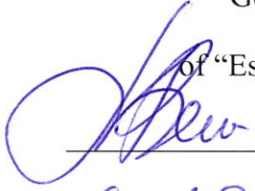



APPROVED BY

General Director

of "Estralin PS" LLC


P.S. Vetkhov
"06" 10 2015**ETI-15-06****Transport and Storage of
110-500 kV XLPE cables and cable accessories**

Approved on 06.10.2015

		Full name	Signature	Date
DEVELOPED BY	Leading Construction Engineer	Grin A.V.		06.10.2015
	Technical Director	Mneka A.S.		
AGREED BY	Deputy of General Manager Head of Projects	Markin A.V.		

1 Scope

1.1 This manual is intended for transportation, loading, unloading and storage of drums with 110 - 500 kV power cables with XLPE insulation (hereinafter - cable) and cable accessories for these cables supplied by "Estralin PS" LLC.

1.2 Cable accessories include: joints, outdoor terminations, GIS compact sealing end, transformers compact sealing end, cross-bonding link boxes, earthing link boxes, and other equipment which are installed on cables and accessories and their components.

1.3 The requirements of this manual should be taken into account at work performance planning and also should be used by carriers and customers during transportation and storage of drums with cables and cable accessories.

2 References

During the loading/unloading works and cables transportation one should observe the safety regulations according to local regulatory documents:

Safety regulations in construction;

Safety regulations in work with power-driven tools and accessories;

Fire protection regulations in power plants;

Safety regulations at construction and installation works;

Regulations on labor protection during loading and unloading and positioning of loads;

Regulations on labor protection during operation of industrial vehicles

3 General

3.1 Main structural elements and the weight of drums for cables are given in Appendices A and B. The size and weight of wooden drums are given in Appendix A. The size and weight of metal drums are given in Appendix B and may also have other parameters. Packaging dimensions are determined by the supplier after obtaining data on the construction lengths from the customer.

3.2 Transportation and storage of drums with power cable should be performed according to local standards.

3.3 Conditions of transportation and storage of cable drums in terms of the climatic factors of the environment impact should meet the following requirements: the open areas in the macroclimatic areas with temperate and cold climates in the atmosphere of any type, at temperatures from -50°C to $+50^{\circ}\text{C}$ except for cables with polymer materials that do not contain halogens. Provider determines the storage conditions for such cables based on the official data from the manufacturer.

3.4 Conditions of storage of cable drums in terms of the climatic factors of the environment impact should also meet the following requirements: sheds and premises, where air temperature and humidity fluctuations differ insignificantly from outdoor fluctuations (for example, tents, metal storages without thermal insulation) located in macroclimatic areas with temperate and cold climates, at the air temperature from -50°C to $+50^{\circ}\text{C}$.

- for cable drums stored in conditions which set out in cl. 3.3 the storage period comprises 2 years;
- for cable drums stored in conditions which set out in cl. 3.4 the storage period comprises 5 years.

Upon the parties' agreement, the storage period can be extended after inspection of the cable drums by the supplier's representative and his/her conclusion on the condition of the drums and the cable on the drums.

3.5 Conditions of transportation of cable accessories in terms of the climatic factors of the environment impact should meet the requirements as per cl. 3.4.

3.6 Conditions of storage of cable accessories in terms of the climatic factors of the environment impact should meet the following requirements: heated and ventilated warehouses, storages located in any microclimatic areas.

Air temperature at storage - from +5⁰C to + 40⁰C.

Relative air humidity at storage:

- average annual value of 60 % at + 20C⁰;
- upper value of 80% at + 25C⁰.

The above upper value of the relative humidity is also normative at lower temperatures; at higher temperatures the relative humidity is lower. Values of 90% at + 20⁰C or 50-60% at +40⁰C correspond to the set upper value of 80% at + 25⁰C.

3.7 The storage period of cable accessories, their components and materials should meet the requirements set by the manufacturer of cable accessories.

3.8 There can be other conditions of storage and transportation of cables and cable accessories set out in the manufacturers' regulatory technical documentation, on which the Customer shall be notified. The Supplier shall request for an official confirmation of conditions of storage of cable and cable accessories from the manufacturer. These conditions of storage and transportation of cables and cable accessories set by the manufacturer shall be obligatorily met, otherwise, the manufacturer's warranty obligations can be withdrawn.

