

RETHINKING HELICOPTER-BASED INSPECTIONS

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ABSTRACT

The works described in this document are collectively conducted by EDF R&D and ERDF (the French distribution network operator).

The objective is to improve the analysis of the helicopter-based inspections of medium voltage overhead lines. The approach consists in establishing an operational standard, which indicates, for the various components, the link between the visual aspect and the residual mechanical strength and life expectancy.

INTRODUCTION

While the new MV distribution networks are essentially realized in underground technique, overhead lines still represent more than 60 % of the existing MV assets - or more than 360 000 km of lines - and their integrity has a direct impact on the safety of the agents and the third parties, and on the quality of supply of the customers.

In order to manage at best its MV overhead network, ERDF needs to refine the indicators that testify to the ageing level of these lines.

HELICOPTER-BASED INSPECTIONS

Campaigns of helicopter-based inspections already allow to identify abnormalities on the network, with a strictly visual criterion. On average, one third of MV overhead assets is controlled each year, which allows to give quick an extensive diagnosis. The detected abnormalities constitute then an important part of the annual maintenance schedule (apart from periodic maintenance).

Operational units deal with the inspection reports at a local level, with a standard that allows to classify the points to be treated. The diagnosis is then confirmed from the ground during the work preparation.

The realized classification is relevant for the all or none defects: broken clamps, broken strands, etc. However, it lacks a gradation on the ageing of some materials, and essentially supports. The diagnosis then includes subjectivity and it can vary from one region to another.

THE TOOL « PHOTOS-GAUGE »

The works performed are first based on the study of the ageing and degradation modes of the most critical components of MV overhead lines.

A theoretical and experimental study besides established for these equipments the relevance of the visual criterion compared to the reality of the ageing: residual mechanical strength and remaining life expectancy.

Criteria were then included in a decision-making tool called "Photos-gauge".

This tool refines the diagnosis of abnormalities, by harmonizing for the various equipments an emergency level for the intervention:

- Urgency 1 = to be realized quickly,
- Urgency 2 = to be realized within a period T,
- Urgency 3 = the treatment can be postponed.

If necessary, when the visual criterion is not relevant, a means of control is proposed for a ground-based inspection.

Concrete poles

The main degradation mode of concrete poles is the corrosion of steel reinforcement. Steel corrosion is triggered by acidity in its environment, when steel rods are exposed (further to the concrete explosion during cycles of frost - thaw) or due to the penetration of aggressive agents through the concrete (carbon and chlorine).

Our study showed that we could estimate the residual mechanical strength of a degraded pole according to the number and to the localization of the visible steel rods on one hand, and to their rate of corrosion on the other hand.

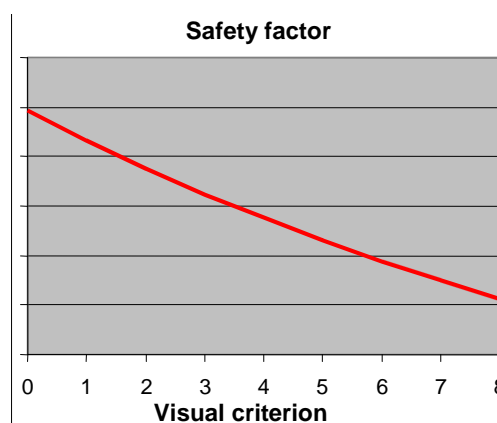
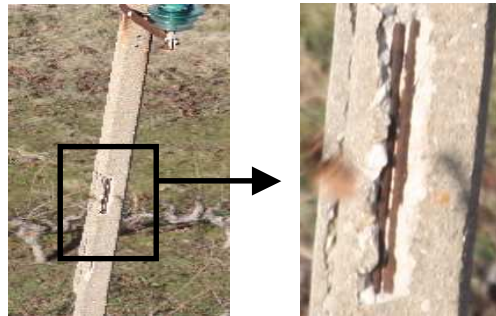


Figure 1: evaluation of the residual safety factor of a concrete pole, based on a visual criterion

These criteria being visual, it results an objective and simplified standard, which allows to draw a gradation of the ageing.

The evaluation can be realized in certain cases directly from photos taken during the helicopter-based inspections, if these are of sufficient quality.



Urgency 3

Figure 2: Diagnostic sur photographie

In any case, an additional measure from the ground allows to refine the diagnosis. An on-site visit is systematically realized to prepare an intervention.

Wood poles

Damages can be divided in two categories: external attacks of animals (woodpeckers, cattle), and internal damages at ground level (rotting).

External damages are visible during the helicopter-based visits. By following the same approach as for concrete poles, we elaborated visual criteria that estimate the residual mechanical strength.

