

SAVE LIVES / SAVE COSTS / SAVE THE ENVIRONMENT

When exposed to fire, FS intumescent coating expands up to 100 times its thickness, forming a heat-protective shield.

Certified Sustainable Solutions

FS offer certified sustainable solutions to extend cable life and avoid electrical fire, using nothing but non-toxic materials.

Our commitment to the environment is documented through our DNV ISO 14001 environmental management systems certification.

Fire Security products and systems are LEED compliant, non-toxic, solvent-free, phosphate-free, and do not contain asbestos or any other substance identified as being cancerogenic. Our products release no poisonous and corrosive gases and smoke.

Significant reduction of excessive production and waste

By extending the life of cables, FS limits the need for resource-intensive cable replacement. Cables contain large volumes of plastic, PVC, XLPE in sheets and insulation. Those components are commonly incinerated openly or disposed of in landfills. Extending cable lifetimes mitigates the negative end-of-life environmental impact of cables, as well as the inherent environmental and resource cost of excessive production and installation of new cables.

Repaired cables are fully restored and functioning

FS procedures are tested and approved. We deliver a turnkey solution that avoids operation shutdown, removes the costly need for cable replacements, and halts the spread of further damages. Rejuvenated cables continue their operation with a warranty backed application.

Prevention of toxic and poisonous gasses

Our coatings prevent flame propagation and prevent escalation from a small fire to a major incident. FS cable fire protection minimizes impact from short circuits, removes cables as a source of combustion and prevents the release of toxic & poisonous gasses.

GREENHOUSE GAS EQUIVALENCIES CALCULATIONS

The Global Warming Potential (GWP 100) of production of 1000 meters of Single Core 630 mm² Voltage Grade 64/110KV cable is 32863 kgCO2eq. Extending the operating life of such cables and avoiding replacement has significant positive impacts.

1 meter = 82 miles
Keeping just 1 meter of cable in service is the equivalent of removing the GHG emissions of an average family car being driven for 82 miles.

10 meters = 39,975 charges
Keeping just 10 meters of cable in service is the equivalent of removing the CO2 emissions 39,975 smartphones being charged.

100 meters = 1.1 tonnes
Keeping just 100 meters of cable in service is the equivalent of avoiding the GHG emissions of 1.1 tonnes of unrecycled waste in a landfill.

1000 meters = 76 barrels
Keeping just 1000 meters of cable in service is the equivalent of removing the CO2 emissions from the consumption of 76 barrels of oil.

FS limits the need for resource intensive cable replacement.

Last updated April 2022

Certified Sustainable Cable Maintenance

FS offer certified sustainable solutions to extend cable life
and avoid electrical fire, using non-toxic materials.

Save Lives / Save Costs / Save The Environment

Our products have been approved by leading classification societies
and authorities including U.S. COAST GUARD, IMO MED D & IMO MED B,
Lloyd's Register, Achilles, Bureau Veritas, DNV, RINA, NMA, ABS, FM and UL

Sjøfartsdirektoratet
Norwegian Maritime Authority

DNV

FM Approvals

Notified Body
0575

BUREAU VERITAS

RINA

IMO

ABS

Lloyd's Register

UL Underwriters Laboratories

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