Metstbytservis Engineering Company

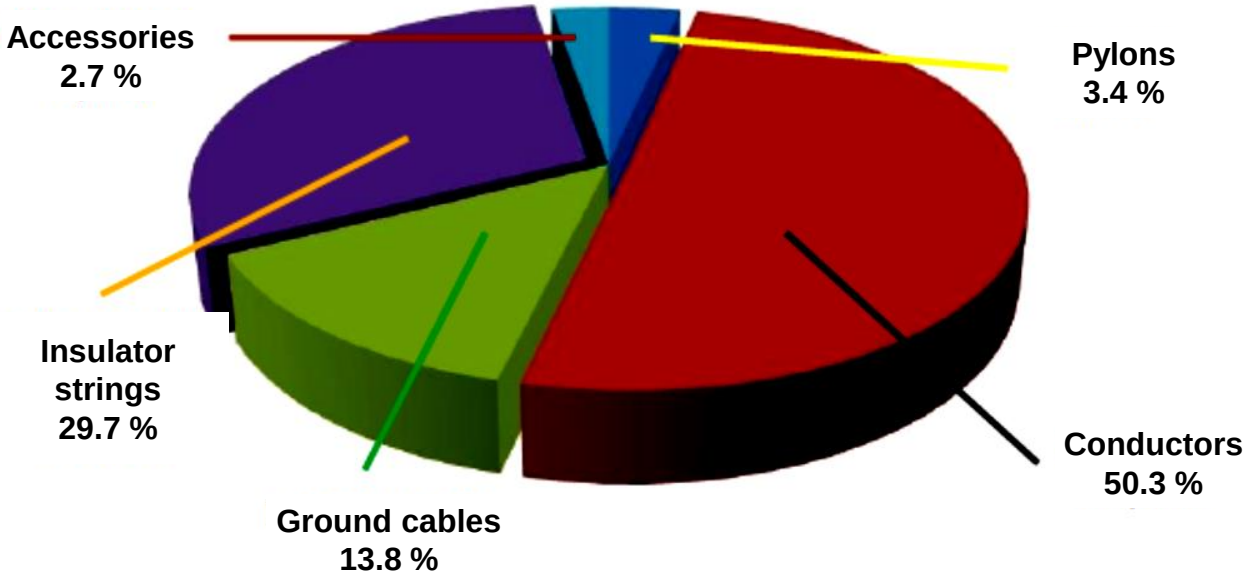
Innovative products for energy infrastructure facilities

Providing simple solutions to complicated problems

Factors that encouraged us to develop new products for overhead power transmission lines

