Specification for Installation of Optical Ground Wires (OPGW) and Optical Phase Conductors (OPPC)

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1. General Information

The installation of OPGW/OPPC with incorporated optical fibers is subject to the accident prevention regulations that pertain generally in the country involved and to the general rules for laying cables as defined in DIN 48 207 and EN 50182, Appendix E or ANSI/IEEE Standard 524-1980.

This Bulletin provides general information and instructions for consultings and contractors for OPGW/OPPC supplied by Lumpi-Berndorf Draht- und Seilwerk GmbH. These procedures and instructions are intended as general guidelines since each installation of a cable is unique and is influenced by local conditions and customer requirements.

Other documents provide further information such as, for example, minimum separations, tables for sagging, and specific cable data.

Stringing methods not mentioned in this Bulletin are not authorized for use with Lumpi-Berndorf OPGW/OPPC. Any use of such equipment without the express approval of Lumpi-Berndorf Draht- und Seilwerk GmbH is done at the customer's own risk.

1.1 Function

On the one hand, OPGW/OPPC with integrated optical fibers serves a protective function in case of lightning strikes and short-circuit currents. On the other hand, they are also used to transmit data (via the optical fibers). To satisfy the stringent requirements for OPGW/OPPC, painstaking care and proper professional handling are required when transporting, pulling, and installing them.

2. Specifications

2.1 Storage and Transport

2.1.1 Transport

Painstaking care must be exercised when unloading cable drums from waggons or road vehicles, transporting them to the construction site, transferring them to other vehicles, and storing them at the site. The transportation of the drums has to be carried out only with horizontal drum axle.

It is not permissible to tip the cable drums off or to throw them from the transport vehicle. This means that an appropriate lifting device must be used to unload the cable drums.

On the floor, the cable drums may be moved only in the direction counter to cable unwinding. (Roll direction - Arrow on the drum) Winding the OPGW/OPPC on other drums will be rejected basically. By way of exception a winding on an other drum can take place but only after agreement with the OPGW/OPPC supplier or in presence of a representative of the OPGW/OPPC producer.
2.1.2 Storage

The wooden lagging must not be removed until just before stringing. A simple check for damage in shipment can be made by visually inspecting the lagging.

If the visual inspection reveals signs of damage to the wooden battens, measurement of attentuation with an optical time domain reflectometer (OTDR) is needed.

The cable drums must be stored standing upright on wooden boards suitable for that purpose. The cable covering must not touch the floor thereby.

The storage temperature should not be less than -30°C nor more than +80°C. Further special precautions must be taken to protect the cable drums from external factors.

In aggressive environment which affects metal and wood, a warehouse storage is prefered.

2.2 Preparation

2.2.1 Preparatory Work

Before starting to string, measure and/or walk over the intended cable route to ensure that it is free of obstacles that would make it difficult or impossible to lay the cables.

While doing the laying, make certain that the cable is not damaged by rubbing. Do not pull the cable across obstacles in the span or on the floor. We recommend removing the obstacles or providing appropriate safety devices to prevent the cable from coming into contact with the obstacle.

Before laying the cable, make certain that the entire team doing the laying is familiar with the cable parameters, the handling required, the minimum bending radii, and the maximum cable pullingforce.

When stringing a Lumpi-Berndorf OPGW/OPPC, follow all precautionary measures and safety rules of the company/country involved. Whenever necessary, set up warning signs and marking cones to direct traffic safely.

2.2.2 Drums

OPGW/OPPC can be delivered on steel- or wooden drums, in case of wooden drums please pay attention to the following:

Before stringing all nuts of the drums have to be tightened.

U-hooks which are fasten the inner OPGW/OPPC end on the drum have to be loosen as far as the inner OPGW/OPPC end is movable. When using steel drums the inner conductor end hast to be released.
2.2.3 Cable Wheels

The minimum cable wheel diameter depends on the structure and diameter of the OPGW/OPPC, the angle of contact, and the installation span.

The minimum permissible bending diameter is calculated for each first roll after the cable winch and cable brake as follows:

- based on the pulling force:
  - for pulling forces \( \leq 50 \text{ N/mm}^2 \) → cable wheel diameter = 25 x the cable diameter
  - for pulling forces \( > 50 \text{ N/mm}^2 \) → cable wheel diameter = 30 x the cable diameter

- based on angle of contact \( \beta \):

  \[ \alpha = \text{deflection angle} \]
  \[ \beta = \text{angle of contact} \]
  
  - for angles of contact \( \beta \leq 120^\circ \) → cable wheel diameter = 30 x the cable diameter
  - for angles of contact \( \beta > 120^\circ \) → cable wheel diameter = 25 x the cable diameter
  
  - for suspension towers → cable roll diameter = 20 x cable diameter (for \( \beta > 120^\circ \))

Width of the rolls: The rolls must have a sufficient width in relation to the OPGW/OPPC diameter.

