Energoservis Engineering Company

Best Implemented Project for Russian State Grid Company «Rosseti» in 2014.

Innovative products for energy infrastructure facilities

Providing simple solutions to complicated problems

HANNOVER MESSE 8–12 APRIL 2013

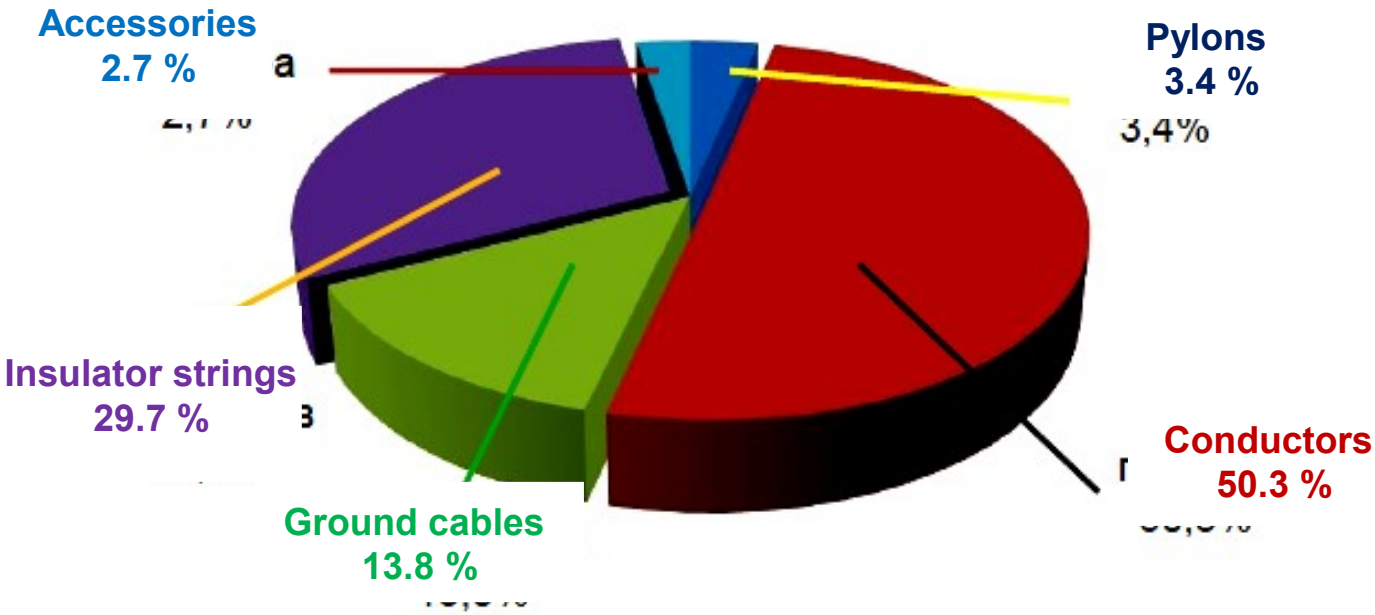
CIGRÉ INTERNATIONAL COUNCIL ON LARGE ELECTRIC SYSTEMS Session 2014

IEC 79th GM MINSK 2015

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

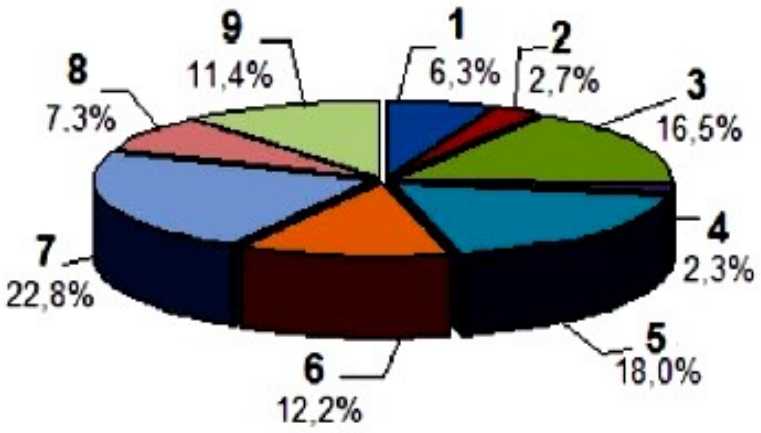
WAYS TO ENHANCE RELIABILITY OF AN OVERHEAD POWER LINE

Reasons of technology breakdowns of overhead power transmission lines 110–750 kV (ten-year Statistics Join Date)



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.



