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A NEW SPECIFICATION TO CHECK CABLE SHEATH RESISTANCE TO TERMITES

Yves BRUMENT, Electricité de France R&D, France, yves.brument@edf.fr
Frédéric LESUR, Electricité de France R&D, France, frederic-der.lesur@edf.fr
Ivan PAULMIER, Centre Technique du Bois et de l'Ameublement, France, ivan.paulmier@ctba.fr

ABSTRACT

Termites are xylophagous insects well known for the spectacular damage caused to wooden buildings or structures.
The distribution surface of theses insects has spread widely from the initial warm climate zones.
Electrical equipment does not escape termite attack. We do not know exactly why termites gnaw the underground cable jacket in places. Several assumptions can be suggested: obstacles, soil softness, magnetic field, etc.
The paper describes the adopted approach, the outline of specification and results of investigation tests made on raw materials used on MV French cable.
The results show that sheath resistance depends on the hardness of the sheath instead of the density of the compound.

KEYWORDS

Termites, specification, density, hardness, environment

INTRODUCTION – CURRENT SITUATION

EDF purchasing department used to buy MV cables with an option called "anti termite". These cables were essentially supplied for the south and southwest areas of France.

Manufacturers add master batch in the PVC or PE sheath compound in order to make it "anti termite".

However, paradoxically, no specification existed to check the efficiency of this option. EDF, the French electricity utility, asked its R&D branch to think about this lacuna and to propose a new specification in order to check the resistance of cable sheath against "termites' attack".

THE PROBLEM TO SOLVE

The elaboration of a new test, representative of the conditions in nature to check the cable jacket is quite difficult. The major reason is to be able to give results in a short time and not after long months period (even years).

Above all, EDF R&D verified the number of faults due to termites attacks on the metropolitan MV network. The result was that **the service experience does not currently indicate** this kind of problem.

These preliminary items have to be considered to imagine a test **economically reasonable** and **technically representative**.

The EU directives are tighter and tighter and the use of chemical products is increasingly more restricting regarding health and environmental matters. So, this work about a new notion "termites resistant" instead of "anti termites" is essential not only for utilities but also for manufacturers.

The question of the cable sheath resistance to termites thus quickly arose with the manufacturers. Their opinion resulted in wondering about the manner of withstanding the termites attacks: increasing of the sheath hardness, addition of insecticide products or addition of repulsive products.

A LITTLE BIOLOGY –TERMITES IN FRANCE

generalities

Termites are social insects of the Isoptera order. They eat deadwood normally. Xylophagous insects adapt to their environment and do not hesitate to attack anything containing cellulose. Termites can thus cause significant damage in particular to buildings or structures using wood.

In France, six species of termites are referenced to date. Among them, five species of underground termites belonging to the *Reticulitermes* genus. Their distribution is widespread. Today, only the areas of the North-East of France seem to be unaffected.

They are often called "white ants" but do not have anything to do with these insects.

Termite colonies are organized into morphological and functional casts : workers, soldiers, larvae, nymphs and two types of reproducers : neotenics (reproductive nymphs) and from swarmer allates.

Distribution of the termites in Metropolitan France

The maps which follow specify the areas covered by termites and in particular the two species which will be used to check the "termite resistance" of the LV and MV cable sheaths: *Reticulitermes Santonensis* and *R. Grassei*.

