Grzegorz Kochan, Krzysztof Lenarczyk,[1)]
PSE S.A. Warszawa

Krzysztof Kiczkajło,[2)]
Eltel Networks Olszyn

Bogumił Dudek[3)]
PSE Inwestycje S.A.

Replacement of existing ground wire with OPGW under live-line conditions New training polygon in Olsztyn

Wymiana istniejącego przewodu odgromowego typu OPGW w warunkach PPN. Nowy poligon treningowy w Olsztynie

Introduction

DURING the ICOLIM'2011 conference we have described first Polish experiences in replacement of ground wires with OPGW [1]. In the years 2011-2013 further works on replacement of wires on 400 and 220 kV lines were performed thus experience enabling professional completion of tasks was gained.

Replacement of existing ground wires with OPGW

Works take place according to the transmission network operator guidelines entitled "Guidelines for live works in network objects of PSE S.A.", June 2013 v.2.3.

Only during one task completed in 2013 a traditional AFL ground wire was replaced with OPGW over the distance of 400 km of a very important LV line (400 kV) in the Polish Power System (KSE): Płock – Miłosna and Rogowiec – Mościska – Miłosna (Fig. 1), taking the power from the Bełchatów Power Plant (Bełchatów Power Plant is the biggest power plant in Poland and Europe heated with brown coal and the capacity of power blocks is 5298 MW).Check the numbering of your graphics (figures and tables) and make sure that all appropriate references are included.

Replacement of conventional ground wires with OPGW is done according to international standards. Consolidated rules in EU for electrical system operation, which have been formed lately, are based on the following European standards (also having Polish equivalents): EN 50110-1 and EN 50110-2. To qualify certain works as live works, you not only have to check the distance to the potential but also several other parameters.

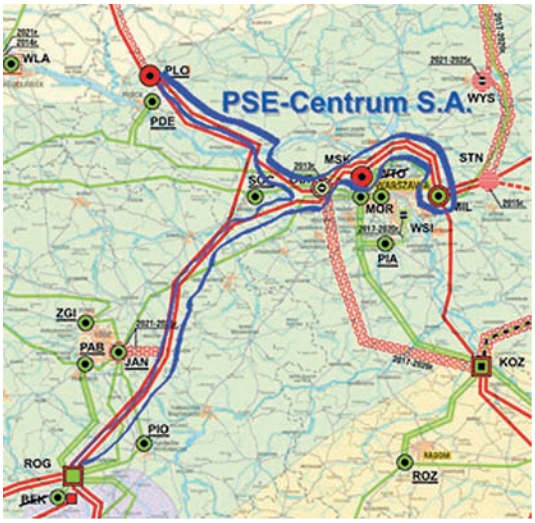

Fig.1. Outline of 400 kV lines on which OPGW wires were installed (400 kV – red line, 220 kV – green line, Lines exchanged – blue line)

Therefore rules for replacement of ground wires in live line conditions are specified in special dedicated standards. The EN 60743 "Live working. Terminology for tools, equipment and devices" describes in Chapter 14 fundamental elements of equipment, which will be used for wire replacement. On the other hand, where wire replacement has been qualified as live work, it does not necessary mean that many works being a part of the task cannot be done using other methods. Dedicated manual or technological design should describe in details which works related to the job task are live works, where special rules apply and which are not.

1) Grzegorz Kochan and Krzysztof Lenarczyk – PSE S.A., 00-033 Warszawa, Poland (e-mail: grzegorz.kochan@pse.pl, krzysztof.lenarczyk@pse.pl).
2) Krzysztof Kiczkajło is with Eltel Networks Olsztyn, Poland (e-mail: krzystof.kiczkajlo@eltelnetworks.com).
3) Bogumił Dudek is with PSE Inwestycje S.A., 40-056 Katowice, Poland (e-mail: bogumil.dudek@pse.pl).

There are techniques and technologies developed all around the world which allow replacing standard ground wire with OPGW without outage of the transmission line. Simultaneously these works may be done over the objects/facilities/other live power lines which this line is crossing. Requirements are standardized and given in the following technical reports (in Poland available in English):

1. IEC/TR 62263: 2005 Live Working – Guidelines for the installation and maintenance of optical fibre cables on overhead power lines;
2. IEC/TR 61328: 2003 Live working – Guidelines for installation of transmission line conductors and ground wires – stringing equipment and accessory items.

Apart from the reports given above, national requirements concerning execution of these technologies are based on the following standards:

1. PN-EN 61230 Live working – Portable equipment for earthing or earthing and short-circuiting.
2. PN-EN 61477 Live working. Minimum requirements for the utilization of tools, devices and equipment.
3. PN-EN 62192 Live working. Insulating ropes.
4. PN-EN 60895 Live working. Conductive clothing for use at a nominal voltage up to 800 kV a.c. and ± 600 kV d.c.
5. PN-EN 61472 Live working. Minimum approach distances for a.c. systems in the voltage range 72,5 kV to 800 kV. A method of calculation.