CIGRÉ INTERNATIONAL COUNCIL ON LARGE ELECTRIC SYSTEMS
Session 2014

HANNOVER MESSE 8–12 APRIL 2013

Energoservis Engineering Company

Development of Overhead ground wire, high-strength and high-temperature conductors, OPGW of new generation for overhead power lines

Energoservice LLS
www.energoservise.com

Experience - 16,000 km of transmission lines

Redaelli

The complex of products by LLC Energoservice for high-voltage transmission lines laureate 1st Prize of the Grid company Rosseti "The best implemented project", is the absolutely unique and innovative the development costs reduction of use and HVL construction costs by using the most cost-efficient technologies. All products are certified and has the experience application.

Design provides for increase of the filling ratio to 92–97 %, a significant improve of strength and cross-section for the same cable diameter, reduction of aerodynamic load (20–35 %) and icing (25–40 %), improves the corrosion resistance.

The process itself is more simple, which means substantially cheaper compared to any analogous product, meanwhile performance values obtained are at least the same.

- **High strength steel-aluminum cable** (hereinafter referred to as ASHS, common grades of Al are used). Higher mechanical strength and compact design allows as follows: to use cables of substantially lower diameter and weight for the same HVL span length or to increase the distance between supports (for the same cable cross-section) for at least 20–30 % without changing the HVL transmission capacity, and to increase the ultimate allowable current value at the same maximum allowable temperature. For the same mechanical strength the transmission capacity 15–25 % higher. For identical electromechanical performance values ASHS price is comparable with standard cables.
- **High temperature steel-aluminum cable (ASHT).** The allowable operating temperature of these cables to 210 °C, developed in cooperation with RUSAL, along with design of the cable and fittings allowed for rapid increase (compared to our ASHS cable) of the transmission capacity (up to 100 %), without significant cost rise.
- **Ground wire MZ** as (in operation since 2008, **16,000 km** supplied) – is the only cable, which withstands the complete cycle of successive tests for lightning current effect, aeolian vibration, dancing and for resistance to short circuit current using a single cable sample, which maintains its initial mechanical properties after passing all the exposures..
- **OPGW** retains the properties of MZ. Number of optical fibers in serial production items – 8–96.

Catenary Carrier cable railway - copper products, with the strength of bronze, electrical conductivity of copper, the best aerodynamic performance, standard diameters.

Technical specifications on ***http://w.w.w.energoservise.com***

Session 2014

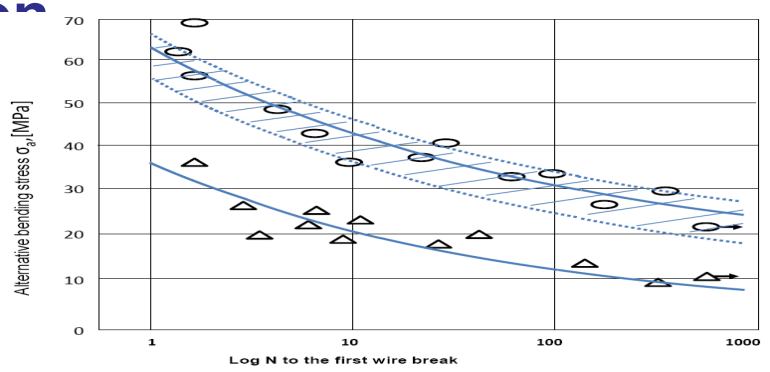
HIGH-STRENGTH STEEL-CORED ALUMINUM CONDUCTORS

In the absence of constraints associated with the routing of the line, the use of our conductors can lead to a 25-30% capital cost savings in the project due to the smaller number of supports (Span length of OHL at one and the same sag).