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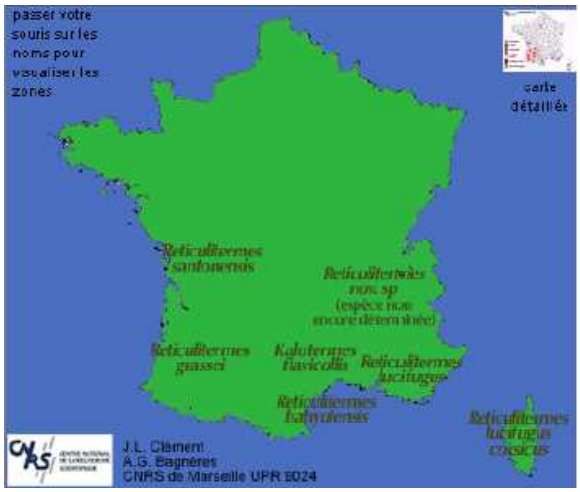
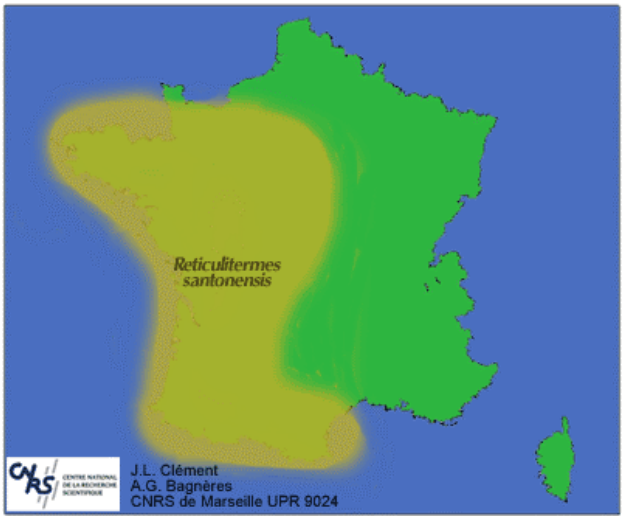
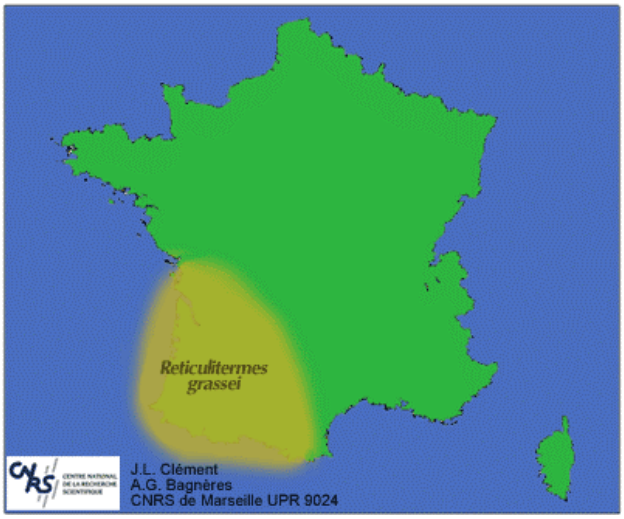


General distribution of termites in France

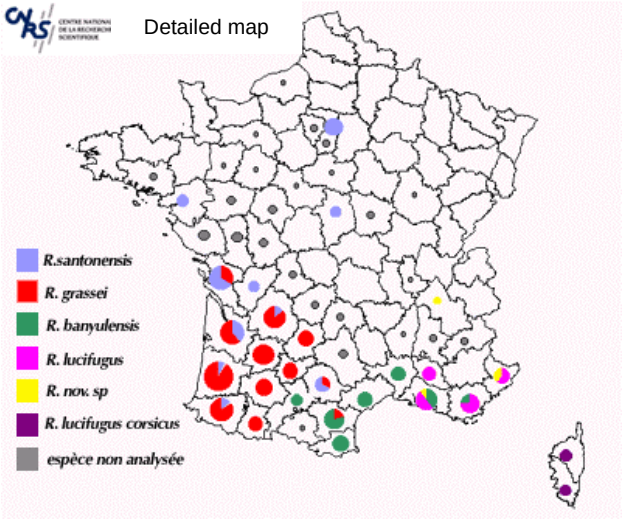


Distribution of the R. Santonensis specie

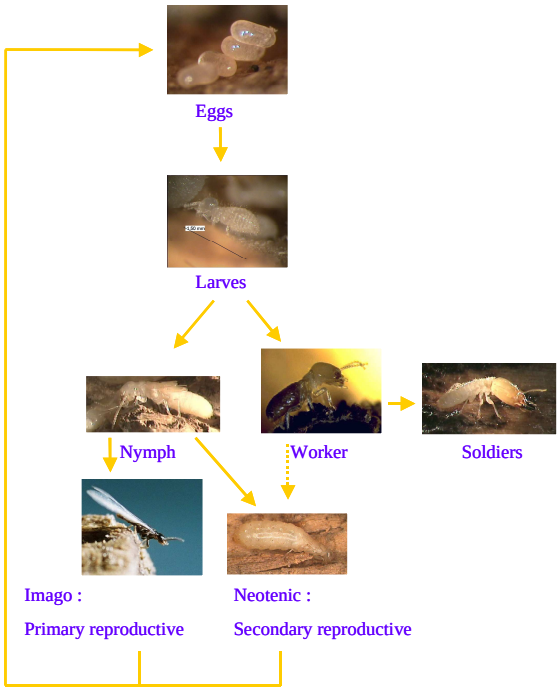


Distribution of the R. Grassei specie

The map below precisely shows the distribution of the termites according to French départements concerned.

