Instrukcja montażu przewodów napowietrznych typu ACSR, ACSR/TW, AAAC, AAC
Rekomendacje producenta
Installation manual for overhead conductors type ACSR, ACSR/TW, AAAC, AAC. Manufacturer's recommendations

1. INTRODUCTION

This document presents recommendations and instructions concerning the (best practice) installation of overhead conductors, equipment and tools, which are used during the conductors installation in overhead transmission and distribution lines. The information presented in this document should be applied to the installation of overhead conductors manufactured by NPA Skawina Sp. z o.o.

This manual should be read in connection with:

- IEEE 524 "IEEE Guide to the Installation of Overhead Transmission Line Conductors" 2016,
- L No. 105 "High-voltage line conductors line construction and repair" 2000.

It should be noted that depending on the characteristics of the project as well as weather and terrain conditions, there may be situations in which it will be necessary to apply installation techniques that may differ from those recommended in this document. In such case it is necessary to determine these differences each and every time and inform NPA Skawina Sp. z o.o. (quality@npa.pl).
The document covers the installation instructions for the following types of overhead conductors: ACSR, ACSR/AW, ACSR/TW, AACSR, AACSR/AW, AACSR/TW, AAAC, AAAC/TW, ACAR and AAC. In case of other types of conductors it is necessary to request respective documents and instructions from NPA Skawina Sp. z o.o.. It is recommended that conductors for the same section should come from one supplier.

2. THE INSTRUCTION INTENTION

The intention of the manual is to give special attention to the risk of damage to the conductor caused by incorrect installation conditions. The main defect that may result in disqualification of the conductor is the phenomenon of loosening of the wires present in the outer layer of the conductor (birdcaging). A view of the loosening effect resulting from improper tensioner condition is shown in Fig. 1a and 1b.

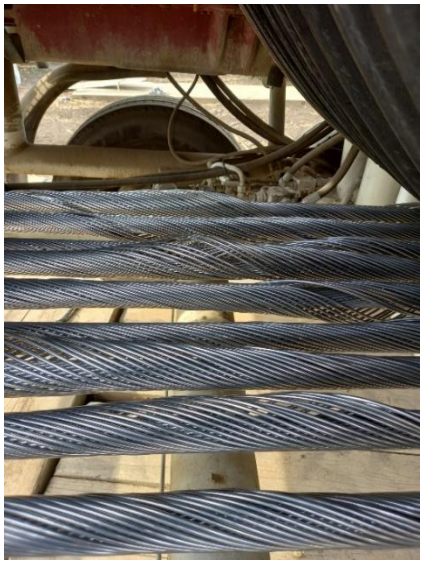

Fig. 1a. *View of the loose conductor layer*

Fig. 1b. *View of the loose conductor layer*

This phenomenon can occur anywhere during the installation: between the conductor drum and the tensioner, on the tensioner (on the bull-wheels), between the tensioner and the tower, on the towers during installation. The reason for this phenomenon, especially for multilayer conductors, is the generation of a torsional torque caused by excessive pressure of the conductor on its contact points with the mounting equipment and, as a result, the wires in the outside layer becoming twisted and loose. The extreme occurrence of this phenomenon can be the cause of damage to the conductor making it necessary to remove the loose section of the power line.

It is very important, therefore, to eliminate or minimise all factors that create or increase the conductor's torsional moment.

In addition, in the recommended installation method, the conductor must not come into contact with the ground, barriers and unprotected or damaged elements of the installation equipment (brake, rollers, guides, stringing blocks), which will prevent any damage to its surface. An example of conductor damage due to installation errors is given in Fig. 2a - 2d.

Fig. 2a. *View of damaged wires in outer layer - catching*

Fig. 2b. *View of damaged wires in outer layer - abrasion*

Fig. 2c. *View of damaged wires in outer layer - contamination*

Fig. 2d. *Incorrect installation of conductors*

3. HANDLING OF DRUMS

During loading and unloading operations of drums with conductors, special care must be taken to avoid damage to the conductor and its surface (e.g. crushing, overloading, scratches, broken wires).

Specific instructions:

- It is recommended to read and follow the conductor unloading instruction issued by NPA Skawina Sp. z o.o. in order to get detailed information (TD-I 1).
- The conductor may not be rewound from its original packaging (drum) to a replacement packaging (drum) under field conditions without informing the manufacturer. Any rewinding of the conductor may only take place on a hardened and protected surface and with suitable equipment. Conductors may only be rewound onto a drum of the same dimensions (drum core diameter) or larger.
- Conductor drums must always have discs (flanges) which must be placed vertically on a hardened surface.
- Conductors must not be dragged, laid on bare ground, stones, fences or other structures that may damage the surface of the conductor.
- Acceptable methods of transporting and handling the drums are:
  - with a crane (Fig. 3),
  - with the help of a forklift (Fig. 4).