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

By using our conductors is increased Breaking strength and decreased Specific losses of electricity at the same current load, aerodynamic loadings (till 35%) and formation of ice (till 25%), conductor temperature expansion coefficient (15%) only due the design!

The correct definition of the conductors creep has recently become one of the important requirements arising from the Exploitation organizations in Russia, as it turned out that the capacity of many of the overhead Lines may not be fully utilized due to increased, after many years of service, sag of the conductors



Prognosis of Fatigue behavior for the ASHS, ASHT conductors (shaded area). The test results as a function σ(N) for single-layer (ellipses) and multi-layer (triangles) conductors ACSR are reproduced on the basis of data [7]. N in Megacycles

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

Type	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 %.

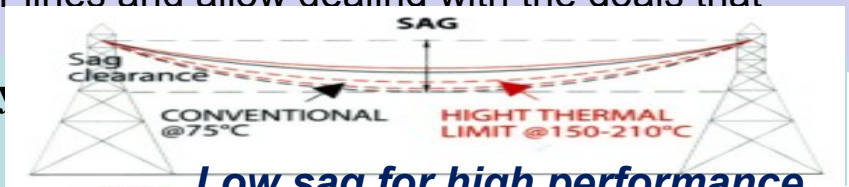
* - Comparison AS400 / 93 and ASVP371 / 106; ** - The high temperature cable (ASHT by Energoservis).

>> ASHS - t_{work}=90°C & ASHT - t_{work}=150°C

Advantages: 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!



Low sag for high performance

Session 2014

HIGH-TEMPERATURE STEEL-CORED ALUMINUM CONDUCTORS

In addition to increased strength Experimentally-confirmed operational temperature -150°C, Maximum allowed – 210°C.

The algorithm and the results of tests on Example conductor Ø 18.8 mm, S-197/56.
Determination of the 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

Technical and economic comparison of conductors spent by Russian State Grid Company «Rosseti» in 2016

For a promising use in the development of the network

	Company manufacturer	Conductor	Ø, мм	Weight, kg/км	AC Continuous carry, A	Breaking load, кN	Resistance, Ом/км	Conductors sag at Tmax, м	Cost* EUR/км
Traditionally used CABLES									
1	Standard steel-aluminum conductor	ACSR 240/32	21,6	921	605	72,7	0,121	13,2	2 812 (62%)
2		ACSR 300/39	24,0	1 132	710	89,2	0,098	11,5	4 030 (89%)
3		ACSR 400/51	27,5	1 490	825	115,4	0,075	11,7	4 550 (100%)
Innovative types of CABLES (with improved performance)									
4	Energoservice	ASHT 461/64 high temperature	26,9	1 802	1 668	170,5	0,063	9,3	6 844(150%)
	- " -	ASHT 371/106	26	1 882	1 476	220,4	0,0776	7,8	6000(149%)
	- " -	ASHT 277/79	22,4	1 400	1 199	163,9	0,1040	7,7	4475(111%)
	- " -	ASHS 277/79 ** high-strength	22,4	1 400	862	163,9	0,1040	7,9	3977(98%)
5	Lumpi-Berndorf	TACSR/HACIN 212/49	21	939	861	95,4	0,1283	10,5	20 000 (450%)
6	Lumpi-Berndorf	TACSR/ACS 212/49	21	914	871	95,4	0,1283	11,6	12 000 (270%)
7	J-Power Systems	GTACSR 217/49	20,3	1 015	840	110,7	0,136	9,1	20 000 (450%)
8	Nexans	366-2Z	23,1	1 014	732	116,2	0,092	9,9	27 000 (600%)
9	3M	ACCR 405-T16	20,1	684	1 059	70,0	0,129	8,2	40 000(1 000%)