3.9 At transportation and storage cable drums and accessories shall not be exposed to the impact of vapors of acids, alkalis and other aggressive media, which affect drums, cable and accessories. The list of substances affecting PE cable sheath is set out in Appendix C.

3.10 At transportation, unloading, loading and storage of drums and cable accessories on the territories of substations and functioning power plants it is necessary to comply with the regulations on labor protection (safety precautions) at operation of power plants.

3.11 Works with application of hoisting machines and mechanisms shall be performed in accordance with the requirements and regulations on labor protection at handling operations and positioning of loads and inter-industry regulations on labor protection at operation of industrial vehicles.

3.12 At transportation and storage cable ends shall be sealed.

3.13 At transportation, handling operations and storage it is necessary to ensure integrity of lagging of cable drums and boxes with cable accessories, as well as integrity of labeling of drums, boxes and accompanying documentation attached to the drum or the box.

3.14 It is prohibited to load, unload, transport and store cable drums with defective lagging and cable accessories with damaged package.

3.15 Before and after transportation cable drums and boxes with cable accessories shall be inspected with the participation of the carrier's representative to determine integrity of the drum, cable sheath, as well as integrity of the cable accessories package. The operating procedure at detection of damages is set out in section 5 hereof.

4 Loading, Unloading and Transportation of Cable Drums and Accessories

4.1 Cable drums and accessories can be transported by all means of transport in accordance with cargo carriage regulations and cargo loading and fastening regulations applicable for each means of transport.

4.2 At transportation cable drums must not lie on the flange.

4.3 At transportation cable drums must be fastened. At fastening of drums it is prohibited to pierce sidings of drum flanges and lagging with nails and clamps.

An example of cable drum fastening on a low-frame platform is shown in Appendix D.

Picture D1 in Appendix D shows that for drum fastening on the platform chains fastened by hooks to clamps with apertures on the metal platform pass through the aperture in the drum axis and pull the drum to the platform. For tensioning chains are fitted with stretchers.

Picture D2 in Appendix D shows that to prevent rolling down of the drum wooden bars with knees for leaning of the drum flanges are fastened across the wooden floor of the platform.

4.4 For transportation of cable drums it is permitted to use special cages in the vehicle's cargo compartment (in the carbody, trailer, railway platform, barge, etc.).

4.5 For transportation of heavy cable drums it is permitted to use special metal supporting structures for fastening of cable drums. It is permitted to unload cable drums from the vehicle together with the supporting structures. An example of transportation and unloading of the cable drum fastened on the metal supporting structure is shown in Appendix E, pictures E1 and E2.

4.6 At fastening of drums by any of the above means the cable drum shall not touch the floor (platform) to prevent cable damage.

4.7 At transportation cable drums shall be arranged in one layer.

4.8 At placement of two or more drums on a vehicle each drum shall be fastened separately from each other to prevent damage of drums at dynamic loads occurred during transportation (for example, during speedup, braking or dusting).

4.9 The speed of transportation of cable drums shall ensure preservation of drums in case of hard braking.

4.10 Heavy and off-size cable drums shall be transported in accordance with local regulations on highway carriage of heavy and off-size cargos by motor vehicles.

At transportation of drums with large external diameters traffic limitations shall be considered. Depending on local regulations and conditions permits issued by traffic regulation authorities and special trailers with a low draft can be required.

4.11 At loading/unloading of cable drums it is necessary to apply handling accessories (cross arms) with straps excluding damage of drum flanges and lagging, as well as spindles, insert bushings and cable jaws with hooks inserted in the aperture on the drum axis (see pictures E2 and E3 in Appendix E).

4.12 It is prohibited to unload cable drums by throwing off from cars and other vehicles.

4.13 It is prohibited to unload cable drums by rolling down from cars and other vehicles, as well as to load them by rolling up, except for cases when the bottom of the carbody (or the bottom of the railway platform, etc.) is at one level with the floor of the site, on which cable drums are unloaded (or from which cable drums are loaded).