Fig. 3. *View of how the drum should be lifted by a crane*

Fig. 4. *View of how the drum should be lifted by a forklift*

4. CONDUCTOR INSTALLATION

NPA Skawina Sp. z o.o. recommends the installation of overhead conductors using the tensioner-puller method. This method consists of uncoiling the phase and lightning conductors under tension. The tension of the stringing conductor is obtained thanks to the use of a tensioner and a puller as well as a rope or old conductor. An example of a conductor installation scheme is given in Fig. 5.

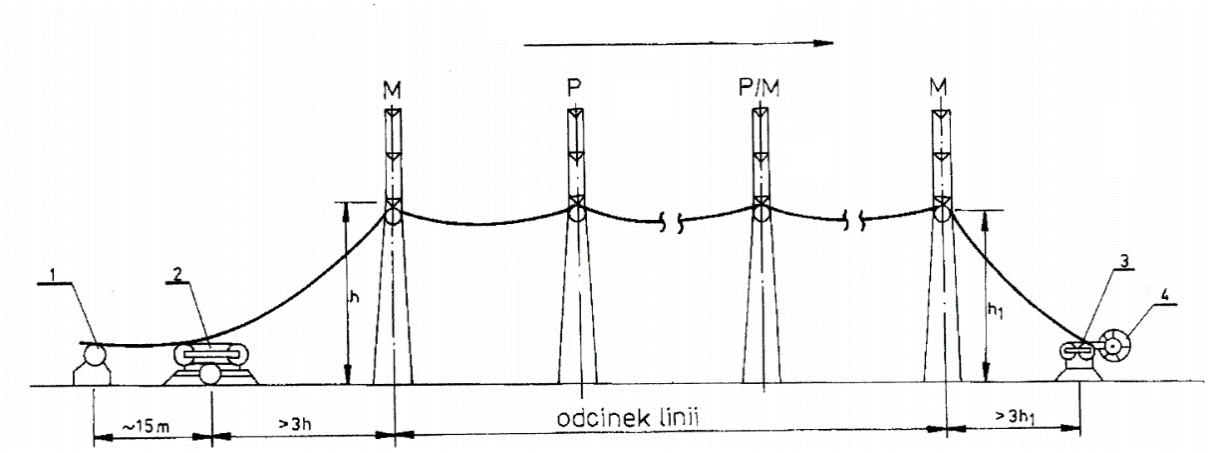

Fig. 5. *Conductor installation in tension section diagram (1 - drum with conductor, 2 - tensioner, 3 - puller, 4 - drum with rope)*

Specific instructions:

- The tensioner must have an up-to-date technical inspection confirmed by an inscription in the inspection register. In particular, the synchronization of bull-wheels (whether they are synchronized) should be checked, as this can cause damage to the conductors (Fig. 1a and 1b).
- The condition of the lining of bull-wheels should be clean, without cracks or cavities that could damage the conductor surface (Fig. 6).

Fig. 6. *View of worn lining of bull-wheels*

- The condition of the guide rollers should not cause damage to the conductor surface (Fig. 7).

Fig. 7. *View of the conductor guide rollers*

- The tensioner should be positioned at a minimum distance of three times the total height of the tower (3H) from the tower on which the first stringing block of the stringing section is located.
- The conductor drum(s) should be positioned at a minimum distance of 15 metres from the tensioner.
- All equipment must be properly anchored to the ground.
- The position of the drum with the conductor should be such that the drum rotates in the same direction as the bull-wheels of the tensioner. The direction of unwinding of the drum is marked with a label on the drum in each case.
- The drum with the conductor should be positioned flat so that the rotational axis of the drum is parallel to the ground surface (Fig. 8).

Fig. 8. *Incorrect drum positioning on the equipment*

- The position of the drum/drums with the conductor in relation to the tensioner shall be such that the transverse angle between the axis of the conductor that enters the tensioner bull-wheels and the plane of wheels (normal to the drum axis) is sufficiently small so that the conductor cannot grind against the groove in the tensioner bull-wheels and so that the conductor cannot grind against the discs (flanges) of the drums during uncoiling. An angle of max. 5° is recommended (Fig. 9).

