

### A.8.3. Evolution de la tenue diélectrique de câbles HT PRC après des essais de longue durée. Corrélation avec les propriétés physiques

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#### Résumé :

L'isolation d'un câble PRC 1200 mm<sup>2</sup> Cu 90 kV a été examinée après un essai de longue durée aux laboratoires d'essais EDF des Renardières. La durée a été de 30 000 heures. La boucle d'essai a été soumise à une tension de 90 kV (gradient maximum d'essai 9 kV/mm) et à des cycles de température jusqu'à 100 et 105°C au conducteur.

Les investigations sur l'isolation (à partir de films déroulés radialement à l'aide d'un tour) ont été réalisées sur le câble juste après sa réalisation puis après 15 000 heures et 30 000 heures de vieillissement. Une boucle (image) placée en parallèle avec le câble en essai et vieillie thermiquement, sans avoir été mise sous tension et servant au pilotage des cycles thermiques a aussi été caractérisée après 30 000 heures afin d'évaluer l'influence des contraintes thermiques et électriques combinées ou des contraintes thermiques seules sur le vieillissement de l'isolation.

Les propriétés diélectriques (tenue diélectrique en alternatif ou en choc) et les propriétés physiques ont été suivies et comparées à celles de l'isolation non vieillie. Les résultats montrent une bonne stabilité des propriétés diélectriques des câbles PRC sous vieillissement thermique ou sous vieillissement thermique et électrique combiné.

### A.8.3. Electrical breakdown strength evolution of HV XLPE cable after long-term test. Correlation with physical properties

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#### Summary :

Insulation of a 1200 mm<sup>2</sup> Cu 90 kV XLPE cable has been investigated after long term test in EDF test site of Renardières. Test was running during 30 000 hours. Cable test loop has been submitted to 90 kV phase to earth (max. working stress : 9 kV/mm) and heat cycled up to 100 and 105°C at the conductor.

Investigations on insulation have been carried out (in the radial direction by cutting thin films on a lathe), immediately after production, after 15 000 hours and after 30 000 hours. A parallel loop (dummy cable) aged thermally without electrical stresses and used for the monitoring of the heat cycles has also been characterized after 30 000 hours in order to evaluate combined thermal and electrical stress and thermal stress influence on the ageing of the insulation.

Dielectrical properties (ac and impulse breakdown strength) and physical properties have been followed with ageing time and compared to those of unaged insulation. The result show good stability of dielectric properties of the HV XLPE cables under thermal or combined thermal and electrical ageing.

#### 1/ TEST OBJECTS

Long duration tests have been performed in EDF Renardières on a 1200 mm<sup>2</sup> 90 kV XLPE cable.

A cable test loop of 100 m with outdoor porcelain terminations and joints had been installed in parallel with a dummy cable in the configuration shown below in fig.1

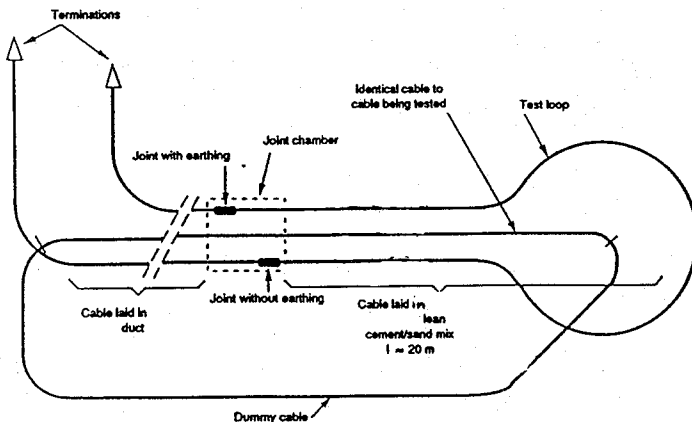


Fig.1 : Installation for long -term test (in EDF Renardières)

Cable test loop was submitted to 90 kV ac voltage phase to earth and heat cycled. The dummy cable was only heat cycled with the same current as in the main cable loop. Thermocouples were installed on the surface of the cables and on the conductor and surface of the dummy cable (image) to monitor the thermal cycling. Heating with a current passing through the conductor : current monitored by the thermocouples installed on the dummy cable's conductor.

Test was running during 30 000 hours, 4000 hours with cycling up to 100°C and the remaining of the time with cycling up to 105°C (8 hours heating, 16 hours off).

After 15 000 hours a piece of 30 m cable from one joint to the outer termination was cut out for ageing investigation. A new piece of cable with a new joint and a synthetic termination was installed to restore the cable test loop and test continued up to 30 000 hours.

Test cable and dummy cable were then digged out for further investigation.

For ageing studies the following test objects were now available

- new 1200 mm<sup>2</sup> Copper 90 kV XLPE cable
- cable pieces aged 15 000 and 30 000 hours under dielectric stresses (9 kV/mm) and heat cycles
- cable pieces aged 30 000 hours only under heat cycles

#### 2/ TESTS PERFORMED ON TEST OBJECTS

##### .Dielectric tests

- impulse breakdown tests
- ac breakdown test
- dc breakdown test

##### .Oxydation

- .Cristallinity
- .Acetophenon content
- .Diffusion of low molecular weight material from semicon to insulation
- .Microvoids
- .Treeing