The cable wheels must be suspended in appropriate roller bearings so that they can turn easily. The running surface must be clean and free of damage, without any grooving worn into it. Only uncoated light metal cable wheels or light metal cable wheels with a hard, smooth plastic coating may be used. It is very important that the cable be able to slip into the middle on the wheel to ensure that no torque will be acting upon the cable.

For OPGW/OPPC with ACS wires in the outermost layer, the cable wheels must be coated.
The cable rolls used for installing the OPGW/OPPC may not have any residues of copper particles or any other material that corrodes aluminium, AlMgSi or galvanised steel. If the cable rolls have been used for installing copper cables, make sure that the cable rolls are cleaned (or machined if required) before being used for OPGW/OPPC.

### 2.2.4 Cable Brake

The braking drum must be at least $40 \times d$ ($d = $diameter of OPGW/OPPC). Before using brake drums with smaller diameters contact the manufacturer of the cable. The brake must be equipped with a hydraulic or mechanical adjustment control.

The running grooves must be clean and undamaged, without any grooves worn into them. The braking of the OPGW/OPPC in the drum frame must be accomplished in such a way that the OPGW/OPPC does not overshoot.

### 2.2.5 Pulling Force

Neither the maximum permissible highest tension of the OPGW/OPPC nor 20% of the calculated breaking load according to the datasheet may be exceeded. The lower value has to be used!

The pulling force must be registered by a pulling force graph recorder and must be consistently documented over the entire length.

It is best to use a cable winch with adjustable pulling-force limits and an automatic shut-off to string the OPGW/OPPC.
2.2.6 Laying Speed
The max. laying speed is 4.000 m/h.

2.2.7 Earthing
The installation company is responsible for earthing according to the regulations.

2.3 Installation of the Cables

2.3.1 Stringing
The pulling cable (guide cable) must be of a non-rotating (Trulay) type. It is best to use braided ropes. A torsion shackle must be put in between the OPGW/OPPC and every guide cable to ensure that any torsional stressing that might occur will not be transferred to the OPGW/OPPC, even while it is being pulled.
For OPGW/OPPC consisting of just one layer separate instructions are valid.
Pulling off the OPGW/OPPC from the drum has to be carried out on the top and in perspective line with the cable brake.
The OPGW/OPPC can be pulled through without cutting on angle towers \( \geq 135^\circ \) if following conditions are fulfilled.
• frictionless stringing by using suitable cable wheels.
• Minimum bending radius must be fulfilled.

The OPGW/OPPC must run in straight on the run-in roller.
While being pulled on, the cables are to be protected with appropriate pulling socks held in place with several wires resp. protected with other suitable pulling fittings.
The cable wheels are to be fastened in such a way that the OPGW/OPPC does not run out on the edge of the rim.
Generally the data of EN 50182, Appendix E have to be observed.
It should be noted that the feeder wheel equipment of the cable brake is not suitable for deflecting the OPGW/OPPC.
The OPGW/OPPC are appropriately tied by the manufacturer in order to ensure the force and frictional engagement of the individual layers of the OPGW/OPPC. If the OPGW/OPPC is cut during stringing or the setting otherwise removed it is to ensure that the layers remain tight and that there is no relative movement of the individual layers.

The protective caps mounted in the factory on the ends of the cable seal off the cable. They prevent the intruding of water into the stainless steel loose tube. These caps must not be removed until the fibers are spliced.

This means that the cables are pulled and introduced into the closures with the protective caps on them. Special care must be taken to see that the protective caps are not damaged by the cable sheaths. If, despite this rule, the protective caps nevertheless have to be taken
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off for some urgent reason, e.g., for pulling the cables, new protective caps must be put on properly after completing the pulling. Make certain that the ends of the steel tubes are sealed off completely. Protective caps can be obtained from Lumpi-Berndorf Draht- und Seilwerk GmbH.

The protective caps are put on filled internally with a polyment. To remove the caps, it is necessary to saw off the entire end of the cable (approx. 10 cm). When this is done, bind the end of the cable that is released firmly together beforehand using a strong binding tape and/or clips. Otherwise the cable might split apart.