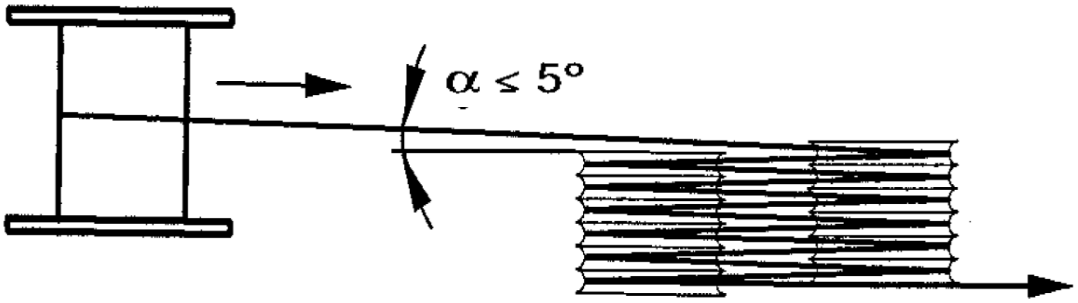

Fig. 9. *Recommended positioning of the drum with conductor in relation to the tensioner*

- In the case of several conductors installed together (bundle conductor), the drum positioning should be symmetrical with a maximum angle of 5° (Fig. 10a -10b).

Fig. 10a. *View of asymmetrical positioning of drums*

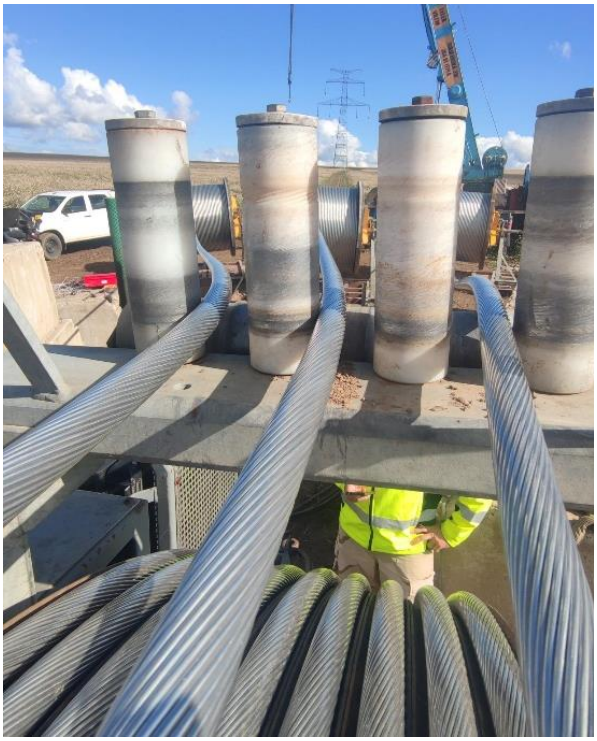

Fig. 10b. *View of asymmetrical positioning of drums*

- The positioning of the drum with the conductor must not cause contact between the conductors, as this can damage their surfaces (Fig. 11).

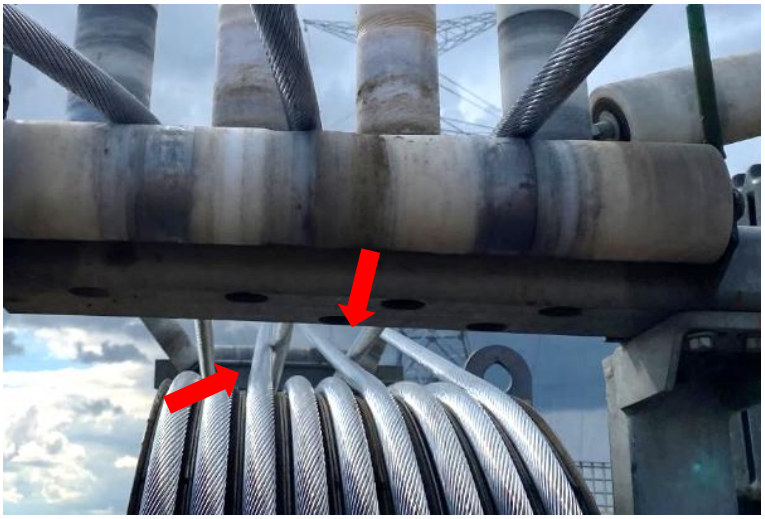

Fig. 11. *Drum position causing contact (friction) between conductors*

- The right-hand lay conductor should enter the bull-wheels from the left side. The arrangement of the right-hand lay conductor on the bull-wheels is shown in Fig. 12.