4.14 At roll-over of cable drums it is necessary to observe the direction of rotation marked by an arrow on the drum flange. Rolling of drums with protruding cable ends is prohibited. Cable ends shall be fastened on the interior of the drum, for mean stress cables it is allowed to bring out the cable end to the drum flange.

4.15 Cable drums shall be unloaded on a flat solid site without objects, which can damage the drum lagging and the cable.

4.16 When unloading outdoors on soil it is necessary to consider potential damage of the drum lagging and the cable due to soil settlement under the drum load. Large drums can be unloaded and further stored on reinforced concrete slabs placed on the soil, on asphalted or metal platforms.

4.17 In all cases of unloading/loading and storage it is necessary to provide for measures on prevention of self-existing rolling of drums.

4.18 At loading and unloading of drums by means of a forklift loader, the fork shall be aligned with the drum, wherein all the drum flanges shall be placed on the fork (see Appendix F, which contains warning signs on loading and unloading of cable drums).

4.19 Cable accessories shall be transported in covered vehicles.

If necessary, the vehicle type can be set in the manufacturer's regulatory technical documentation.

4.20 Before transportation cable accessories shall be safely fastened in the vehicle.

4.21 It is prohibited to unload cable accessories by throwing off from the vehicle.

4.22 Cable accessories shall be stored in the manufacturer's original package.

4.23 At storage packed cable accessories can be arranged in several layers. The number of permitted layers shall comply with the specification marked on the cable accessories package; otherwise, it is determined by the supplier of cable accessories.

4.24 Cable accessories shall be stored in covered premises beyond the reach of unauthorized persons.

4.25 During storage cable accessories shall be protected from mechanical impact, vapors of acids, alkalis and other aggressive media, which affect package and cable accessories themselves, as well as from sun rays, precipitations and dust.

4.26 During storage it is necessary to observe completeness of cable accessories. It is prohibited to seize components from cable accessories without re-registration of cable accessories in the accounting storage documentation.

5 Operating Procedure at Detection of Defects in the Cable on the Drum, Cable Accessories, Damage of Drum Lagging or Cable Accessories Package

5.1 All detected damages of cable, drum, drum lagging, defects in cable accessories and damage of cable accessories package shall be immediately notified to "Estralin PS" LLC.

5.2 Damages shall be inspected by a commission in the presence of an authorized representative of "Estralin PS" LLC.

5.3 In case of a cable drum damage, the damage report shall contain: order number, name of the cable line, for which the cable is meant, cable grade, factory number of the cable drum, date of manufacture, factory length, cable length on the drum, location and nature of damage, date and place of drawing up the protocol, last names and positions of signatories with specification of represented organizations or enterprises.

5.4 Upon detection of defects in cable accessories or damage of cable accessories package the report shall contain: order number, name of the cable line or substation, for which the cable accessories are meant, grade of the cable, for which the cable accessories are meant, manufacturer of the cable accessories, brief description of the detected defects or damage of package, date and place of drawing up the protocol, last names and positions of signatories with specification of represented organizations or enterprises.

5.5 Photos of the defects shall be also attached to the report.

5.6 One copy of the report shall be submitted to “Estralin PS” LLC.

5.7 In case of considerable cable damages it is necessary to inspect not only cable sheath but also structural elements under the sheath with obligatory participation of “Estralin PS” LLC’s representative. The necessity and procedure of such inspection shall be determined by the commission on inspection of the damage site with the participation of “Estralin PS” LLC’s representative.

5.8 In particular cases, in case of doubts about the quality of parts and units of cable accessories, these parts and units can be returned to “Estralin PS” LLC for quality expertise with attraction of specialists from the manufacturer of cable accessories. A conclusion on causes of the defects and suitability for mounting shall be drawn up based on the examination results.

6 Appendices

Appendix A. Dimensions and Weight of Wooden Cable Drums.

Appendix B. Dimensions and Weight of Metal Cable Drums.

Appendix C. List of Substances Affecting PE Cable Sheath.