Taking into account amendments to the standards, there were detailed regulations formulated and given in the:

- Instruction manual for work organization during replacement of ground wires with OPGW or standard type (AFL) as well as installation of fibre optic cables on live 220 kV and 400 kV power transmission lines. – Case study of ELTEL Networks Olsztyn S.A. no IT-3/LWN-PPN/13 from 27 April 2008.

As well as directly linked to the above instruction manual:

- Detailed technological instruction for ground wire replacement on the 220 kV and 400 kV live power transmission lines – by ELTEL Networks Olsztyn S.A. (Olsztyn, 2011-12).

Rules and requirements given in the international standards and included in the instructions are fully adopted by contractor companies during project execution, which proves professionalism in implementing world-wide expertise.

For replacement of conventional ground wires with OPGW in live-line conditions the two well-known methods were implemented: tension stringing method and cradle block stringing method. Experiences of recent years were presented in this paper in the form of pictures (Fig. 2-4).

Additional innovations comprehensively applied in the last project include:

1. Laces scanning – based on a helicopter flyover of entire line under the task.
2. Generation of a dot cloud from scanning giving a 3D image of entire line used for processing in the PLS-CADD environment. Imaging of the line in scale with great precision.
3. Classification of dots in PLS-CADD giving true reflection of entire surrounding of the line strip. The classification defines buildings, landform features, plants, etc. It is possible to turn on/off any group of dots depending on work needs.
4. During the flyover situational photos of under the line were taken, the so-called ortophotomap.
5. Adding the ortophotomap (photo) to the 3D image of the line enabling assessment of the land below the line.
6. Possibility to define very precisely the distance from the line construction and active elements to crossed-over objects.
7. Defining, with the use of dot cloud, type of crossed-over objects, i.e. power lines with different voltage and telecommunication lines.
8. Selection of wire stress in order to fulfil standard guidelines, keeping the angle of shade shielding angle and capabilities of support structures (poles). Immediate line model verification.
9. Using the above-mentioned information to prepare line profiles according to the Investor's standard.
10. Using information from scanning to update assembly lists and line passports.

Thanks to conducted works technical and exploitation documentation has been comprehensively supplemented with completed technologies. Some works regarding replacement of ground wires with OPGW were performed with mixed technique, preparing line for wire replacement i.e. putting wires on rolls under tension in live technique but stretching the wires was completed after turning off of the line. This led to indirect limitation of turn-off times. During works in live wire conditions electromagnetic impact analysis was conducted and workers performed works in conductive clothing screening from field impact.

Fig. 2. Plan view of the pole head

Fig. 3. Roller stand during works

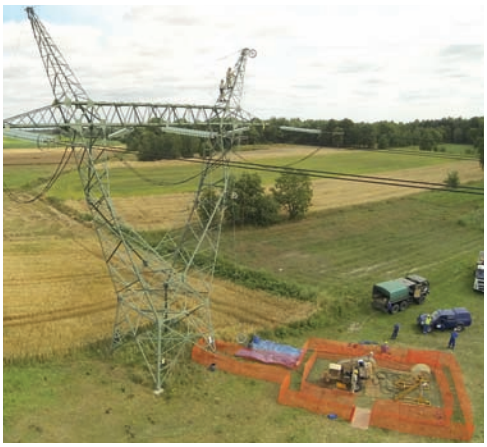

Fig. 4. Back-stop stand during works

New training polygon in Olsztyn

In order to extend experience, offer vocational training and complete tasks on lines in different countries in the years 2011-2012 a training polygon was built in Olsztyn [5].

The decision on construction of an Eltel polygon within the warehouse areas in Olsztyn was taken in October 2011. It was decided to build a polygon based on overhead double-circuit 400 kV line, glass isolators, PLP equipment typical for British lines (Fig. 5-6).

Technical description (see enclosed picture material)

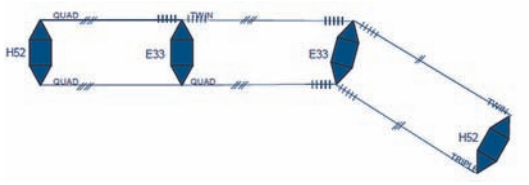

Fig. 5. Layout of the training polygon in Olsztyn

1. Objectives

Assembly of four OHL lattice towers within one section will aim to be a training centre for alliance partners Carillion/Eltel.

Fig. 6. Entry to the polygon is possible according to special rules, in complete protection clothing

2. Foundations

Prefabricated foundations are to be established, design due to tower load specifications.

