



# Power Line Maintenance Inspection: Analysing 2 months of regular work in Portugal

The Power Line Maintenance inspection system [PLMI] developed by Albatroz Engineering has been regularly used by LABELEC since November 2007 to inspect transmission lines (REN) and distribution lines (EDP Distribuição). The system has now inspected more than 4000km lines and it is expected to achieve 10000km by the end of 2008.

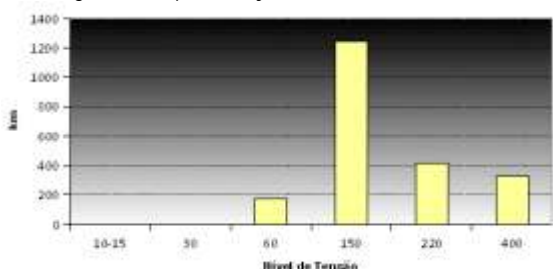
To evaluate the system's overall efficiency after the initial training period (concluded in 2007), we have analysed, in detail, the statistical data of 2 months of regular work, between April 14<sup>th</sup> and June 5<sup>th</sup>. At this time, all line inspection teams and pilots were completely familiar with the system. This analysis excludes the winter period, when the number of available days for inspection is small. The overall inspection data is described in Table 1.

## Voltage level

Figure 1 presents the total length of inspected lines in terms of voltage level. It shows that almost all the inspections were performed on transmission lines (400kV, 220kV and 150kV), particularly on 150kV. This is explained by the fact that, in November and December of 2007, most inspections covered 1025km of 220kV and 400kV and only 328km of 150kV lines.

The figure also shows that the 10-15kV and 30kV classes are empty, because EDP decided to inspect the 60kV high voltage

Figure 1 - Inspection by tension level

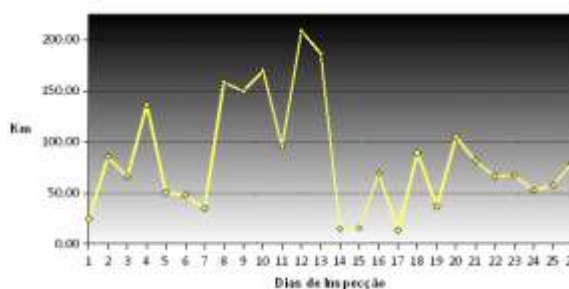


lines first, since these are most critical for the overall quality service.

## Daily Inspection

Figure 2 shows the daily inspection lengths in km. Considering the total number of days analysed, the average daily inspection length is 83km. It is also clear that there was a period (end of April, beginning of May), where the daily inspection lengths were longer than

Figure 2 - Daily inspection length



100km followed by a period where the total daily inspection length was shorter than 50km.

Figure 3 shows the distribution of km inspected per day. From an overall set of 39 working days (excluding weekends and holidays), in one third of the days there were no inspections and in another third, the total inspection length was in the 50-99km range. In 80% of the cases, the total inspection length was shorter than 100km.

There are two main reasons for this distribution:

- May was exceptionally rainy, which limited the total time available for inspections. Therefore this data describes a more pessimistic scenario than expected.

⇒ page 2

Line Inspection: 2 months analysis in Portugal ⇒ p. 1, 2

Lessons learned after 4000km of line inspection ⇒ p. 2

Tabela 1 - Statistical data	
Total inspection length (km)	2159
Number of inspected lines	37

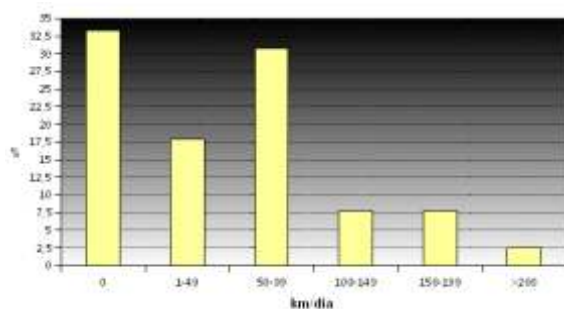
## Acknowledgment

Albatroz Engineering would like to thank LABELEC and HELIPORTUGAL for making available the data for the statistical analysis and the all their collaboration towards the continuous improvement of PLMI.



## Analysing 2 months of work in Portugal (cont.)

Figure 3 - Daily length distribution



- The transmission lines are longer and require less inspection manoeuvres, enabling easier and longer inspections. In the middle May, the inspected lines were mainly distribution lines (69kV), which are

shorter and need longer ferries between each line.

Nevertheless, if we consider 250 annual working days, where the average inspection length is 83km, it is possible to inspect more than 20000km per year with one helicopter. Since the clearance analysis with LiDAR is fully automatic and integrated, the on board inspection crew use most of their time for thermography and visual inspections and only occasionally take notice and review clearance issues.

### Lessons learned after 4000km

#### Lesson #1: reality rules

Despite all the technical and operational constraints defined before an inspection mission, a daily inspection plan has to be executed, with more or less variations, in conditions that will be most of the times different from the ones expected. Whether

this is driven by weather conditions or other operational reasons, the inspections have to be done as long as there are safety conditions. Therefore, onboard systems have to offer sufficient robustness to cover the range from expected conditions to real operation conditions.

Figure 4 to 6 illustrate an inspection done on June 23rd on a 60kV line in the mountains, where 50m distance and 30kt speed are maximum ceilings. However, the sequence of peaks and valleys, aircraft dynamic constraints and air rarefaction forced the pilot to fly faster and farther from the line; 1500m after the line start, there is a critical valley where the speed raises to 37kt and the distance to line nears 90m.

A plain failure under these circumstances is unacceptable. Thus the need for a robust and interactive system where performance follows operation conditions and allows pilot and crew to take informed and timely decisions on whether to carry an inspection, minimising risks taken and the use of resources with inspections of inferior quality.

Figure 4 - Altitude profile of the sensors (blue), the over-head line (red) and the ground (brown); scales in metres

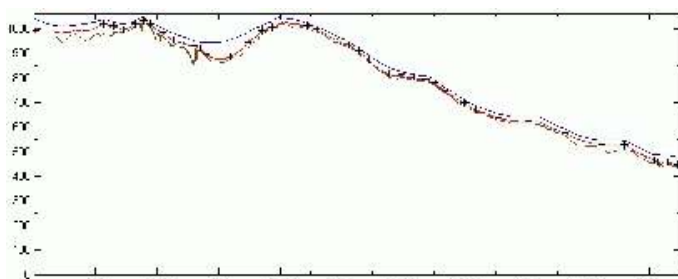


Figure 5 - Distance to line in metres along 8000 scans

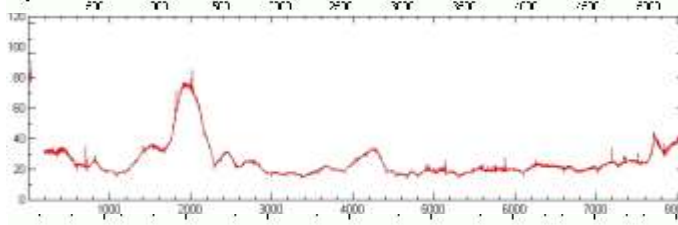


Figure 6 - Inspection speed in knots along 8000 scans