* - *The Cost of providing estimations for autumn 2015;* ** - If the increase in the support load is not desirable, it is suitable to replace the ACSR 300/67 conductor ASHS 317/47, has less weight and heat losses, higher bandwidth compared with the ACSR300/67 with almost equal tensile strength (125 kN) . With the new construction of overhead lines with increasing distance between the supports and the low current loadings on line is possible to use ASHS 277/79, and when it is necessary to significantly increase the capacity of the line - that ASHS 389/59. Conductor ASHS295/44(116 kN) is more suitable for the replacement of AS240/56(98 kN) conductors for overhead lines, where a slight increase in weight and load on the bearing is permissible, with the need to increase bandwidth, while lowering heat loss._

Modification of the conductor recognized as promising for several projects relating to projects increasing transmission capacity of overhead lines without replacing the supports

(Unit investment department network expansion Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railways)

Designation	Querschnitt Al, nominell, mm²	Cross section Al, actually, mm²	Number of Al wires in the conductor	The diameters of the wires, AL, mm					Conductor diameter, mm	weightt, kg/km	tensile strength, kN	R, Ω/km	modulus of elasticity, N/mm²	expansion coefficient, 1/K	I permissible**, A	t working, C°
243-AL1***	240	242,5	61	2,25	0	0			20,3	671,1	43,66	0,1193	55000	0,000023	625)*	80
ANHS 240,72*	240,72	240,72	36	3,75	2,8	2,7	2,05	3,35	18,5	670	52,96	0,126	65000	0,000023	610,5	80
ANHS 309,35*	309,35	309,35	36	4,3	3,15	3,05	2,35	3,8	21	860	68,06	0,098	65000	0,000023	725,3	80
ANHS 354,29*	354,29	354,29	36	4,6	3,35	3,3	2,55	4,05	22,5	985	77,94	0,086	65000	0,000023	794,4	80
ASHT 201,59	201,59	201,59	36	3,45	2,55	2,5	1,9	3,05	17	561	34,1	0,1429	63000	0,000023	752,4	120
ASHT 240,72	240,72	240,72	36	3,75	2,8	2,7	2,05	3,35	18,5	670	40,4	0,1196	63000	0,000023	853,7	120
ASHT 309,35	309,35	309,35	36	4,3	3,15	3,05	2,35	3,8	21	860	50,4	0,0931	63000	0,000023	1016	120
ASHT 240,72	240,72	240,72	36	3,75	2,8	2,7	2,05	3,35	18,5	670	40,4	0,1196	63000	0,000023	994	150
ASHT 309,35	309,35	309,35	36	4,3	3,15	3,05	2,35	3,8	21	860	50,4	0,0931	63000	0,000023	1185	150

*-Conductor plastically deformed high-strength from an aluminum alloy without the steel core

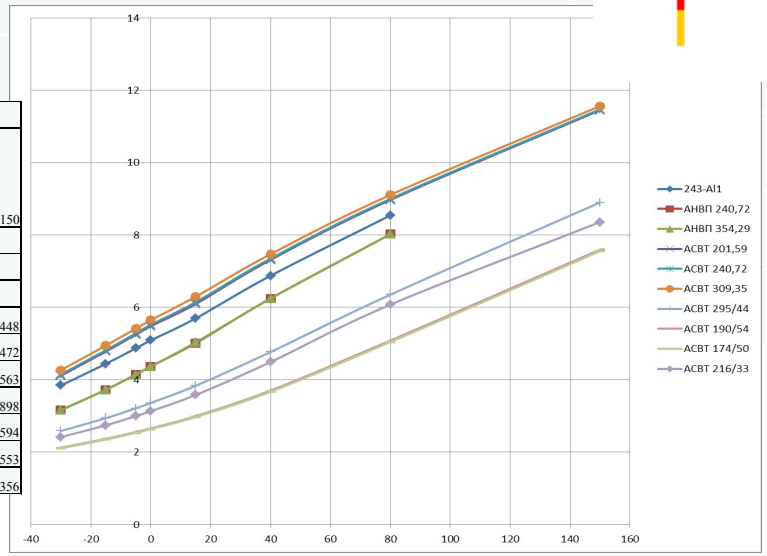
** - I allowed (permanently permitted current) calculation at the following ambient conditions: air temperature +35 C °, wind speed 0.6 m / s.