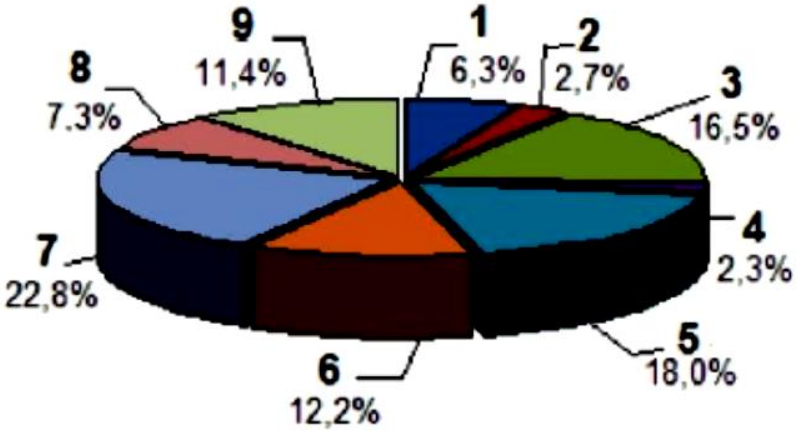
WAYS TO ENHANCE RELIABILITY OF AN OVERHEAD POWER LINE

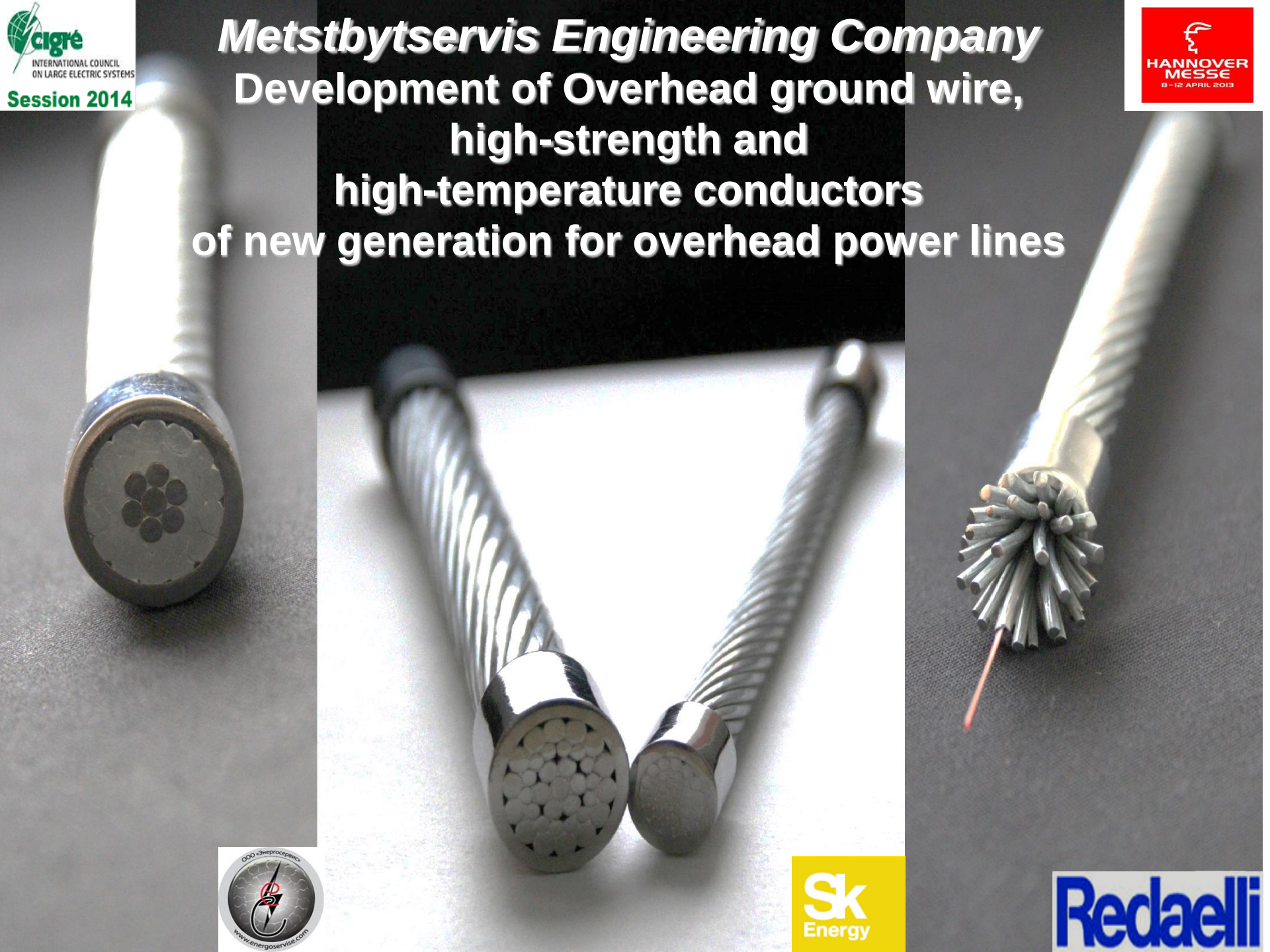
Reasons of technology breakdowns of overhead power transmission lines 110–750 kV



Reasons of conductors damage

1 – cable swinging, vibrations;
2 – thefts;
3 – glaze frost, wind load;
4 – clamp damage;
5 – external effects;
6 – defects of design and installation;
7 – operation defects;
8 – atmospheric overvoltages;
9 – strength loss, corrosion.

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INTERNATIONAL COUNCIL ON LARGE ELECTRIC SYSTEMS
Session 2014
HANNOVER MESSE
8–12 APRIL 2013
Metstbytservis Engineering Company
Development of Overhead ground wire, high-strength and high-temperature conductors of new generation for overhead power lines
Sk Energy
Redaelli


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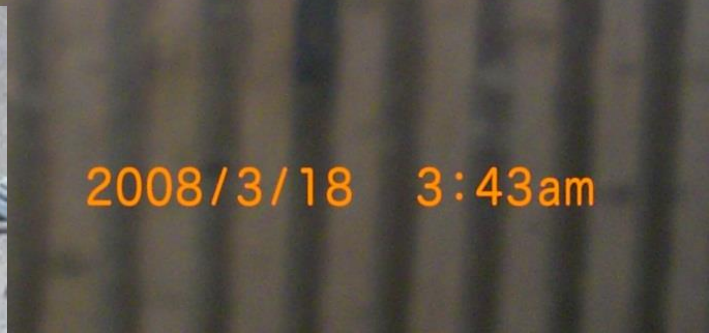
INTERNATIONAL COUNCIL ON LARGE ELECTRIC SYSTEMS
Session 2014
HANNOVER MESSE
8 - 12 APRIL 2013
This is the first in Russia
product designed
to protect overhead power lines
from direct lightning strikes. It provides absolute resistance to lightning strikes of up to 147 ampere-second, wind and vibration loads and offers 40 years of service life.
ООО «Энергосервис»
www.energoservise.com
Sk Energy

Ground wire to wire of aluminum after exposure to lightning 85 coulomb, retains only ~29% from the original breaking strength

We first created specially for line protection, lightning protection - Virtually no damage even after discharge in 147 Cl.

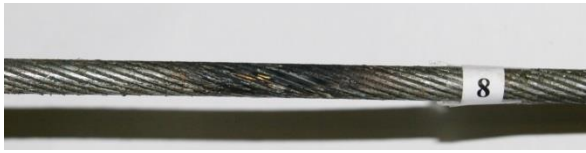
Analogue of our products after testing (49.6% of the estimated breaking load).