Photos	Report	Diagnosis
	Woodpecker hole 37% of the diameter > ¾ height	Urgency 3
	Cattle rubbing Decrease of the diameter by 30%	Urgency 1

Figure 3: Examples of diagnoses of external damages of wood poles

Nevertheless, the detection of the rotting of a pole next to the ground, for example, requires a ground-based inspection, and the use of a monitoring device.

Conductors

The mechanical strength of conductors decreases essentially due to the break of strands because of lightning or due to mechanical fatigue. The treatment of broken strands is made systematically as a matter of urgency, what allows to slow down the process of degradation, by protecting the internal layers.

For bi-metallic conductors, there is also a phenomenon of steel core corrosion, but which was not observed on a large scale on the French territory. So we do not recommend a systematic control of these conductors.

A second security criterion - statutory – is the clearance to the ground. This height decreases with the lengthening of the conductors, after high overloads or creep. Our study - validated by laboratory tests in 2009 - showed that retensioning a conductor allows to free oneself to a large extent from later elongations.

Fittings

U-bolt eye assemblies, on suspension sets, wear out by friction by the insulator sets swinging under low and frequent wind. The eye becomes then the weak point of the chain. The global level of wearing can be detected on photos taken by helicopter or from the ground.

In 2008-2009, we conducted two campaigns of measurement on aged materials from the network, which permitted us to estimate on the one hand the rate of wear localized on the eye, and on the other hand the residual mechanical strength as a function of the rate of wear of the eye.

The criterion of the life end corresponds to a sufficient residual thickness to ensure the mechanical strength of the set. An ageing model permits then to obtain the residual life expectancy of a set as a function of to the age of the material and the observed rate of wear.

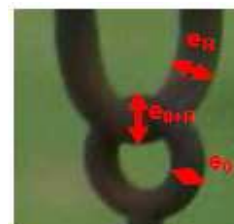


Figure 4 : Evaluation of the wearing of a U-bolt eye assembly

The emergency level for the replacement of an assembly is then based on the estimated residual life expectancy.

USE OF THE TOOL

The tool "photos-gauge" based essentially on a visual report, it seemed naturally adapted to refine the treatment of the helicopter-based inspections. The reports of these visits accumulate the advantage to be a computerized document (with an predefined synthesis of the inspection, which is homogeneous on a national scale), to define the abnormalities (recording of an emergency level, geographically localized and on a line plan) and to show a photography for every abnormality.

In 2010, we applied the tool to the helicopter-based visits in two ERDF's operational units.

The main goal was to take into account the technical and operational expertise of operational units. Do the treated cases correspond to field realities? What is the perception of the tool by its potential users? What are the use limits of the tool? What are the new needs for the specification of future helicopter-based inspections?

The first feedback shows that the tool authorizes the implementation of a real objective inter-classification and allows to avoid the empirical judgments. The diagnosis results are questioning very often preconceptions, dominant among field workers, and allow to put in perspective the urgency of some interventions.

Moreover, the tool becomes integrated easily into the usual working procedures, what facilitate the acceptance by operational units.

Finally, we note that the analysis requires a good quality of inspection reports. Criteria identified as necessary for the analysis complete the helicopter-based visit specifications. The very favourable return of the experimental units allows us to set the objective of a national deployment in 2011-2012.

This deployment campaign will permit to estimate the gain of the tool. On one hand qualitatively, by the evolution of the distribution between the various emergency levels - according to the materials and the regions; on the other hand quantitatively, by the evolution of the global number of abnormalities to be treated.

The results will also allow us to draw up a representative and harmonized map of the abnormalities that have been recorded on the whole French territory.

ASSET MANAGEMENT

These results will be afterward included in a global platform also taking into account the economic constraints and system aspects.

A balance will be established for every kind of abnormality according to the urgency of intervention and the criticality of the equipment. It will permit to establish a level of criticality on the scale of a line section or a complete MV

overhead line.

This new classification of the weak points will be an input to value several strategies of asset management such as the replacement of the equipments with the current, the partial renewal of the network or the burying of the line.

CONCLUSION

The approach led to elaborate the tool "photos-gauge" was a way to transcribe a deep theoretical and experimental study in a simple decision-making support for ERDF operational units, that manage the French distribution network.

For 2011 the expected result is a national deployment of the tool. The new policy rethinks the MV overhead lines helicopter-based inspections to measure indicators of life expectancy, and identify needs in additional diagnoses.

The national harmonization and the precision brought to the treatment of the helicopter-based visits will then supply reliable data for the valuation of various asset management strategies.

Acknowledgments

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