*** - Conductor used in Germany

Bundesnetzagentur

Comparison of cables sag conductors in the span of 300 m

Bezeichnung	Zerreißfestigkeit, кN	Spannung, кN	Maximale Spannung, бr кN/мм²	I zulässig, A	Min		Temperatur, C					Max
					-30	-15	-5	0	15	40	80	150
243-Al1	43,66	19,65	0,081	625	3,844	4,442	4,87	5,09	5,698	6,875	8,543	
ANHS 240,72	52,96	23,83	0,099	614	3,163	3,726	4,149	4,371	5,015	6,247	8,024	
ANHS 354,29	77,94	35,07	0,099	800	3,16	3,723	4,145	4,367	5,033	6,244	8,022	
ASHT 201,59	34,1	15,35	0,0761	864	4,114	4,783	5,248	5,482	6,096	7,315	8,969	11,448
ASHT 240,72	40,4	18,18	0,0755	981	4,147	4,818	5,284	5,519	6,145	7,348	8,999	11,472
ASHT 309,35	50,4	22,68	0,0733	1170	4,267	4,946	5,414	5,649	6,297	7,47	9,107	11,563
ASHT 295/44	116,8	52,56	0,1552	1131	2,586	2,94	3,212	3,36	3,836	4,768	6,351	8,898
ASHT 190/54	113,054	50,87	0,2083	840	2,124	2,367	2,554	2,656	2,995	3,702	5,084	7,594
ASHT 174/50	104,886	47,2	0,2102	790	2,109	2,349	2,535	2,636	2,969	3,67	5,044	7,553
ASHT 216/33	92	41,4	0,1657	911	2,417	2,743	2,996	3,134	3,581	4,49	6,076	8,356



243-Al1
ANHS 240,72
ANHS 354,29
ASHT 201,59
ASHT 240,72
ASHT 309,35
ASHT 295/44
ASHT 190/54
ASHT 174/50
ASHT 216/33

Permissible current for air t calculated = 35 ° C and 80 ° C temperature of the wire (for 243-Al1 wire ANHS 240.72, 354.29 ANHS). For other wire conductor temperature = 150 ° C. Ambient conditions at a speed of 0.6 m / s parallel to the wire, the allowable current calculate wind. The maximum voltage for each wire is received, with minimal negative temperature = 30 ° C.

- ***It was also recognized as promising conductor 216/33 to Bundesbedarfsplan (Projekt Nr. 21), Daxlanden nach Eichstetten (70km)***

Another attempt of this kind is made in Table

This is a very important task - to identify those niches where the use of new conductors would be most beneficial.

Parameters of the conductors to be compared	ACSR 150/24	ASHS, ASHT 162/47	
	value	value	Change in percent to ACSR
Core cross section, mm2	24,2	47,3	+90
Al part cross section, mm2	149	162,3	+8,9
Diameter, mm	17,1	17,1	0,0
Rated Breaking strength, daN	5227,9	9882,4	+89,0
Max current load, A	554	590,5 (822)	+ 6,6 (+ 48,4)
Span length of OHL at one and the same sag, m	280	364	+ 30
Towers on the 10 km of OHL	37	27	- 27
Specific losses of electricity at the same current load (150 A), MWh/km per year	41,7	36,4	- 12,7
Conductor temperature expansion coefficient, 10-6 1/ °C	19,2	16,7	- 13
Conductor elasticity modulus, E*10-3, N/mm2	82,5	88	+ 6,7
Sag at the highest air temperature (+40 °C), m, for the spans: 250 m / 300 m	6,29 9,26	3,32 4,87	- 47,2
Sag at ambient temperature - 5 ° C in the 3rd region of the wind and ice load, m: 250/300	6,66 9,63	4,41 6,04	- 33,8
The electric field of the corona onset at dry weather, kV/cm	34,04	40,0	+17,5
DC Resistance (20 0C), Ohm/km	0,2039	0,1780	-12,7
Preliminary conductors' relative costs estimation	100 %	110-120 %	

