

## 138 kV Insulated Cable System for Temporary Connection of Transmission Lines and Substations

Gustavo **SILVESTRE**, Sérgio **CAPARROZ**; AES Eletropaulo, São Paulo, Brazil, [gustavo.silvestre@aes.com](mailto:gustavo.silvestre@aes.com), [sergio.caparroz@aes.com](mailto:sergio.caparroz@aes.com)

Julio Cesar R. **LOPES**, Simone C. N. **ARAUJO**, Walter **PINHEIRO**; TAG Inovação Tecnológica, São Paulo, Brazil, [julio.lobes@tagpower.com.br](mailto:julio.lobes@tagpower.com.br), [simone.araujo@tagpower.com.br](mailto:simone.araujo@tagpower.com.br), [walter.pinheiro@tagpower.com.br](mailto:walter.pinheiro@tagpower.com.br)

### ABSTRACT

*This article describes the results of studies conducted on the development of new equipment in Brazil for temporary connection between sections of overhead transmission lines and into AES Eletropaulo's substations. The equipment will be used in variants during the reconstruction of overhead transmission lines and maintenance operations into substation. It is constituted of extruded insulated cables at 138kV voltage, flexible dry insulated terminations and a system to lay and to rewind the cables. This system is used also to transport and to store the cables.*

### KEYWORDS

Transmission Lines, Variants, Temporary Connection with Insulated Cable

### INTRODUCTION

In Brazil, the regulatory requirements that reflect the aspirations of the society regarding the continuity of electricity supply are increasing. Thus it is essential that the maintenance services, construction and expansion of the electrical system are executed by reducing outages, mainly due to scheduled services.

Nowadays, one way used for this purpose when performing maintenance on overhead transmission lines towers is to build variants, employing in its implementation temporary structures and all the infrastructure (foundations, grounding, etc.) required. These variant constructions require time, space and loss of materials and services used therein.

The lack of space in the right-of-way of transmission lines and substations of AES Eletropaulo creates considerable difficulties, even it is impossible, to implement these variants, which increases the time needed for scheduled outages and maneuvers as well as increases the risk of accidental shutdowns during construction or reconstruction of sections of lines and substations. Another not less important aspect is the amount of waste during the construction, which increases costs and enhances the environmental problems.

Aiming to solve this problem AES Eletropaulo decided to invest in a research and development project that has as main objective the development of new equipment in Brazil to be used in variants of overhead transmission lines and substations. Currently there is not in the Brazilian market a device with 138 kV insulated cables that can be used as variants in the reconstruction of overhead transmission lines.

This paper presents the obtained results and the studies that were the basis for the development of the equipment to make temporary connections between sections of

overhead transmission lines and feeding lines to substations of AES Eletropaulo.

### R&D PROJECT

The R&D project was developed following the steps below:

- search of the characteristics of refurbishments and reconstructions of transmission lines and substations of AES Eletropaulo;
- preparation of the engineering specification for the equipment to be designed to make temporary connections between transmission lines sections and substations;
- development of flexible 138 kV insulated cable;
- selection of dry terminations and compact accessories;
- development of the system to store and transport the temporary connection, and mechanism to rewind and lay the cables;
- manufacturing of the prototype and testing;
- development of procedures to use the equipment;
- transference of the developed technology.

It is noteworthy that the major difficulties encountered in developing this type of equipment were related to:

- the constitution of the insulated cable, which should be more flexible than the cables used permanently in underground lines, and can be moved without damage to it. Stands out as the main hindrance the high level of short circuit required by the electrical system of AES Eletropaulo;
- finding the adequate dry and easy connection terminations;
- development of a reel to accommodate the cable and terminations, and a system for pulling and winding the cable that could be used in places with limited space as the available areas in the right-of-ways of the transmission lines and substations of AES Eletropaulo;
- development of the procedure for installation taking into account the particularities of the transmission overhead lines of the AES Eletropaulo system and in particular that its lines are located in densely populated regions.

### TRANSMISSION LINES AND SUBSTATIONS CHARACTERISTICS

#### Transmission Lines Refurbishment

The main services that normally need to be executed at the AES Eletropaulo's transmission lines are:

- reconstruction of transmission line with replacement of