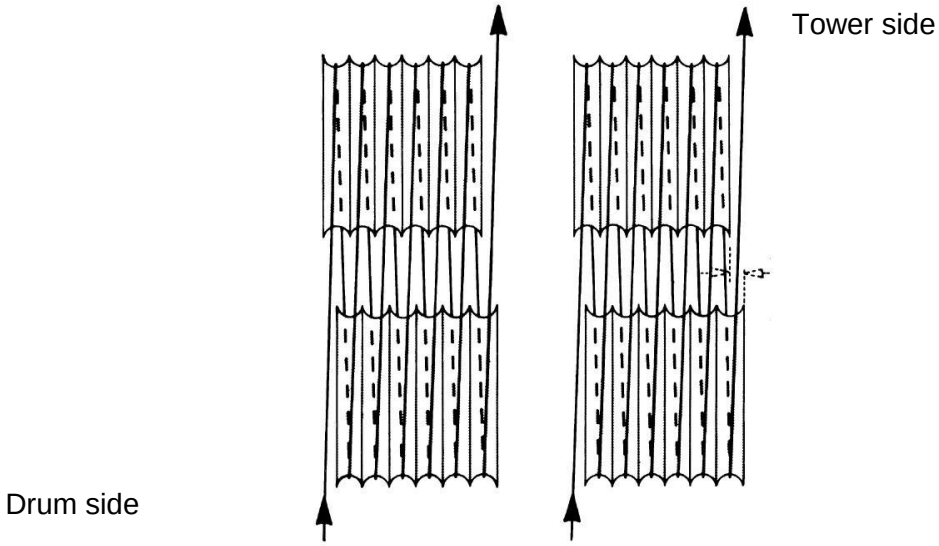

Fig. 12. *Scheme of placing a right-handed stranded conductor on the tensioner's bull-wheels*

- The conductor drum must be installed on unwinding equipment which is equipped with a controlled, adjustable brake. This prevents the conductor from twisting or stretching due to rapid changes in stringing speed or inertia of the drum during the installation of the conductor. During the unwinding process, the conductor must be monitored and adequate, constant pull-back tension must be maintained, the purpose of which is to prevent the pulling of the conductor in the event of a rapid stop of the drum. The pull-back tension must be adjusted so that the conductor fits tightly into the first groove of the tensioner bull-wheels to prevent the conductor from coming loose between the tensioner bull-wheels and on the drum. The pull-back tension of the conductor should be adjusted so that the conductor is not pushed between the layers of the conductor on the drum (Fig.13).

Fig. 13. *View of the conductor pushed between lower layers of the conductor due to excessive pull-back tension*

- As the pull-back tension changes during unwinding of the conductor from the drum (resulting from the change in diameter of the wound conductor), the pull-back tension on the drum should be periodically reduced, as this may cause the conductor to block during unwinding.
- A correctly adjusted pull-back tension value allows the operator to manually deflect the conductor in the middle of the length between the drum and the tensioner by approximately 20-30 cm (Fig.14a - 14b).

Fig. 14a*. View of how to control the optimum pull-back tension - no load*

Fig. 14b*. View of how to control the optimum pull-back tension - under load*

- The process of installation of the conductor must take into account the use of elements to compensate for the torsion of the pulling rope and conductors (the so-called swivel joints) adapted to the stringing tension. The swivel joints must be free of dirt and regularly inspected and lubricated so that it can rotate easily under tension (Fig. 15).

Fig. 15. *View of conductor torsion compensation elements (swivel joints)*

- The conductor installation process must start with fixing the conductor in the mesh sock joint. The mesh sock joint must be free of dirt and appropriately sized for the conductor diameter (Fig. 16).

Fig. 16. *View of the conductor diameter range operated by the mesh sock joint*

- During the installation process, the end of the conductor on the drum must be freed (not fastened to the flange). This is due to the phenomenon of the conductor moving backward as a result of the thermal effects of the drum (especially the wooden one). The conductor must be secured so that it is free to move backward and does not become caught in the construction of the unwinding equipment (Fig. 17). The length of the conductor that has been moved out can be cut off, leaving an approx. 1 m section, which must be fastened (nailed) to the drum in the final phase of installation (when approx. one layer of the conductor remains on the drum) so that the conductor does not slip out of the drum due to the pull-back tension.