One can see from this pattern that almost all the exploitation parameters of the new conductors important for the OHL designer do exceed greatly than those for ordinary ones. The new conductors they would fit excellent for the new Line to be built in the regions with excessive wind/ice loads or for long River crossings or extended anchor sites . In the case of the new conductors' application at large crossings, it is possible to reduce the height of the terminal anchor supports of the crossing up to 25-30 %, subject to the standardized dimensions of the support Towers; this in turn will lead to considerably lower cost of all the crossing. In addition, with a reduction in height of the support Towers their inductance decreases, correspondingly reduces probability of direct lightning strokes.

Modification of the High strength conductor for replacement on old lines without it reconstruction**

Using this design modification, depending on a problem the replacement conductor provides two options: d_{cond}=const >> S_{AL} - increase or S_{AL}=const >> d_{cond} decrease

Rated Core cross section, mm² (standard conductor)	AC Continuous carry, Icc ACHS, t-70°C	Icc ACHT, t-150°C	design parameters high strength conductors**					
			Core cross section, Al/Steel, mm2	Diameter, мм		DC Resistance (20 0C), Ohm/km	Rated Breaking strength, N*	Weight of conductor kg/1000m
				Conductor	steel core, mm			
216/33	718,00	1097,0	216,3/32,9	18,5	6,7	0,1334	89500*	870
150/23	563,00	855,0	150,1/22,7	15,40	5,60	0,192	61140	598
295/44	879,00	1348,0	294,8/43,9	21,50	7,80	0,098	116800	1183
317/47	922,00	1416,0	317,3/47,3	22,30	8,08	0,091	125400	1267
389/59	1053,00	1622,0	388,6/58,8	24,75	8,99	0,074	154400	1558
403/61	1071,00	1639,0	403,4/61,0	25,20	9,17	0,072	160380	1617

throughput by increasing the aluminum part by 15%, thus AC Continuous carry and Throughput increase significantly.

**- If necessary, conductor can be produced as a high temperature (t_{work}=150°C, t_{max}=210°C).

***- For areas with high wind and sleet loadings

>Section (conductor) may be different. Presented designed for demands of Russian Grid Company

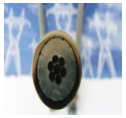
>Design provides for increase of the filling ratio to 95–97 %, a significant improve of strength and cross-section for the same cable diameter, reduction of aerodynamic load (20-35 %) and icing (25-40%) improves the corrosion resistance. The process itself is more simple, which means substantially cheaper compared to any analogous product, meanwhile performance values obtained are at least the same.

>Tests were carried out in accordance with the regulations of the Russian State Grid Company "Rosseti« (Russian Grids), in the system "wire-fitting".

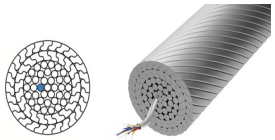
>Modulus of elasticity – 0,79 * 10^5 N/mm² ASHS/ASHT (0,63 * 10^5 N/mm² Standard conductor)

Parameters of new cables ASHS / ASHT in conjunction with the ground wire or OPGW can be extremely effective in the construction of the extended transition.

Application of new cables may allow reduce the height of the end anchor poles go up to 25-30% compared to standard sizes of support masts that will reduce the cost of the entire transition

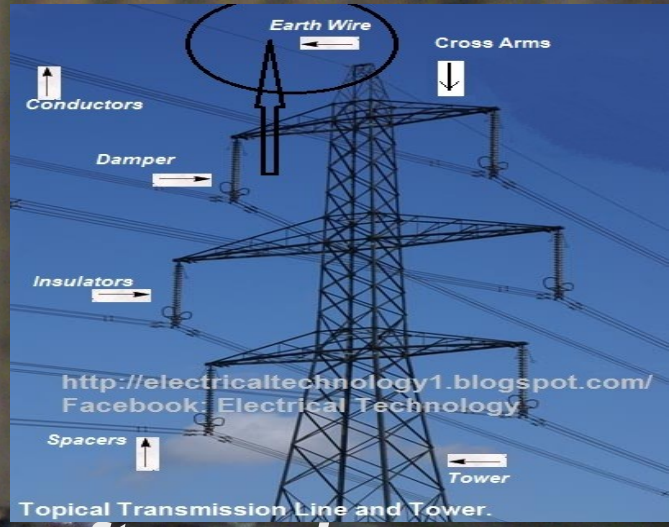


When selecting optimal technical solutions for specific transitions, we can offer many years of experience to create new complex designs