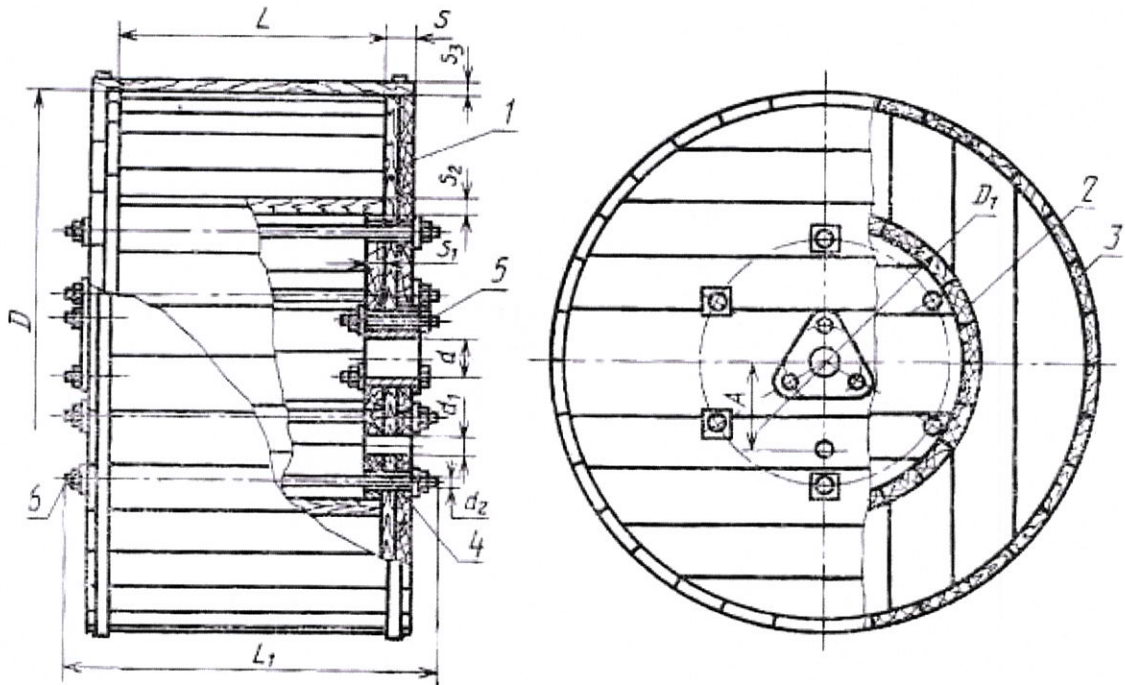
Appendix D. Fastening of a Cable Drum on a Low-Frame Platform.

Appendix E. Transportation, Loading and Unloading of Cable Drums

Appendix F. Warning Signs with Requirements to Loading and Unloading of Cable Drums.

Appendix A

Dimensions and Weight of Wooden Cable Drums



1-flange; 2-barrel; 3-lagging; 4- barrel ring; 5-central bore; 6-pin

Table A1. Dimensions of Sidings and Tapes for Wooden Drum Lagging

Drum number	Siding, mm		Thickness and width of the steel tape, mm
	Thickness of siding S_3 , mm	Width of siding, no more than, mm	
5-8б	16	150	0,3-0,5 x 20-35
10-14g	19	200	0,3-0,5 x 20-35
16-18v	25	250	0,3-0,5 x 25-35
20-22v	32	250	0,3-0,5 x 35-45
25-30a	40	250	0,3-0,5 x 45-55

Appendix A (continued)

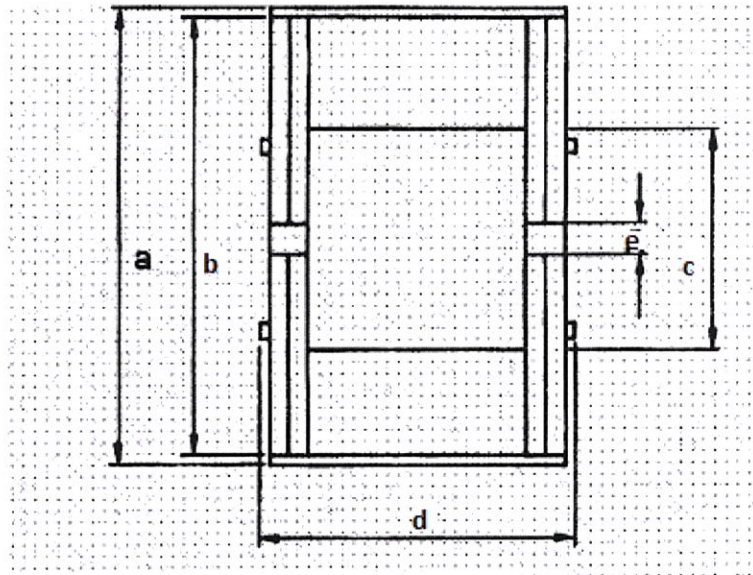
Table A2. Dimensions of Wooden Drums (all dimensions in mm)