3. Steelwork

Lattice towers types as listed below:

Position	Pole type	Pole series	Height [m]	Spacing [m]
1	ON 150	H52	20.3	4.02x4.02
2	P	E33	25.7	1.80x3.00
3	ONI	E33	25.5	3.00x3.00
4	ON 150	H52	20.3	4.02x4.02

4. Conductors

- Ground wire: 2 x AFL 1,7-70 mm2 both circuits with tension 10 MPa
- Conductors attached to upper crossarms:
  - Circuit I – 4 x ZEBRA 400 mm2 with tension 5 Mpa between towers 1-2 and 2 x ZEBRA 400 mm2 between towers 2-3-4,
  - Circuit II – 4x ZEBRA 400 mm2 with tension 5 Mpa between towers 1-2-3 and 3x ZEBRA 400 mm2 between towers 3-4.

5. Insulators

Glass insulator strings will be assembled as follows:

- single string of duplex suspension insulators 400 kV - 150 kN - 2 sets
- single string of quadruple tension insulators 400 kV - 150 kN - 1 set
- single string of duplex tension insulators 400 kV - 300 kN - 2 sets
- single string of triplex tension insulators 400 kV - 300 kN

All insulators manufactured by Sediver.

6. Fittings

Fittings shall be equal to target Year 1 OHL project. Manufacturers: PLP and Mosdorfer.

7. Earthing

All towers will be earthed with the means of banding steel – rod type TU9 5x5 earthing, 20 mm rod 9 m long, 25x4 mm banding steel.

8. Other issues

Section will be established on the territory of Eltel Warehouse. This facility is fenced and secured/supervised 24/7.

In April 2012 Training Centre was made available and in May 2012 first practical training was conducted (Fig.7-8). A model training programme includes below presented activities and the practical part lasts 12-15 days:

Fig. 7. Theoretical and practical training on the polygon including rescue training

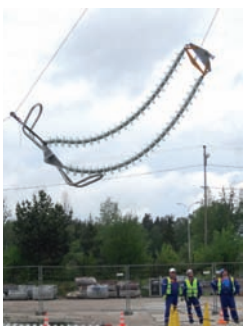

Fig. 8. Polygon exercise in assembly of different line elements, soon also LLW

Initial training

1. Earthing according to rules in NSI-4
2. Fixed strap as safety measure against fall form height
3. Evacuation of injured from height
4. Assembly of working platform 21m
5. Replacement of insulators on strain support (chain 4x21>2x21)
6. Replacement of insulators on straight-line support (chain 2x21>1x21)
7. Sag adjustment
8. Repair of damaged wires
9. Safe work on carts
10. Measurement of bolt connection resistance and possible repair
11. Adaptation of strain support for work as straight-line support

There are ongoing works on the programme and training in the scope of work techniques in vicinity zone and of live works as well as various aspects of work safety both on turned-off as well as live lines [2]-[4].

REFERENCES

[1] B. Dudek, K. Mikołajczyk, L. Rogiński: Replacement of an existing ground wire by OPGW; experiences of the Polish work on the energized 400 kV overhead power line, Zagreb, ICOLIM'2011

[2] A. Balawender, B. Dudek: 220-750 kV overhead transmission lines live work, Toruń, ICOLIM'2008.

[3] J. Andruszkiewicz: Zagrożenia związane z oddziaływaniem napięć i prądów linii elektroenergetycznej przy pracach w pobliżu napięcia, Eltel Networks 2011

[4] L. Grzeszkiewicz, M. Schwann: Technical equipment of training field for practical teaching live voltage technology, Toruń, ICOLIM'2008.

[5] R. Tochman: Modern Polygon for Network Technologies, Presentation of Eltel Networks Olsztyn SA, Warsaw, 29.10.2013.

Wojciech Lubicki, Bogumił Dudek [1)]

PSE Inwestycje S.A.

Eighty years of Polish experiences in technology of live-line working and impressions from all 10 ICOLIM conferences

80 lat polskiego doświadczenia w dziedzinie technologii PPN oraz impresje związane z wszystkimi 10 konferencjami ICOLIM

Introduction

Historically, live-line technologies (PPN) in Poland have been started since 1933, so 80 years ago, while a regular and continuous progress in the development of PPN techniques next year will reach 40 years.

During the 75th anniversary of these works, Polish power engineers organized the European conference ICOLIM'2008, which was also attended by representatives from many countries including South America [1-10]. In addition, Poland has been organizing national conferences dedicated to this topic since 1988. Regular development of live-line working in Poland took place since 1975, when we started taking advantage of French experiences with low voltage lines, Irish experiences with medium voltage lines, as well as Hungarian, German, Russian, Italian and American experiences with high voltage lines 110-750kV.

Fig. 1. First live Line working in Poland (1933)

[1)] Wojciech Lubicki and Bogumił Dudek are PSE Inwestycje S.A. employees, 40-056 Katowice, Poland (e-mail: wojciech.lubicki@pse.pl, bogumil.dudek@pse.pl).