2.3.2 Installation Temperature

The minimum temperature for laying cables is -20°C. The cable laying equipment is not reliable at lower outdoor temperatures, which means that the work must be stopped.

2.3.3 Adjustment of OPGW/OPPC

For adjusting the OPGW/OPPC either immaculate working rods or the later fixed applied tension rods inclusive reinforcing rods must be used.

The support rollers of the cable carriages might cause transverse pressure stressing on the OPGW/OPPC fibers, any travelling with cable carriages on OPGW/OPPC should be avoided. For installation of warning globes, reflectors, or the like, it is permissible to travel with a cable carriage upon undamaged OPGW/OPPC in an as-new condition provided the following conditions are met:

- The cable carriage must be equipped with plastic rollers or with plastic coated metal rollers with a diameter of at least 120 mm (4-point suspension).
- The vertical loading on the cable per support roller must not exceed 1500 N, i.e., with 2 support rollers, the maximum permissible total weight is 3000 N.
- When travelling on the cable, the cable pulling force must not exceed \( \frac{1}{3} \) of the calculated rupture force for the OPGW/OPPC. The pertinent Data Sheet shows the rupture force for the type of OPGW/OPPC in question.
- Before and after travelling on the OPGW/OPPC, it may be necessary to take an optical measurement of the fibers using an optical time domain reflectometer (OTDR).

2.5. Installation of Fittings

The installation instructions issued by the fitting producer have to be observed. For the tension point exclusively dead end sets and protection rods resp. cone type tension clamps are permissible. For the suspension point armor grip suspension clamps are
prescribed. For OPGW/OPPC with a high steel- or aluminium clad steel portion cone type tension clamps are recommended.

Vibration dampers must be provided. The supplier of the vibration dampers prepares the basic vibration concept, but it can be obtained via Lumpi-Berndorf Draht- und Seilwerk GmbH as part of the general contract.

How the vibration dampers are mounted on the cable depends on the basic approach to vibrations. The dampers may never be mounted directly on the cable, i.e., they must always be fastened to suspension rods or dead-end grips or protection rods.

### 2.6. Fastening the OPGW/OPPC to the towers

**OPGW:**

After completion of the stringing process, the optical ground wire must be anchored directly to the tower. The ends of the OPGW are taken off using the cable grips required for the chain patterns desired on the tower shaft.

During later splicing in the joint box, a supply of fibers is laid in the sleeve. This requires an extra length of approx. 6 to 7 m of OPGW, measured starting from the joint box.

We recommend dimensioning the length of the optical ground wire so that the joint box can be put on the ground and then fastened to the pylon after having been finish-assembled.

The extra length of OPGW needed for this is to be fastened to the pylon in such a way as to allow for the minimum bending radii and to preclude any damage that might result from movements caused by wind.

Where necessary, protection rods should be installed at the ticklish points.

**OPPC:**

After completion of the stringing and tensioning process, the optical phase conductor must be connected to the closures (straight joint closure or optical fiber phase insulator) instantly. In order to keep the cut off time of the transmission line low splicing should be performed immediately after stringing. For this splicing work a fiber store of up to 2 m will be put down in the joint closure. This requires an extra length of approx. 6 to 7 m of OPPC, measured starting from the joint box. Splicing of the straight joint closures as well as the optical fiber phase insulators can normally not be done on the ground. Hence appropriate scaffolds have to be used for the installation of the closures. Laying from tension point to the closure must be carried out under consideration of the minimum bending diameter in such a way that a damage of the OPPC caused by short circuit or wind is avoided. If this cannot be excluded unequivocally strengthening members or protection rods have to be added at that locations.
3. Warranty Conditions

Adherence to these installation guidelines is a requirement for the warranty conditions agreed with Lumpi-Berndorf Draht- und Seilwerk GmbH taking effect.
4. Examples of Fastening for OPGW to the Pylon

Tension Point (anchoring tower, jointing on OPGW):

- Tension frame
- Sag adjusters
- Double eye twisted
- Dead end grip
- Protection rod
- OPGW
- Short-circuit bridge
- Parallel groove clamp
- Thimble
- Vibration damper
- Earthing clamp
- Sag adjusters

Tension Point (suspension tower, non jointing on OPGW):

- Suspension clamp
- Turnbuckle (clevis-tongue)
- Dead end grip
- Protection rod
- Shackle
- Single link
- Thimble
- Vibration damper
Suspension Point (OPGW):

- Suspension support (C-Shape)
- Suspension rod with ev. protection rod
- Copper shunt (Earthing)
- Stockbridge damper
- OPGW