Results of comparative test for the Technical Council Of Russian Grid Company “Rosseti” (2.04.2013)

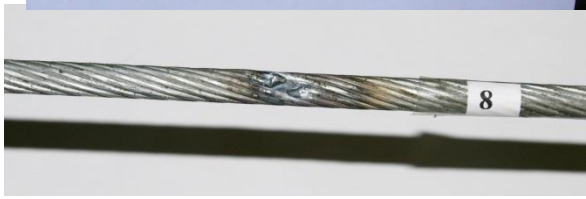
Cable 9,2-Г (МЗ)-В-ОЖ-МК-Н-Р

Cable 9,2-Г (МЗ)-В-ОЖ-Н-Р-1770; **Enterprise Standard 71915393-TU 062-2008 by Metstbytservis**, completely and successfully passed the entire test sequence. Cable 2-Г (МЗ)-В-ОЖ-Н-Р-1770; STO 7915393-TU 062-2008 by Severstal-Metiz, Volgogradsky branch, is resistant to lightning strikes with charges over 110 ampere-second, aeolian vibration and swinging; during the tests the actual braking strength did not reduce and was 103 % of its nominal breaking strength. Grounding cable 9,2-Г (МЗ)-В-ОЖ-Н-Р-1770 by Metstbytservis, is the most reliable and preferred for protection of high-voltage power lines from lightning strikes.



Cable ПК-9,2-МЗ-В-ОЖ-Н-МК-Р

Cable ПК-МЗ-В-ОЖ-Н-МК-З-1770; Enterprise Standard 14-173-35 by Mechel failed to pass the test sequence. Cable ПК-МЗ-В-ОЖ-Н-МК-З-1770; TU 14-173-35 by Mechel may be recognized resistant to lightning up to 95 ampere-second; the cable failed to withstand vibration and swinging. Its actual strength during the test reduced to 32.8 kN (55 % of the nominal breaking load). Ground cable ПК-МЗ-В-ОЖ-Н-МК-З-1770; TU 14-173-35 by Mechel cannot be recognized reliable; it is not recommended for protection of high-voltage power lines from lightning strikes.



Cable ГТК20-0/50-9,1/60

Cable ГТК20-0/50-9,1/60 Enterprise Standard 3500-007-63976268-2011 by EM-Kabel, the city of Saransk, failed to pass the test sequence. Cable ГТК20-0/50-9,1/60 TU 3500-007-63976268-2011 by EM-Kabel, the city of Saransk, cannot be recognized resistant to lightning up to 85 ampere-second; its actual strength during the test reduced to 32.8 kN (49.6 % of the nominal breaking load). Ground cable ГТК20-0/50-9,1/60 TU 3500-007-63976268-2011 by EM-Kabel, the city of Saransk, is absolutely unreliable and cannot be used to protect high-voltage power lines from lightning.

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Optical ground wire (OPGW, in the IEEE standard, an optical fiber composite overhead ground wire)

The product keeps on a par with the global analogs and offers highest reliability

Sk Energy

Technical characteristics of OPGW, model 1X36 (T+7+7/7+14)

OPGC	Diameter, mm of wire: of steel tube (d_1)	Of 1st layer 7 pcs (d_2)	Of 2nd layer: big diam. 7 pcs	Of 2nd layer: small diam. 7 pcs	3rd layer 14 pcs (d_5)	Nominal section area of all wires in OPGC, mm^2	Tentative weight of 1000 m of lubed OPGC, kg
1	2	3	4	5	6	7	8
9,2	1,90	1,40	1,35	1,00	1,65	56,17	472,0
10,0	2,10	1,50	1,45	1,10	1,80	66,21	553,0
11,0	2,30	1,65	1,60	1,25	1,95	79,42	670,0
12,5	2,60	1,90	1,85	1,40	2,20	102,61	860,0
13,0	2,65	1,95	1,90	1,45	2,35	113,04	950,0
14,0	2,90	2,10	2,05	1,55	2,50	129,28	1085,0
15,0	3,05	2,25	2,20	1,70	2,70	150,49	1260,0
16,0	3,25	2,40	2,35	1,80	2,90	172,32	1420,0
17,0	3,45	2,55	2,50	1,90	3,05	189,69	1615,0
18,5	3,75	2,80	2,70	2,05	3,35	229,68	1925,0
21,0	4,30	3,15	3,05	2,35	3,80	294,84	2470,0
22,5	4,60	3,35	3,30	2,55	4,05	337,68	2835,0

Diameter of OPGC, mm	Marking group N/mm^2 (kgf/mm^2)				Max. Outer curve radius of OPGC, mm
	1570 (160)	1670 (170)	1770 (180)	1860 (190)	
	Total nominal breaking force for all wires in OPGC, N (kgf), At least				
9,2	88187 (8987)	93804 (9549)	99421 (10111)	104476 (10672)	99,60
10,0	103950 (10594)	110571 (11256)	117192 (11918)	123151 (12580)	110,00
11,0	124689 (12707)	132631 (13501)	140573 (14296)	147721 (15090)	120,50
12,5	161098(16418)	171359 (17444)	181620 (18470)	190855 (19496)	136,25
13,0	177473 (18086)	188777 (19217)	200081 (20347)	210254 (21478)	139,00
14,0	202970 (20685)	215898 (21978)	228826 (23270)	240461 (24563)	152,00
15,0	236269 (24078)	251318 (25583)	266367 (27088)	279911 (28593)	160,00
16,0	270542 (27571)	287774 (29294)	305006 (31018)	320515 (32741)	170,50
17,0	297813 (30350)	316782 (32247)	335751 (34144)	352823 (36041)	181,00
18,5	360598 (36749)	383566 (39046)	406534 (41342)	427205 (43639)	196,75
21,0	462899 (47174)	492383 (50123)	521867 (53071)	548402 (56020)	225,50
22,5	530158 (54029)	563926 (57406)	597694 (60782)	628085 (64159)	241,25