Drum number	Diameter:		Barrel length L	Thickness:		Inside diameter:		Dimension A	Lagging length	Pin length L1
	flange D	barrel D1		flange S	barrel S2	axial d	driving d ₁			
5	500	200	230	38	16	35	35	60	306	350
6	600	200	250	38	19	35	35	60	326	370
8	800	450	230	38	19	50	50	150	306	350
8a	800	450	400	38	19	50	50	150	476	520
8b	800	450	500	38	19	50	50	150	576	620
10	1000	545	500	50	22	50	50	150	600	646
10a	1000	500	710	50	22	50	50	150	810	864
12	1220	650	500	50	22	70	50	250	600	650
12a	1220	650	710	50	22	70	50	250	810	864
12b	1220	600	600	50	22	70	50	250	700	746
14	1400	750	710	58	28	70	50	250	826	875
14a	1400	900	500	58	22	70	50	250	616	665
14b	1400	1000	600	58	28	70	50	250	716	770
14v	1400	750	710	70	28	70	50	250	850	904
14g	1400	750	900	58	28	70	50	250	1016	1065
16	1600	1200	600	58	30	70	50	300	716	770
16a	1600	800	800	58	30	80	50	300	916	970
17	1700	900	750	70	28	80	50	300	890	944
17a	1700	900	900	70	28	80	50	300	1040	1094
18	1800	1120	900	80	36	80	50	300	1060	1120
18a	1800	900	900	80	36	80	50	300	1060	1122
18b	1800	750	1000	80	36	80	50	300	1160	1222
18v	1800	900	730	80	30	80	50	300	890	950
20	2000	1220	1000	90	36	80	50	300	1180	1250
20a	2000	1000	1060	90	36	80	50	300	1240	1302
20b	2000	1500	1000	90	36	80	50	400	1180	1242
22	2200	1320	1000	118	46	100	50	400	1236	1298
22a	2200	1480	1050	118	46	100	50	400	1286	1348
22b	2200	1680	1100	118	46	100	50	400	1336	1398
22v	2200	1320	1100	118	46	100	50	400	1336	1398
25	2500	1500	1300	130	56	120	50	400	1560	1630
26	2600	1500	1500	140	56	120	50	400	1780	1850
30	3000	1800	1800	180	56	150	50	400	2160	2230
30a	3000	2500	1700	96	46	150	50	400	1892	1962

Note: there are other customized dimensions of wooden drums (dimensional group 32 and higher).

Appendix B

Dimensions and Weight of Metal Cable Drums



- a) diameter, including lagging;
- b) flange diameter;
- c) barrel diameter;
- d) total width;
- e) central bore diameter.

Table B1. Dimensions and Weight of Metal Drums

Drum type	Volume, m ³	Weight, including weight of lagging, kg	Diameter, including lagging, mm	Flange diameter, mm	Barrel diameter, mm	Total width, mm	Central bore diameter, mm
St.28	20,6	1500	2930	2800	2000	2400	150
St.30	23,5	1700	3130	3000	2000	2400	150
St.32	26,6	2200	3330	3200	2000	2400	150
St.34	28,9	2600	3530	3400	2000	2400	150
St.35	31,6	2700	3630	3500	2000	2400	150
St.36	33,4	2800	3730	3600	2000	2400	150
St.37	35,2	3000	3830	3700	2000	2400	150
St.38	37	3100	3930	3800	2000	2400	150
St.39	38,9	3300	4030	3900	2000	2400	150
St.40	40,9	3500	4130	4000	2000	2400	150
St.43	47,1	4000	4430	4300	2000	2400	150

Note: there are drums with larger external diameters.