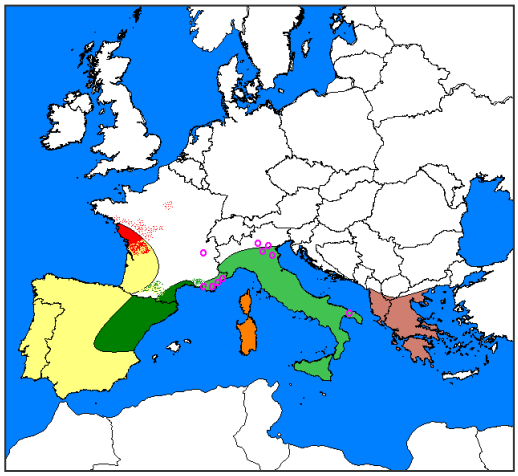


The biological life cycle of termites is the following:



By courtesy of CTBA - Bordeaux

To be as exhaustive as possible on the distribution of sub-terranean termites, the map below shows their **distribution in Europe**:



key:

- Red area = R. santonensis
- Yellow area = R. grassei
- Dark green = R. banyulensis
- Green = R. lucifugus
- Orange = R. corsicus
- violet circle = R. urbis (balkanensis ?)
- purple = R. balkanensis

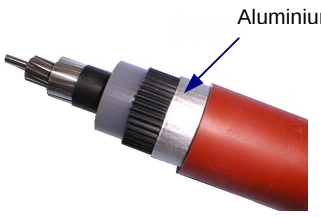
PROBLEMS ARISING IN THE EVENT OF EDF USED CABLES ATTACKED BY TERMITES

Today, we still do not have a sensible explanation of cable sheaths being devoured by Termites. We can think that these beams of cables represent an obstacle to their progression.
But other assumptions can be suggested:

- the soil softness around the cable would attract the termites,
- the magnetic field would disturb the insects …

As many assumptions as we cannot answer.

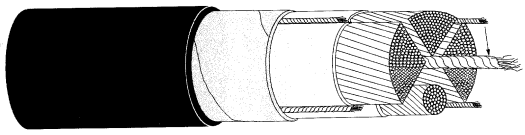
For MV cable design: when a termite attacks the cable jacket, it faces the aluminium tape screen. This obstacle is insurmountable for insects but opens up the way to humidity and then to aluminium screen corrosion.



The screen corrosion is the most known degradation of premature ageing mode on MV cable with PVC sheath (HN 33-S-23 or UTE C 33-223 cables).

The generalization of polyethylene sheath use with the technical stage NF C 33-226 modifies noticeably the jacket behaviour. **However for the moment we cannot predict this behaviour in case of termites attack**.

For LV cable design: the problem is slightly different because this cable, by its design, is not watertight.



The French LV network cable is made up of an external PVC sheath, two galvanized steel tapes with twist lay, three sector shape phases with reticulated polyethylene insulation, fillers with swelling powder, and a stranded aluminium wires and grease (neutral conductor) with lead sheathing for water tightness.

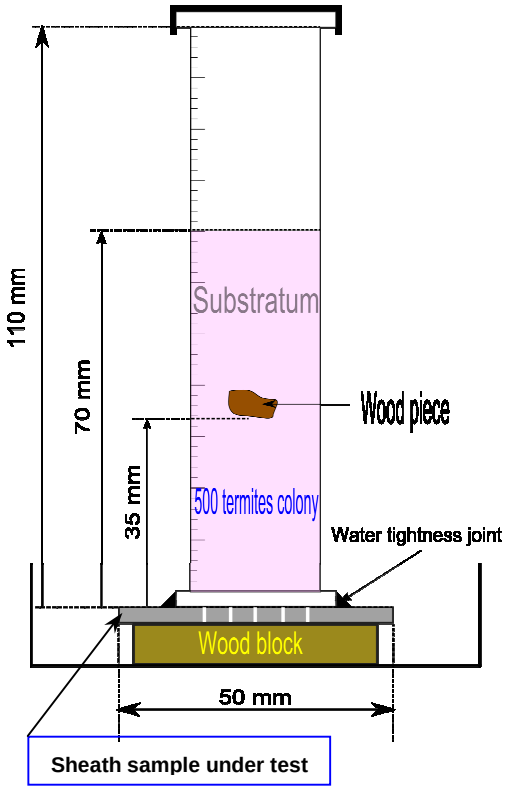
In case of termite attack, after gnawing the cable jacket, the termites could penetrate inside the cable through the interstices between the tapes. Then they are in contact with phase and fillers which contain cellulose. The local absence of water tightness may cause corrosion of the galvanized steel screen or the termite workers may gnaw the insulation causing short-circuits.