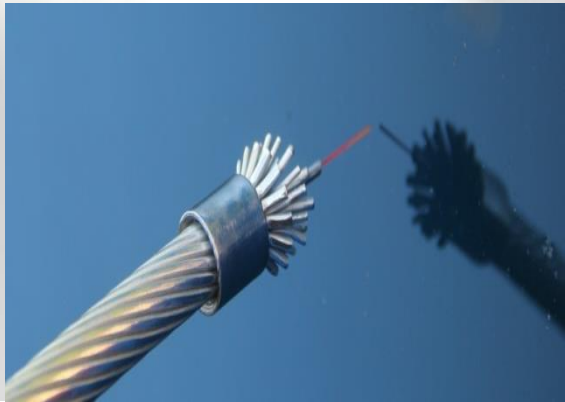
Elasticity module (terminal) x 105, N/mm2 – 1.80
Linear extension coefficient x 10-6, 1/°C – 12.0

Diameter of OPGC, mm	DC resistance at 20 °C, Ohm/km	Internal inductive reactance, Ohm/km	Max. short-circuit current, for glaze frost melting, effect of 1 sec, kA
9,2	3,2	0,39	2,992
10,0	2,64	0,36	3,57
11,0	2,2	0,34	4,3
12,5	1,9	0,311	5,24
13,0	1,8	0,298	5,66
14,0	1,4	0,278	6,86
15,0	1,2	0,251	7,98
16,0	1,11	0,223	8,81
17,0	0,94	0,201	10,21
18,5	0,77	0,151	12.32
21,0	0,6	0,068	15,81
22,5	0,52	0,0137	18,19

OPGW suspension accessories:

OPGW suspension accessories:
standard used to connect with a central location optical module
Connecting couplings:
standard used to connect with a central location optical module, it is required to use the special input complexes having in their designation (melting).

Tests have shown that our OPGW has sufficient resistance to short-circuit currents (I^2 to 330kA). Settlement possible more current can be expected on some lines only at the approaches to the substations. Therefore, it is not advisable to use more expensive steel-aluminum product, also less durable, on all extent overhead lines.



Optical module (ISO 9001 – 2000 certifications)

All products provide great mechanical and thermal strength, even in case of lightning strike or short circuit. The tube is made of a special stainless steel stripe.

Diameter, mm	Wall thickness (s), mm	Deviations, mm	Of fibers*
1,9 - 2,1	0,203 _+0,005	+0/-0,04	8
2,2 - 2,5	0,203 _+0,005	+0/-0,04	30
2,6 - 2,8	0,203 _+0,005	+0/-0,045	30
2,9 - 3,4	0,203 _+0,005	+0/-0,045	38
3,5 - 4,2	0,203 _+0,005	+0/-0,05	50

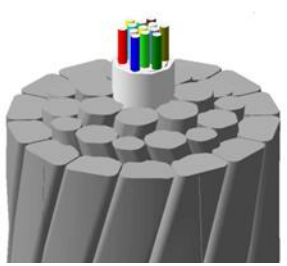
*** The quantity of fibers may be significantly increased on request.**

Potting compound (standard): Gel LA444 by **Huber**.

Industry-standard optic fibers: Single-mode: TFO, ITU – T G652 Maximal fiber attenuation: 1310 nm 0.34 dB/km and 1550 nm 0.21 dB/km; multimode fibers may be used.

Waterproofing: The test is performed according to DIN 0472, section 811.

Description of OPGW tests



Tension resistance test*

Optic fibers deformation tests*

–No visible damage of the cable structure elements.

Compression resistance test*

–attenuation gain is within the instrumental error*;

Lightning currents resistance test – 110 ampere-second*

Rerolling resistance test*

Aeolian vibration test * – no damage of the cable components.

Bending resistance test

–Attenuation gain is within the instrumental error*:
–No visible damage of the cable structure elements.

Elongation test (1000 hours)

Galloping Test * - No visible damage of the cable structure elements.

Test of resistance to external factors between -40 and +70 °C

Result: The attenuation ratio gain in the third cycle and after the tests is within 0.05 dB/km, including the instrumental error *.

Waterproof test – 100 %

Short-circuit current resistance test: The optical attenuation ratio gain is within 0.05 dB/km. The integrity of OB and the minimal breaking strength are preserved. (Values, kA: I_L=7,27; $I_{нп}$= 5,1; $I_т$=4,3)

*** attenuation ratio growth is within 0.05 dB/km at 1550 nm wave-legth.**

SAG

Technischer Bericht Nr. 2014-055

Notwendige Prüfungen eines LWL-Erdseiles zum Nachweis der Funktionsfähigkeit für den deutschen Markt

Auftraggeber:	EnergoInno GmbH Alte Jacobstraße 77 CD 10179 Berlin
Gegenstand:	Stahl-Lichtwellenleiter-Erdseil nach Unterlagen der Fa. EnergoInno
Verfasser:	Dipl.-Ing. Wolfgang Marthen
Datum:	Juli-August 2014

SAG GmbH
Leitungsbau
Versuchs- und Technologiezentrum, Pittlerstraße 44, 63225 Langen
Telefon: +49 6103/7600-0, Fax: +49 6103/7600-149

Marthen Unterfinger

SAG

Conformity testing requirements of Germany (DIN & IEC), confirmed by SAG Deutschland - Versuchs- und Technologiezentrum

The research by OPGW of various designs shown:

- Use of steel rods with galvanized coating in OPGW with plastically deformed external layer allowed reducing temperature on surface of optical module by 35 °C in comparison with wire made of steel rods without coating while passing guaranteed short-circuit current 4.3 kA within 1 s. Obtained temperature values don't result in degradation of optical properties of fiber optic.
- New OPGW, provides significantly greater resistance to lightning discharge, mechanical properties and less sag, and has a number of properties with sufficient resilience to short-circuit current.
- Aluminum coating low resistance to discharge lightning, strength, exposure to extension (directly proportional to the fraction of aluminum in the section), has an advantage of only one thing - excessive resistance to short-circuit current.
- Aluminum coating of rods allows additional reduction of temperature, but its use is associated with a number of negative factors: low corrosion resistance of aluminized coating in the area of contact with stainless tube of optical module; low resistance of ground wires with aluminum coating at lightning strokes.
- When selecting a type of protective coating for steel rods it is necessary to consider not only possible change of temperature field in OPGW at similar values of short-circuit current, but also dependence of its value on specific resistance of ground wire, as well as resistance to lighting current, corrosion resistance and rod bearing capacity.

Details: http://www.energoservise.com/files/Statya_CIGRE.pdf

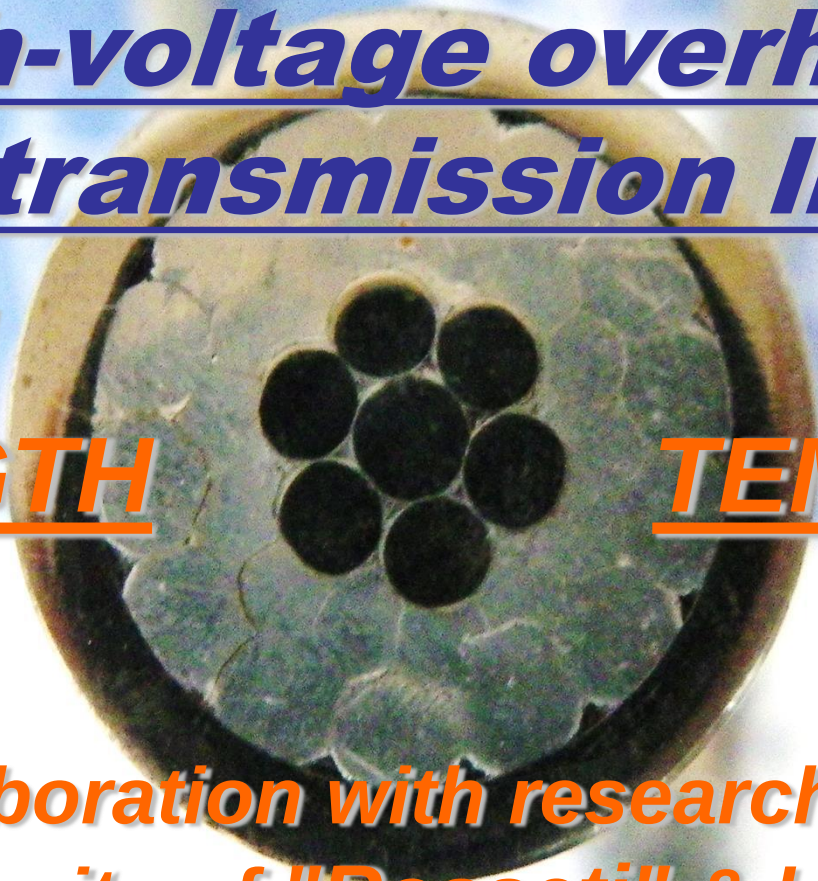
Feasibility study
Of usage of ground cables ES 71915393-TU 062-2008 as power line pylon guys, СТО 71915393-ТУ062-2008.

A number of problems may be solved by making pylon guys of the ground cable manufactured under ES 71915393-TU 062-2008 that ensures:

- Mechanical characteristics of a new level.
- Reduced aeolian and blaze frost load of the guys due to the modified design of the cable lay: it is a “compact” system with more compact (than the used ones) arrangement of the wires both in the external layer and in the cable section in general.
- Much higher elasticity module (higher by 14-16 %) normally reducing the guy deflection.
- High corrosion resistance
- Milder wear of the fasteners and foundations of power lines pylons.
- Minimization of the operational elongation

In many ways the cable under ES 71915393-TU 062-2008 will prevent many other associated problems, such as intensive generation of glaze frost, intensive aeolian vibration and many others.

STEEL-CORED ALUMINUM CONDUCTORS for high-voltage overhead power transmission lines



HIGH STRENGTH

HIGH TEMPERATURE

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In collaboration with research centers and operating units of "Rosseti" & branch institutes, have developed several variants of a new design conductors and ground wire.

HIGH-STRENGTH (ASHS) AND HIGH-TEMPERATURE (ASHT) STEEL-CORED ALUMINUM CONDUCTORS

In collaboration with research centers and operating units of "Rossetti" and branch institutes, have developed several variants of a new design bare steel-cored aluminum conductors of regular lay and linear wires contact with reduced steel and aluminum parts. ***The steel-cored aluminum conductors are manufactured under enterprise standard 71915393–TU 120–2012 and designed for transmission of electric power through overhead power lines of 35–750 kV.***

Severstal-Metiz uses this radically new technology for a wide range of dimension types:

- ***Conductor is resistant to the lightning charge pulse.***
- ***The conductor is resistant to thermal effect of the short-circuit current generated during operation with single-/double-phase ground connections; the value and time of the effect is determined according enterprise standard 56947007-29.060.50.015-2008***
- ***The conductor is resistant to at least 100 mln. cycles of aolian vibration which frequency shall correspond with the nearest resonant frequency of 4–8 m/s wind.***
- ***The cable is resistant to galloping (swinging).***

In the absence of constraints associated with the routing of the line, the use of our conductors can lead to a 25% capital cost savings in the project due to the smaller number of supports.