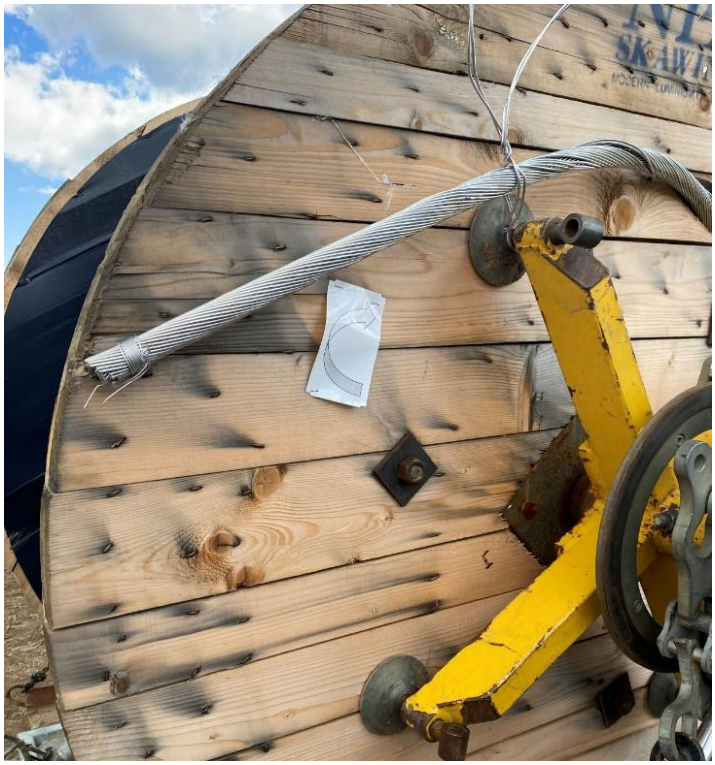

Fig. 17. *View of the secured end of the conductor*

4. OTHER RECOMMENDATIONS

- **Selection of type and dimensions of the tensioner bull-wheels (model of tensioner)**

According to IEEE 524, a tensioner bull-wheels with a 'V' groove is not recommended for multi-layer conductors. In addition, all grooves of the tensioner's bull- wheels that are in contact with the conductor should be equipped with a protective layer (lining) made of synthetic material to protect the conductor from damage to its surface during installation.
The recommended dimensions of the tensioner bull-wheels should be in accordance with the recommendations and specifications of the equipment manufacturer.

- **Selection of installation stringing blocks**

It is recommended that stringing blocks of appropriate diameter are used to help obtain a proper bending radius for the conductor. This will reduce the load and relative movement between conductor interlayers. A suitable stringing blocks diameter will also minimize damage to the layers when the conductor is stringing. All the grooves of the block which are in contact with the conductor should have a protective layer of rubber, plastic (e.g. neoprene, polyurethane, nylatron) lining to protect the conductor surface damage during installation.
It is very important to check the condition of the bearings and the condition of the lining on all stringing blocks, as worn bearings or damaged lining should not be used. Worn bearings will cause damage to the conductor surface or a loose layer (birdcage) effect. A worn lining at the bottom of the groove means that the conductor will not be guided evenly. All stringing blocks should rotate smoothly when pulling the conductor. A block that kicks back or does not rotate at a constant speed indicates damaged bearings and should be replaced immediately.
Stringing blocks with an unprotected grooves made of aluminium or steel are not recommended, as they can scratch the conductor's surface.
In addition, according to IEEE 524 recommendations, additional pressure between the conductor and the tensioner bull-wheels must be considered when installing overhead conductors. Too much pressure can damage the conductor by deforming it and loosening the aluminium wires of the outer layer of the conductor (birdcage effect). Excessive pressure also accelerates the wear of the lining material of the tensioner's bull-wheels.
Detailed force calculations and recommendations are included in the study: IEEE 524 "IEEE Guide to the Installation of Overhead Transmission Line Conductors" 2016 - Annex G.

- **Speed of stringing**

The speed of the conductor stringing is an important factor in achieving a smooth installation process. The choice of speed should be based on the possible field conditions. It is not recommended to exceed a speed of 5 km/h for the phase conductor and 8 km for the lightning conductor.
Special care must be taken when passing the head boards (Fig. 18) through the stringing blocks. In this case, slowing down the stringing speed should be done each time, and check that the conductors have not fallen off the stringing blocks.

Fig. 18. *View of the head boards*

- **Maximum stringing tension during conductor installation**

According to the recommendations of IEEE 524, the maximum stringing tension applied during conductor installation should not exceed 10% of the rated strength of the conductor. During conductor installation, additional resistance such as stringing blocks should also be considered, as detailed in IEEE 524 "IEEE Guide to the Installation of Overhead Transmission Line Conductors" 2016 - Annex F.

- **Conductor assembly time**

The time from when the conductor is stringed in line to the time of mounting the clamps (accessories) and time of adjustment of the conductor's sag should be in accordance with the recommendations of IEEE 524 "IEEE Guide to the Installation of Overhead Transmission Line Conductors" 2016.

- **Installation of fittings**

It is strongly advised to follow the recommendations, tools, and instructions of the fittings manufacturer when accessories are mounted on the conductor.