ACCURATE MAPPING THANKS TO RFID MARKERS

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ABSTRACT

This paper presents how mapping underground electrical network with accuracy thanks to the technology of RFID markers developed by ELIOT Solutions.

INTRODUCTION

ERDF manages 95% of the electricity distribution network in France with 35 million customers served and more than 1 300 000 km of power lines, ERDF is one of the main players in the energy market by the volume of its activity and its long history.

The new French regulations "No damage" obliges operators to rethink how they map their networks. The intention is to not only assist their operational needs but it should also be a source of reliable quality information and to ensure the positioning of the networks (underground and air) when work is being undertaken nearby.

Thus, ERDF is obliged to detail in its mapping the whole of the underground network including connections (between the mains and the installation of the client). Since 1st July 2012 this must be geo-referenced with an accuracy of class A[1] in accordance with the regulatory requirement.

To meet this regulation, ERDF has decided to equip new underground connections with RFID tags. This paper first presents the specific context of the work that guided the company to make this choice of equipment. There will then follow a presentation of RFID (Eliot) and installation methodologies. The practical requirements to ensure the technology works on an industrial scale will be addressed and then the paper will conclude on the prospects.

SPECIFICATION - ISSUE

The work of installation or modification to connections is very specific. Highways regulations do not allow trenches to be left open for a long period to allow tracing of every cable thus, these works have a very short timeframe, so coordination with a topographer is impossible. In addition, it is difficult to map at this level as it is very specific and precise (geo referencing 3D accuracy of the order of 10 cm to meet the regulatory requirements of class A class), thus a skilled topographer is needed for this operation. The electricity network has the advantage to be detectable from the surface of the ground by an electromagnetic detector. However, to meet the requirements of accuracy, detection should be done by electromagnetic injection and requires access to the networks, which introduces an electrical safe hazard for the operator

Thus, one of the technologies tested by ERDF to ensure new installations are georeferenced is the laying of RFID markers, including one developed by ELIOT Solutions.

TECHNOLOGY

The Eliot solution (Equipment for the Location and the Identification of Earth structures) is a French innovative technology enabling 'Intelligent detection of buried structures'. Once installed, the electronic detector reports with an accuracy in the order of centimeters, even buried up to 1.50 m in depth. It is essential to note that it remains accurate in any soil or humidity conditions.

The ELIOT marker is composed of a passive RFID transponder protected by a stiff polymer case. The case is waterproof and highly resistant to both pressure and impacts. Two adhesive strips on the bottom of the case are used to fix the marker to a pipe. The bottom side is designed to be placed on any curved or flat surface.

[1] Class A: a book or section of the book is classified in class A if the maximum uncertainty of location indicated by its operator is less than or equal to 40 cm if it is rigid, or 50 cm is flexible; the maximum uncertainty is increased to 80 cm for underground civil engineering structures attached to facilities for the movement of railway vehicles or guided when these works have been built previously to the 1St January 2011 [1].

Note: The electrical works are considered flexible works.

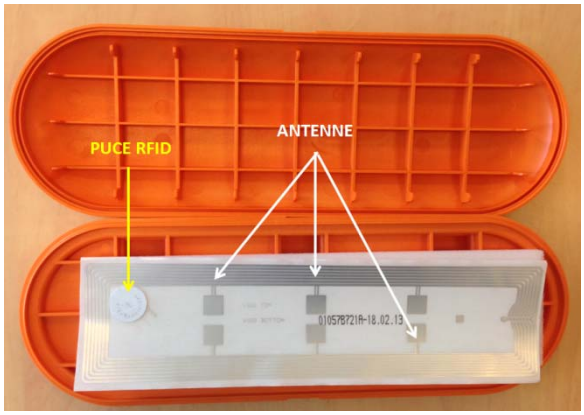


Figure 1: RFID Marker

Characteristics	ELIOT Marker
Type of transponder	Passive
Communication Protocol	ISO 15693 – NFC compatible
Dimensions	285 x 95 x 35mm
Weight	240g

METHODOLOGIES (INSTALLATION & LOCATION)

The installation of markers is simple and requires no specific competence thus, this operation can be carried out by the team installing the network. Once the cable has been laid, the operator attaches to the horizontal top surface of the cable, and on network accessories, the RFID markers using the adhesive strips under the Eliot device. The operator takes a picture of the installation or makes a sketch of the structures with the number and the position of the markers. The trench can then be back filled making sure not to damage the markers.

Figure 2: Installation of RFID Marker

In order to map the network to class A it is required that the operator lays Eliot markers at strategic locations of the cable. Thus, markers must be placed:

- all changes of direction or slope
- at 10m intervals if the cable is linear
- on the 2 tangents of curves if the radius of curvature is less than 1m (the most common case for connection)
- 2 tangents and in the middle of curve if the radius of curvature is greater than 1m
- on all the connections to precisely locate the starting point of the connection with the network