High strength steel-aluminum conductor offers high mechanical strength and large section of the aluminum part with constant diameter

Comparison of AS. AERO-Z. ASHS. ASHT conductors a diameter of 22.4

Tipe	Diameter, mm	Breaking force, kg	Weight,Kg/km	Permissible continuous current, A
Standard AL-Steel 240/56	22,4	98253(100%)	1106(100%)	610(100%)
AERO-Z 346-2Z	22,4	111320(113%)	958(87%)	852(140%)
Lumpi -TACSR	22,4	86260(113%)	957(87%)	861(141%)
J-Power Systems GATACSR	22,4	110000(113%)	1100(100%)	860(140%)
ASHS 277/79 Energoservis	**22,4**	163940(167%)	1399(127%)	861(141%)
ASHS 258/73 Energoservis	**21,6**	151553(154,2%)	1296,5(117%)	812,72(133%)
Standard AL-Steel 400/93*	29,1	173715 (100%)	1851 (100%)	860(100%)
ASHS 371/106* Energoservis	**26,0**	225001(122,79%)	1872(113%)	1059,9(123%)
ASHT 277/79 Energoservis**	22,4	163940(167%)	1399(127%)	1199(197%)

Note: The values for Standard AL-Steel 240/56 conductors (serially used now) are assumed as 100 %.

* - Comparison AS400 / 93 and ASVP371 / 106; ** - The high temperature cable (ASHT by Energoservis)

Advantages

AERO-Z conductors greatly improve current properties of the conductor and reduces the resistance and the bulk weight. Meanwhile, ASHS and ASHT conductors are more than twice stronger; ASHS conductor's current is almost as high as AERO-Z's current; and ASHT conductors offers capacity almost twice higher than AC conductor and 1.5 times higher than AERO-Z conductors of similar diameters. It supposes that the new ASHS and ASHT conductors expand designing of HV power lines and allow dealing with the goals that used to be unpractical or used to require great efforts.

Using OUR conductors may considerably increase the capacity of HV-lines as compared with standard conductors

The unique technological solutions in the production of our wire allows us to offer a significant reduction in price relative to other wires with the same characteristics!

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High-temperature conductors ASHT

In creating the high-temperature conductor we relied on the solutions improving the capacity of the available lines. Such goal-setting is attractive in terms of both engineering and economy.

- maximal conductivity;
- maximal mechanical strength;
- low weight;
- resistance to high temperatures
- small thermal extension
- resistance to ageing and aeolian effects.

Experimentally-confirmed operational temperature
ASHT-150°C
Maximum allowed – 210 °C.

The required thermal resistance was achieved with zirconium alloys, the new compression technology and the innovative design of the core and the entire conductor.

The conductors have passed the full test cycle and have been certified by JSC "ROSSETI" (Russian Grid Company), including the management of the entire production process.

Results of the tests of the high-temperature conductor (ASHT)

The sample conductor was of 18.8 mm diameter., S – 197/56.
Determination of the conductor breaking strength in connecting and tension grips –116.1 kN;
Aeolian vibration resistance test – 100 mln. cycles, frequency – 44.3 Hz, loading – 25 % of the breaking force. No breaking was recorded.
Swinging (galloping) resistance test under pulsing load: number of loading cycles – 45,000; loading vibration frequency – 0.06 Hz, load regime – 20-26-20 % of the breaking load. The breaking load after tests – 115.3 kN.;
Electric test to find the DC resistance of 1km of the conductor at 20 °C, Ohm, actually within – 0.139
Thermal-cycling resistance test: operational temperature 150 °C, loading regime as related to the breaking load 4 % - 20 % - 70 %, than 4 cycles 20–70 %, and 96 %, marker shift – 0 mm;
Determination of the conductor strength after exposure to the emergency temperature: at 210 °C load of 17 kN (15 % of the breaking load) with subsequent loading up to 112 kN (> 96 %) caused no conductor damage or marker shift;
Electric test to determine the specific resistance of the contact – spiral grip CC-18,8-11(115)
Admissible continuous current at 150 °C, air temperature 20 °C, wind speed ≤ 1.2 m/s – 944.8 A

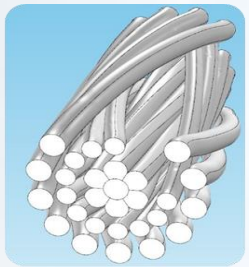
The research by the passage of AC steel-aluminum wires of various designs show additional effect:

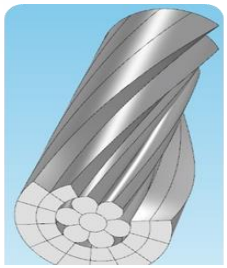
Change in laying direction slightly changes value of released heat in elements of steel-aluminum wire, and use of plastically compression with formation of electric contacts with high conductivity between rods causes reduction in heat (**Produced by Energoservis Engineering Company**):