THE BASES OF THE NEW SPECIFICATION

A first investigation test was performed by a manufacturer on 2003 at the CTBA (Centre Technique du Bois et de l'Ameublement / Technical centre of wood and furniture). Based on the European Norm EN 118 [1]. This new test has adapted the standard to the particular situation of cable.

Test facility

The figure below show the test facility developed for checking the cable sheath behaviour against termite attack.



Sample

The sheath sample is a square whose side is 50 mm. For each material, the number of samples is fixed to 3.

The sample thickness has to be as close as possible to the minimum thickness declared in the identification file and to indicative medium thickness.

A description datasheet will have to follow the sample.

Test requirements

This test assembly is put into a climatic dark room whose **temperature** is regulated at **(27±2)℃** .

The substratum is kept wet regularly. The **relative humidity** in the climatic chamber is controlled and regulated at **(80±5)%.**

The conditions of temperature and humidity must be as close as possible to natural conditions. In this favourable environment, Termites feel comfortable and can be as active as possible.

The test lasts **8 weeks**. After this test period, the samples are removed from the test facility and observed under a microscope to evaluate the extent of attack.

Two species of termites were chosen. They represent the largest distribution of termites in France:

- *Reticuliterme santonensis* (or de Saintonge)
- *Reticuliterme grassei*

A first test lead to define the main characteristics of the requirements:

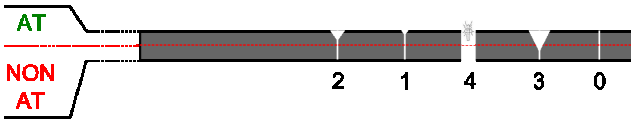
- the number of termites
- the scale of degradation and sanctions adapted to the cable

For the first point, two tests were carried out to determine the number of termites (250 termites colony and 500). Finally, the number of 500 termites was held to obtain a sufficient pressure on the sample and to be able to enlarge the holes made in the sample (4 holes of 0.5 to 0.6 mm in diameter to be compared with termites dimensions: 4 to 6 mm long and at least 1 mm large).

For the second point, we think that if sheath thickness after the attack is more than the halfway through, the sheath must be considered as **termites resistant**.

So we put in place a sanction scale as below:

Quotation	Interpretation / Visual examination	Sanction
0	No attack	Resistant to termites
1	Surface erosion of very low depth not being able to be measured or maximum depth attack ≤ 25% sheath sample thickness	Resistant to termites
2	Medium depth attack between 25 et 50% sheath sample thickness	Resistant to termites
3	Severe attack of the sheath with depth higher than 50%	Non resistant to termites
4	Complete boring of the sheath and passage of termites	Non resistant to termites



If only one hole is quoted 3 on one sample then the model of sheath is declared **non resistant to termites**.

Tests in progress

Some first difficulties appeared in the manufacturing of the samples. Tests are now in progress at the CTBA biology laboratory.

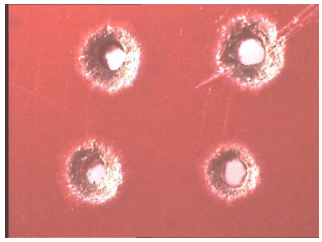
Test facility

Climatic chamber

The samples under test represent all the kinds of sheath used on MV EDF network.

After this first test campaign, the test duration seemed too long for termites which cannot survive all the 8 weeks required. The termites dead after a 4 to 5 week period. The solution to maintain alive and active the termites consists in giving them more wood (food) in the tube to ensure their conservation.

The depth of attack for each holes is measured with a comparator with a precision of 0.01 mm. Then we compare this depth to the sheath thickness in order to evaluate the quotation according to the quotation scale.