Our ground (earth) wire and OPGW are indifferent to the lightning discharge all documented values

Experience of 15,000 km of transmission lines



Virtually no damage even after a charge of 147 ampere-second.

During a vibration/swinging resistance test, the cable got no extra damage; the post-test condition of the cable was satisfactory.
After the test of resistance to direct lightning current, vibration and swinging, the breaking strength of the cable complied with the initial requirements of the specifications.

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

Cable 9,2-Г (М3)-В-ОЖ-МК-Н-Р **Energoservis**

Cable 9,2-Г (М3)-В-ОЖ-Н-Р-1770; **Enterprise Standard 71915393-TU 062-2008 by Energoservis** and Severstal-Metiz, completely and successfully passed the entire test sequence. Cable 2-Г (М3)-В-ОЖ-Н-Р-1770; 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 (М3)-В-ОЖ-Н-Р-1770 by Severstal-Metiz, Volgogradsky branch, is the most reliable and preferred for protection of high-voltage power lines from lightning strikes.

After the lightning discharge and after the vibration tests

Cable ПК-9,2-М3-В-ОЖ-Н-МК-Р

Cable ПК-М3-В-ОЖ-Н-МК-З-1770; Enterprise Standard 14-173-35 by Mechel failed to pass the test sequence. Cable ПК-М3-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-М3-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.

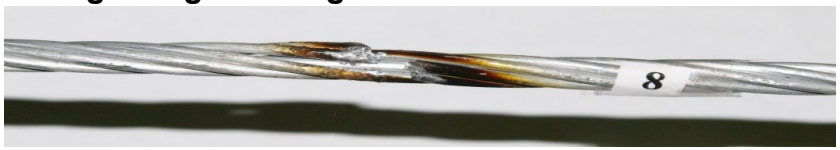
After the lightning discharge but before the vibration tests

After the lightning discharge and after the vibration tests

Exterior cladding aluminum **Cable** **analogue used in EU**

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.

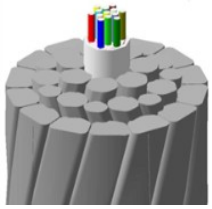
After lightning discharge but before the vibration tests



After the lightning discharge and after the vibration tests

✓ **Exterior cladding aluminum only enhances the resistance to short circuit currents (it is important only at the end of some lines) decrease all other characteristics of grounding wire**

Optical ground wire



(*OPGW*, in IEEE standard, optical fiber composite overhead ground wire)

OPGW suspension accessories:

Suspension accessories: **standard** used to connect with 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).

OPGW is produced in cooperation with European optical module.

Description of OPGW tests


SAG

Technischer Bericht Nr. 2014-055

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

Auftraggeber: Energotnn GmbH, Alte Jacobstraße 77 CD, 10179 Berlin

Gegenstand: Stahl-Lichtwellenleiter-Erdseil nach Unterlagen der Fa. Energotnn

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 Unterfertiger

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*.**

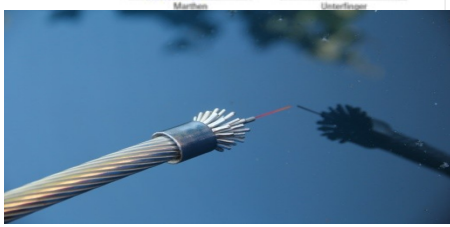
Elongation test (1000 hours)

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

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

Waterproof test – 100 %

Short-circuit current resistance test: **The optical attenuation ratio gain is within 0.05 dB/km. The integrity of optical fibers and the minimal breaking strength are preserved.**