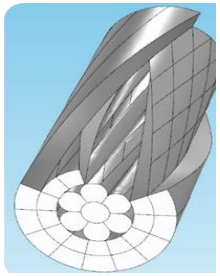
- **1 % in aluminium,**
- **10 % in steel.**

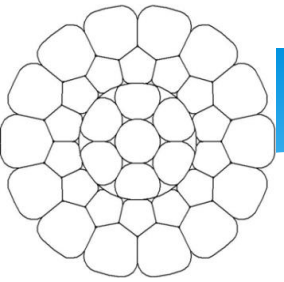
In addition, due to the design, there is a reduction of wind load on the wire ASHS (ASHT), relative to a standard AS 25-40%, Risk of formation of ice 25-30%

Details: http://energoservise.com/t4v_developments_developments140910012746.htm





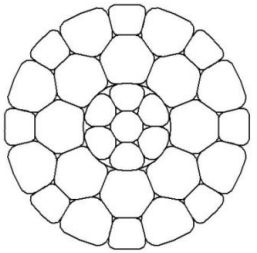




Three basic designs

high-temperature (ASHT)

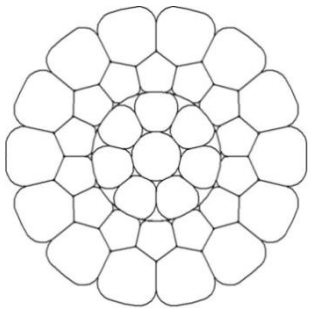
high-strength (ASHS) conductors



Admissible continuous current of ASHT at 150 °C, air temperature of 20 °C and wind speed 1.2 m/s

Nominal section, mm²	Current, A
(128/36)-ver.I; (128/37)-ver.II	690,9
(133/37)-ver.I; (133/38)-ver.II	713,2
(139/38)-ver..I; (139/39)-ver..II	735,4
(159/44)-ver..I; (159/45)-ver..II	808,9
(162/46)-ver..I; (162/47)-ver..II	821,6
(168/50)-ver.I; (168/51)-ver.II	846,2
(174/50)-ver.I; (174/51)-ver.II	864,7
(190/54)-ver.I; (190/55)-ver.II	918,0
(197/55)-ver.I; (197/56)-ver.II	942,8
(197/56)-ver.I; (197/57)-ver.II	944,8
(214/60)-ver.I; (214/61)-ver.II	998,0
(218/62)-ver.I; (218/63)-ver.II	1009,6
(258/73)-ver.I; (258/74)-ver.II	1141,0
(277/80)-ver.I; (277/81)-ver.II	1199,6
(371/108)-ver.I; (371/109)-ver.II	1475,9
(461/64)-ver.III	1667,8
(477/66)-ver.III	1711,7
(571/80)-ver.III	1941,7

Ver. III



Admissible continuous current of ASHS at different temperature of conductor, air t= 20°C and wind speed ≤ 1.2 m/s

Nominal section, mm²	t=70°C, A	t=90°C, A
(128/36)-ver.I; (128/37)-ver.II	434,4	496,637
(133/37)-ver.I; (133/38)-ver.II	448,4	512,659
(139/38)-ver.I; (139/39)-ver.II	462,37	528,591
(159/44)-ver.I; (159/45)-ver.II	508,7	581,406
(162/46)-ver.I; (162/47)-ver.II	516,5	590,494
(168/50)-ver.I; (168/51)-ver.II	531,9	608,117
(174/50)-ver.I; (174/51)-ver.II	543,6	621,411
(190/54)-ver.I; (190/55)-ver.II	577,0	659,667
(197/55)-ver.I; (197/56)-ver.II	592,6	677,481
(197/56)-ver.I; (197/57)-ver.II	593,8	678,937
(214/60)-ver.I; (214/61)-ver.II	627,2	717,059
(218/62)-ver.I; (218/63)-ver.II	634,5	725,439
(258/73)-ver.I; (258/74)-ver.II	717,0	819,724
(277/80)-ver.I; (277/81)-ver.II	753,8	861,767
(371/108)-ver.I; (371/109)- II	927,1	1059,9
(461/64)-ver.III	1047,6	1197,65
(477/66)-ver.III	1075,1	1229,09

CARRIER CABLE OF CONTACT NETWORK

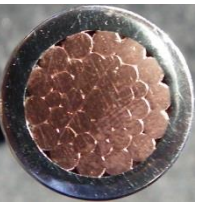
Achieved goal: Create a carrier cable combining a number of features:

- High mechanical strength
- Little temperature-caused extension
- Corrosion resistance
- Enough conductivity
- Better aerodynamic properties
- Standard diameters,
- Manufacturable enough for batch production without serious rise in price of the final product

The design reduces power losses

by 11.35 % as compared with serial design M 120

by 28.7 % as compared with Bronze 120



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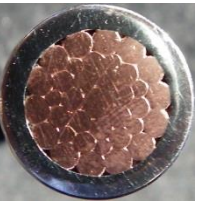
Russian Railways

Eventually, we created the copper carrier cable ensuring better conductivity and mechanical strength (breaking force higher by 25–30 % and with Ø 14 mm, breaking force of 58–59 kgf/mm²), with constant diameter.