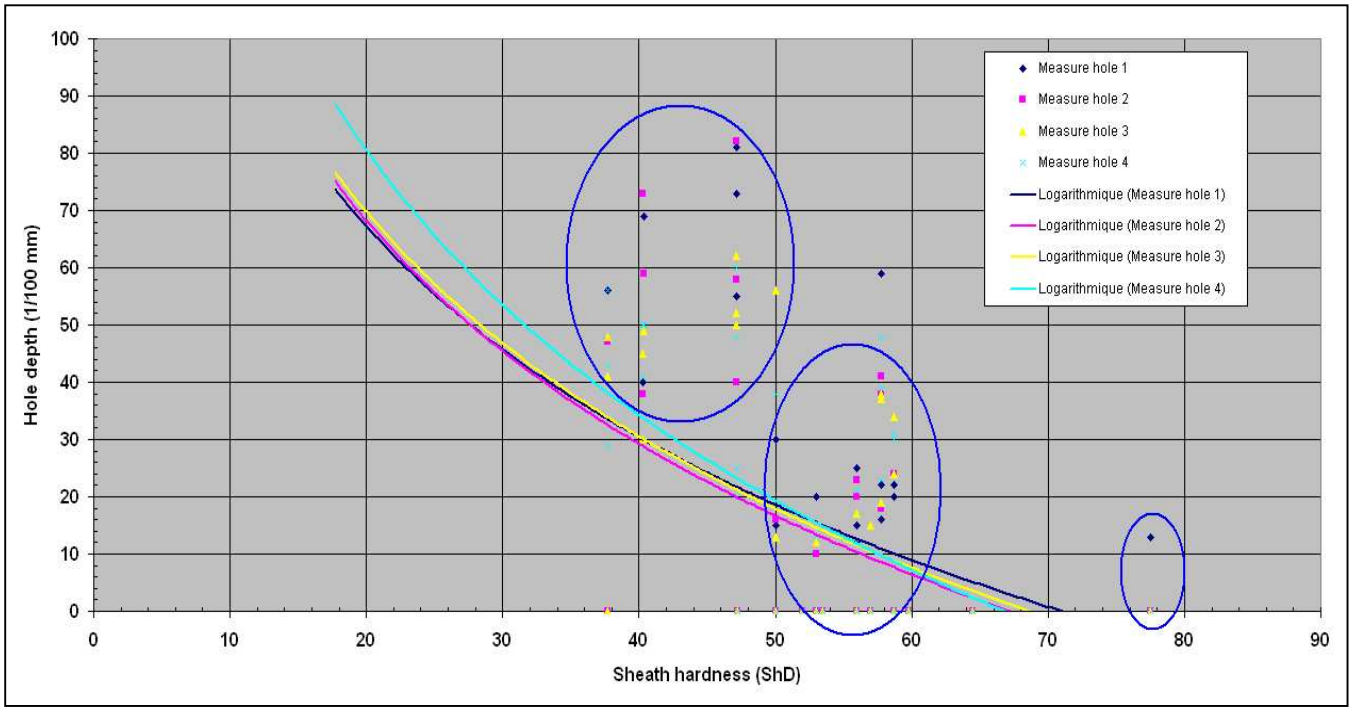


Enlargement of holes in sheath

zoom

The quotation of attack is compared to the hardness of each sample.

The diagram below shows the depth measures in function of sheath hardness.



Three families of sheath behaviour can be highlighted:

- A first one under 50 ShD for which the depth of holes is generally more than 0.4 mm.
- A second one, between 50 and 60 ShD in which the depth of hole is near 0.2 mm.
- the final family is upper 70 ShD where termites have a lot of difficulties to attack the sheath.

CONCLUSION

All the results show that for the kind *R. santonensis*, the sheaths can be validated as “Resistant to termites”, the maximum quotation measured being 2 according to measured scale.

So **we think that the use of biocide or repulsive products added to raw material is not really required** even if their adjunction show their action during the test.

These results are on all points in accordance to the CIGRE study led on 1994 which showed the importance of sheath hardness.

PROSPECTS

We know that the sheath hardness is a solution to protect the underground cable against termite attack. But in some case, we could not increase this parameter for laying reasons.

For environmental considerations, we could think that instead of useing chemical products to avoid termite attack, an increase of sheath hardness should be sufficient.

However the most important is not yet known: the reasons why sometimes termites attack cables.

A new study in **real operating conditions** could be put in place to better understand the conditions which launch a termite attack:

- influence of magnetic field
- influence of soil softness
- etc.

ACKNOWLEDGEMENTS

We would like to thank especially all the members of the “biology” laboratory of the CTBA who helped us to produce this paper.

REFERENCES

[1] EN 118: Wood preservatives - Determination of preventive action against Reticulitermes species (European termites) - Laboratory method