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

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

CARRIER CABLE OF CONTACT NETWORK

Achieved goal: Create a carrier copper (alloys without, only due the design) cable combining a number of features:

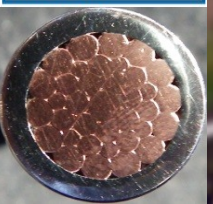
- **High Breaking strength (at level of the Bronze)**
- **Larger current load and resistance to overheating**
- **Little temperature-caused extension**
- **Enough conductivity & Better aerodynamic properties**
- **Standard diameters, simple installation & Manufacturable for serial production without increased cost of the final product**


ПАТЕНТ
№ 2509666
НЕСУЩИЙ ТРОС КОНТАКТНОЙ СЕТИ ЖЕЛЕЗНОЙ ДОРОГИ

The design reduces power losses by 11.35 % as compared with serial design & by 28.7 % as compared with Bronze cable

Experience of application - the busiest areas of the South-Ural and West Siberian Railway from 2014

*In view of this experience, the **IEC** Technical Committee (TC-9) has accepted our proposal to establish the IEC on the CARRIER CABLE of contact network of railways. The proposal was supported by **Germany, Switzerland, Italy, Japan, China (AHG 14).***



РОСПАТЕНТ

Deutsches Patent- und Markena

Developments are protected by Russian and International patents, which we hope to shall be respected

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2447525

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

Патентообладатель(ли): *Фокин Виктор Александрович (RU), Власов Алексей Константинович (RU), Петрович Владимир Викторович (RU), Зягинцев Александр Васильевич (RU), Фролов Вячеслав Иванович (RU)*

Автор(ы): *см. на обороте*

Заявка № 2011110323

Приоритет изобретения 21 марта 2011 г.

Зарегистрировано в Государственном реестре изобретений Российской Федерации *10 апреля 2012 г.*

Срок действия патента истекает 21 марта 2031 г.

Руководитель Федеральной службы по интеллектуальной собственности Б.П. Симонов

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ПОЛЕЗНУЮ МОДЕЛЬ

№ 132241

СТАЛЕАЛЮМИНИЕВЫЙ ПРОВОД ДЛЯ ВОЗДУШНОЙ ЛИНИИ ЭЛЕКТРОПЕРЕДАЧИ

Патентообладатель(ли): *Фокин Виктор Александрович (RU)*

Автор(ы): *Фокин Виктор Александрович (RU), Власов Алексей Константинович (RU), Петрович Владимир Викто... Зягинцев Александр Владимирович (RU), Фролов Вяч... Иванович (RU)*

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

ГРОЗОЗАЩИТНЫЙ ТРОС

Патентообладатель(ли): *Петрович Владимир Викторович (RU)*

Автор(ы): *см. на обороте*

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.

Руководитель Федеральной службы по интеллектуальной собственности, патентам и товарным знакам Б.П. Симонов

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2441293

ГРОЗОЗАЩИТНЫЙ ТРОС С ОПТИЧЕСКИМ КАБЕЛЕМ СВЯЗИ

Патентообладатель(ли): *Власов Алексей Константинович (RU), Фокин Виктор Александрович (RU), Петрович Владимир Викторович (RU), Фролов Вячеслав Иванович (RU)*

Автор(ы): *см. на обороте*

Заявка № 2010145083

Приоритет изобретения 03 ноября 2010 г.

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

Срок действия патента истекает 03 ноября 2030 г.

Руководитель Федеральной службы по интеллектуальной собственности Б.П. Симонов

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ПОЛЕЗНУЮ МОДЕЛЬ

№ 136625

ВЫСОКОПРОЧНЫЙ МЕТАЛЛИЧЕСКИЙ СЕРДЕЧНИК ДЛЯ НЕИЗОЛИРОВАННЫХ ПРОВОДОВ

Патентообладатель(ли): *Фокин Виктор Александрович (RU), Власов Алексей Константинович (RU), Фролов Вячеслав Иванович (RU)*

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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