- **The new cable design also allows lower range and intensity of swinging, lower risk of cable break or damage caused by external effects and less cable metal fatigue; therefore, the operational lifetime increases due to vibration self-quenching.**
- **Their unique design supposes milder slush build-up and icing.**
- **The production process is completely mastered by Severstal-Metiz.**
- **The design provides a stronger copper carrier cable without using alloys that would increase losses.**



Sk Energy

Comparative electrotechnical and mechanical properties of the carrier cables of various designs

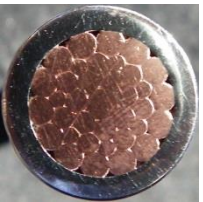
• Electrotechnical properties

Diameter	Section	Specific electric resistance, Ohm/km, at 20 °C, at most			
mm	mm²				
		The copper		Bronzed	Bronze-tin
		Standard	by Energoservis*	-	-
10,7	67,7	0,2723	0,2209	0,3077	0,4107
12,6	94	0,1944	0,1533	0,221	0,2958
14	117	0,156	0,1383	0,178	0,2376
15,8	148	0,1238	0,1008	0,1408	0,1879

* for plastically deformed carrier cables, diameter/section-area ratio is different,

Stated below:

Diameter	Section	Expansion		Reduction of specific electric resistance, As related to the standard cable design					
mm	mm²	Of section							
	For cable by Energoservis	With the same diameter of standard wire,%	Standard copper		Bronzed		Bronze-tin		
			Ohm/km	%	Ohm/km	%	Ohm/km	%	
10,7	87,7	29,54%	0,0514	18,88%	0,0868	28,21%	0,1898	46,2	
12,6	124	31,91%	0,0411	21,14%	0,0677	30,63%	0,1425	48,1	
14	139	19,66%	0,0231	11,35%	0,0451	25,34%	0,1047	44,0	
15,8	182,2	28,38%	0,023	18,58%	0,04	28,41%	0,0871	46,3	
				$\Delta P=3\cdot I^2_{ск}\cdot R\cdot 10^{-3}$					

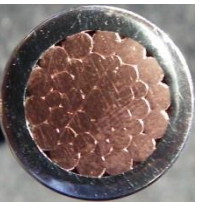


•Mechanical properties

Comparison of mechanical properties					
Diameter	Breaking	Increase of breaking force, kN,			
mm	force	As related to the standard cable design			
	For cable	Cop	per	Bro	nze
	by Energoservis	kN	%	kN	%
10,7	32,944	5,829	21,50%	0,474	1,75%
12,6	45,73	8,093	19,20%	0,64	1,42%
14	55,5	8,655	18,48%	0,05	0,091%
15,8	72,26	17,109	31,02%	1,28	1,80%

The mechanical properties have been confirmed with tests

As calculated for an average bay. the weight difference of standard and plastically-deformed carrier cables amounts, depending on the diameters, to 6–9 kg.



РОСПАТЕНТ

Deutsches Patent- und Markena

All products are secured with Russia's & German's patents

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2447525

СПОСОБ ИЗГОТОВЛЕНИЯ ВЫСОКОТЕМПЕРАТУРНОГО ПРОВОДА ДЛЯ ВОЗДУШНОЙ ЛИНИИ ЭЛЕКТРОПЕРЕДАЧИ И ПРОВОД, ПОЛУЧЕННЫЙ ДАННЫМ СПОСОБОМ

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РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ПОЛЕЗНУЮ МОДЕЛЬ

№ 132241

СТАЛЕАЛЮМИНИЕВЫЙ ПРОВОД ДЛЯ ВОЗДУШНОЙ ЛИНИИ ЭЛЕКТРОПЕРЕДАЧИ

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Заявка № 2011124358

Приоритет полезной модели 17 июня 20...

Зарегистрировано в Государственном ре... моделей Российской Федерации *10 сен...*

Срок действия патента истекает 17 июн...

Руководитель Федеральной с... по интеллектуальной собств...

РОССИЙСКАЯ ФЕДЕРА...

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2361304

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Заявка № 2008122713

Приоритет изобретения 04 июня 2008 г.

Зарегистрировано в Государственном реестре изобретений Российской Федерации *10 июля 2009 г.*

Срок действия патента истекает 04 июня 2028 г.

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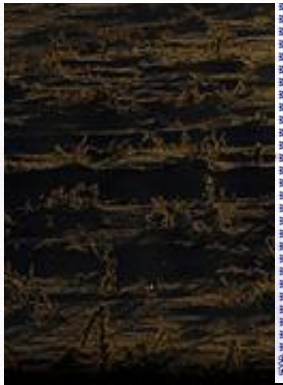

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ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2441293

ГРОЗОЗАЩИТНЫЙ ТРОС С ОПТИЧЕСКИМ КАБЕЛЕМ СВЯЗИ

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Заявка № 2010145083

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Зарегистрировано в Государственном реестре изобретений Российской Федерации *27 января 2012 г.*

Срок действия патента истекает 03 ноября 2030 г.

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РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ПОЛЕЗНУЮ МОДЕЛЬ

№ 136625

ВЫСОКОПРОЧНЫЙ МЕТАЛЛИЧЕСКИЙ СЕРДЕЧНИК ДЛЯ НЕИЗОЛИРОВАННЫХ ПРОВОДОВ

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Автор(ы): *см. на обороте*

Заявка № 2013117965

Приоритет полезной модели 18 апреля 2013 г.

Зарегистрировано в Государственном реестре полезных моделей Российской Федерации *10 января 2014 г.*

Срок действия патента истекает 18 апреля 2023 г.

Руководитель Федеральной службы по интеллектуальной собственности Б.П. Симонов

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