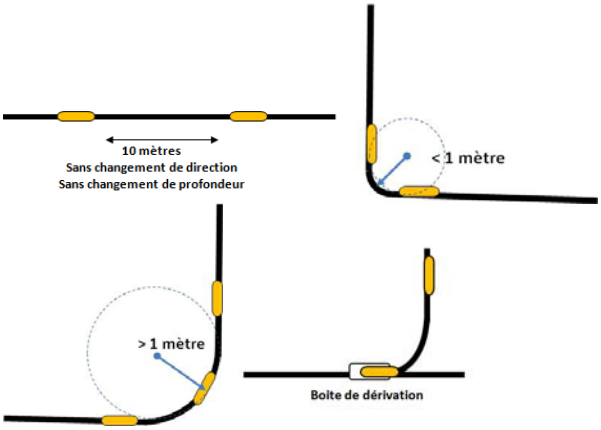


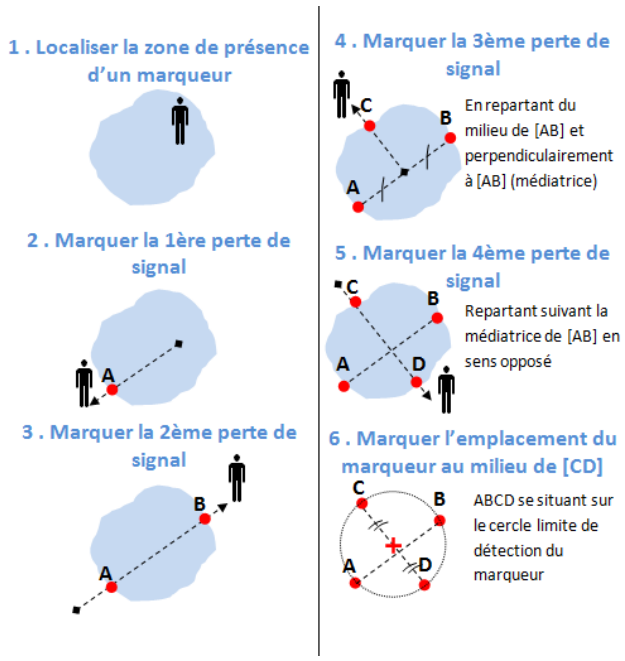
Figure 3: Examples of installation of RFID Markers

After the installation is completed the positioning of the markers is done in two steps:

- the location of each marker recorded
- the geo referencing of the detected position

Figure 4: Detection of RFID Marker

A mapping technician equipped with a detector will follow after the installation detecting each individual marker and its depth. By raising the ground point it is possible to get coordinates in three dimensions from the center of the marker and therefore the network.



1. Locate the presence of a marker
2. Mark the first point where the signal is lost
3. Mark the second point where the signal is lost
4. Mark the third point where the signal is lost – this point must be perpendicular to the line AB.
5. Mark the fourth point where the signal is lost – this should be directly opposite point C and perpendicular to the line AB.
6. Mark the location of the marker in the middle of the line CD – ABCD are positioned on the circular detection limit of the marke

The map provider also adds the visible items where markers have not been placed: electric box and pole during an aero-underground lift. The as-built network is then recorded by points obtained by markers and those directly recorded from the surface. The operator then provides a map of the installed connection.

TECHNICAL REQUIREMENTS TO BE CONSIDERED TO ENSURE THE RESULTS ON AN INDUSTRIAL SCALE

The use of the RFID tags in this context is relatively complex as it is installed by civil contractors. The installation of markers is carried out during the construction of the connection. Therefore, the outer casing of the markers must be compatible with the landfill, be waterproof and shock-resistant. They must meet the standards for the IP67 protection class and class IK10 shock resistance.
Similarly, the detector must be waterproof and shock resistant guaranteeing 8 hours of use without data loss.

The ERDF installations use the PLC (Powerline online) technology to communicate with the ERDF information system. It is a specific CPL narrowband (2, 5Kbits per second) reserved for distributors of electricity in Europe (9-95 KHz). It is standardized at European level (under standard EN 50065-1).
Regarding the emission of waves, the material used by ERDF is class B which, like any electrical appliance uses standard electronic components likely to emite electromagnetic waves. The equipment conforms to French and European standards EN 50470 and NF EN 55022 in terms of both electrical and magnetic emissions.
Markers and the means of detection must respect technical constraints to this standard in order to ensure no interference between systems.

RESULT: CONTROL BY DETECTION OF SITES OF CHIPS

Like all new installation of work sites, ERDF controls via sampling of the positioning of the works by comparison to electromagnetic detection by injection. Construction of connections referenced via the RFID tags is ongoing.

CONCLUSION AND PERSPECTIVES

ELIOT markers were defined using 'traditional' EMS technology for their ability to remain in the class precision (A) of the regulation.
Because ELIOT uses RFID technology, the potential of the chips offer markers with the features that interest ERDF because of its issues of traceability of the material. Indeed, the markers are able to store and return an amount of information more important than markers using EMS technology.
In the longer term, RFID paves the way for networks communicating, as coupled with telemetry technology, the markers would be able to transmit short intrinsic measures for the operation of the equipment (temperature, voltage, humidity...). This opening would allow exploitation of the markers in the world of operators as a tool for decision support in the maintenance and intervention for buried structures.
ELIOT paved the way for the use of RFID technology in the exploitation of buried structures. This technology can bring a lot to facilitate and optimize the work of networks owners & operators

REFERENCES

[1] Article 1er - title 1 of the Decree of February 15, 2012.