Appendix C

List of Substances Affecting PE Cable Sheath

The list contains data on stability (satisfactory, limited or unsatisfactory) of the material of cable sheath (high density PE) to the impact of different substances in the absence of internal pressure and external mechanic tension and at the temperatures of 20⁰C and 60⁰C.

1. The material of cable sheath has an **unsatisfactory stability at the temperatures of 20⁰C and 60⁰C** to the impact of the following substances:

- brome (liquid or gas), iodine in alcoholic solution and potassium salt, fluorine (gas);
- halogen derivatives: methyl bromide, bromoform, Dutch liquid, dichlorobenzene, dichloropropylene, methylcyclohexane, propylene dichloride, tetrachloroethylene, trichlorobenzene, trichloroethylene, tribromomethane, benzene chloride, chloroform, chlorosulfonic acid, thionyl chloride, ethyl-chloride, ethylene chloride, methyl chloride, methylene chloride;
- aromatic hydrocarbons;
- depentene, tetradecane, tetrahydrofuran, sulfur trioxide, diethyl ether, depentene, iso-pentane, isopropylamine, isopropanol amine, ethyl mercaptanate, nitrobenzene, nitrotoluene, N-pentane, oleum, pentane-2, furfural, cyclohexane, O-Zylene, P-Zylene, ethyl benzene;
- nitric acid (95% and higher), nitrohydrochloric acid (HCl / HNO₃=3/1), sulfuric acid (boiling);
- kerosene, turpentine (gum).

2. The material of cable sheath has a limited stability at the temperature of 20⁰C and unsatisfactory stability at the temperature of 60⁰C to the impact of the following substances: ethyl acrylate, decane, dibutyl amine, carbon disulfide, carbon tetrachloride, xylene, ligroin, lysol, methylcyclohexane, N-heptane, ozone, styrene, titanium tetrachloride, tetrachloromethane, boron trifluoride, toluene, brake fluid, chlorine (saturated water solution or gas), allyl chloride.

3. The material of cable sheath has a satisfactory stability at the temperature of 20⁰C and unsatisfactory stability at the temperature of 60⁰C to the impact of the following substances: isopropyl ether, nitroethane, octyl alcohol, olive oil, hydrogen dioxide (90%), sulfuric acid (from 90% to 98%), perchloric acid (70%), ethyl acetate.

4. The material of cable sheath has a limited stability at the temperatures of 20⁰C and 60⁰C to the impact of the following substances: acetone, banana oil, benzol, benzene, diacetone alcohol, diethyl ketone, hexachlorophene, camphor oil, calcium sulfide.

5. The material of cable sheath has a satisfactory stability at the temperature of 20⁰C and a limited stability at the temperature of 60⁰C to the impact of the following substances: diesel fuel, oil products, carriage grease, solid oil, aniline, hexane, benzaldehyde, benzolchloride, isooctane, sulfuric acid (70%), acetic acid (over 96%), butyric acid, chromic acid, perchloric acid (50%), furfural alcohol, ethyl alcohol, hydrogen dioxide and some other substances.

Note: The material of cable sheath has a **satisfactory stability at the temperatures 20⁰C and 60⁰C** at the impact of engine lubricating oils (automobile engine oil, etc.), bitumen, castor oil, sunflower, corn and cotton oils, mineral butter, silicone greases.

The list is drawn up based on the data provided by Borealis company, source of information - ISO/TR 7472, 7474; Carlowitz: Kunststofftabellen-3. Auflage

Appendix D

Fastening of a Cable Drum on a Low-Frame Platform



Pic. D1. Fastening of a cable drum to the platform with chains passing through the axis



Pic. D2. Fastening of cable on the platform with wooden bars and supports to prevent rolling down

Appendix E

Transportation, Loading and Unloading of Cable Drums



Pic. E1 Transportation of a cable drum fastened on a metal support structure



Pic. E2. Unloading of a cable drum fastened on a metal support structure

Appendix E (continued)



Pic. E3 Loading and unloading of a cable drum by means of a cross arm with straps and cable jaws

Appendix F

Warning Signs with Requirements to Loading and Unloading of Cable Drums

