Energoservis
Engineering Company

Best Implemented innovative Project for Russian States Grid company «Rosseti»

Complex innovative products for overhead power lines of 6–750 kV

Providing simple solutions to complex challenges

HANNOVER MESSE 8–12 APRIL 2013

IEC 79th GM MINSK 2015

cigré

VDE Testing and Certification

BNetzA

The new principle of production of plastically deformed unidirectional twisted conductors and Ground-wire (including OPGW) turned out a very promising direction in the development of the conductors production technology. The most attractive features of new conductors type are: an effective use of the internal volumetric space, better mechanical strength and carrying capacity at a very moderate costs, reduction of aerodynamic load and icing, low operating elongation and excellent stability.


Bundesrepublik Deutschland

Urkunde

Bundesrepublik Deutschland

Urkunde

über die Erteilung des
Patents Nr. 10 2014 101 833

Bezeichnung:
Verfahren zum Herstellen eines Drahtseils

IPC:
D07B 1/06

Inhaberin/Inhaber:
Fokin, Viktor Alexandrovich, Moskauer Gebiet, Odinzovskiy, RU

Erfinder/Erfinderin:
Vlasov, Alexey Konstantinovich, Moskau, RU; Frolov, Vyacheslav Ivanovich, Volgograd, RU; Zvyagintzev, Alexander Vladimirovich, Moskau, RU; Fokin, Viktor Alexandrovich, Moskauer Gebiet, Odinzovskiy, RU; Petrovich, Vladimir Viktorovich, Volgograd, RU

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Die Präsidentin des Deutschen Patent- und Markenamts

Cornelia Rudloff-Schäffer

München, 25.08.2016

Den aktuellen Rechtsstand und Schutzumfang entnehmen Sie bitte dem DPMAregister unter www.dpma.de.

Maximum coefficient of filling in the least costly way

Experience of 20,000 km of transmission lines

Patent DE102014101833


VDE-Institute

Project report
Test sequence for aluminum-steel conductor rope

Project report for the test sequence for an aluminum-steel conductor rope for power lines
Type ASHT 19.6-216/33-1 and the corresponding fittings

The ASHT 19.6-216/33-1 conductor rope is a new development of a compact, high-temperature, aluminum-steel conductor for power lines for which a test program will be developed.

The manufacturer of this power line is the Volgograd (Russia) subsidiary of Severstal AG.

During the test sequence, both the mechanical and electrical characteristics will be examined in accordance with the required, latest European norms and standards.

During the course of the project, a testing matrix was created, which was discussed beforehand with various noteworthy and accredited testing institutes.

Two internationally renowned companies were commissioned with performing the tests:

The mechanical tests of the conductor rope, including the appropriate fittings, were performed by Spie/SAG in Langen.

FGH Engineering & Test GmbH in Mannheim was commissioned with the electrical tests.

The VDE Testing and Certification Institute carried out this project in conjunction and was responsible for the entire, general project management.

The individual tests defined in the test matrix were performed in a timely manner and successfully completed.

Therefore, the conductor rope meets the basic requirements for the European market.

Details on the execution, test setups, the results as well as expert commentary can be found in the respective test reports attached to this letter.

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Deutsches Patent- und Markenamt

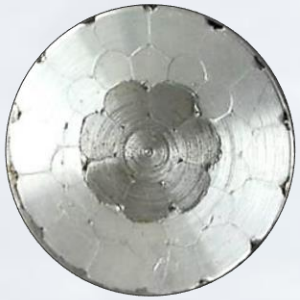
VDE INSTITUTE

The general technological principle - plastic deformation

World trend - the maximum filling of the space of the conductor, achieved in the cheapest way

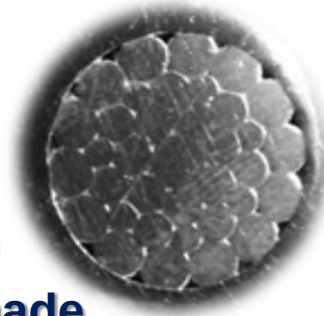
Products for new overhead power lines (OHL)

Products for reconstruction of old OHL without replacement of supports

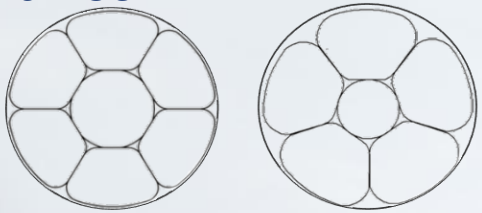


High temperature (ASHT, t_{cw}=150°C,t_{max}=210°C) and high strength (ASHS, t_{max}=90°C) performance

The cross sections for aluminum from 128 to 700 mm² for OHL 35 - 750 kW.



The cross sections for aluminum from 46 to 112mm² for overhead power lines 6 - 35 kW.



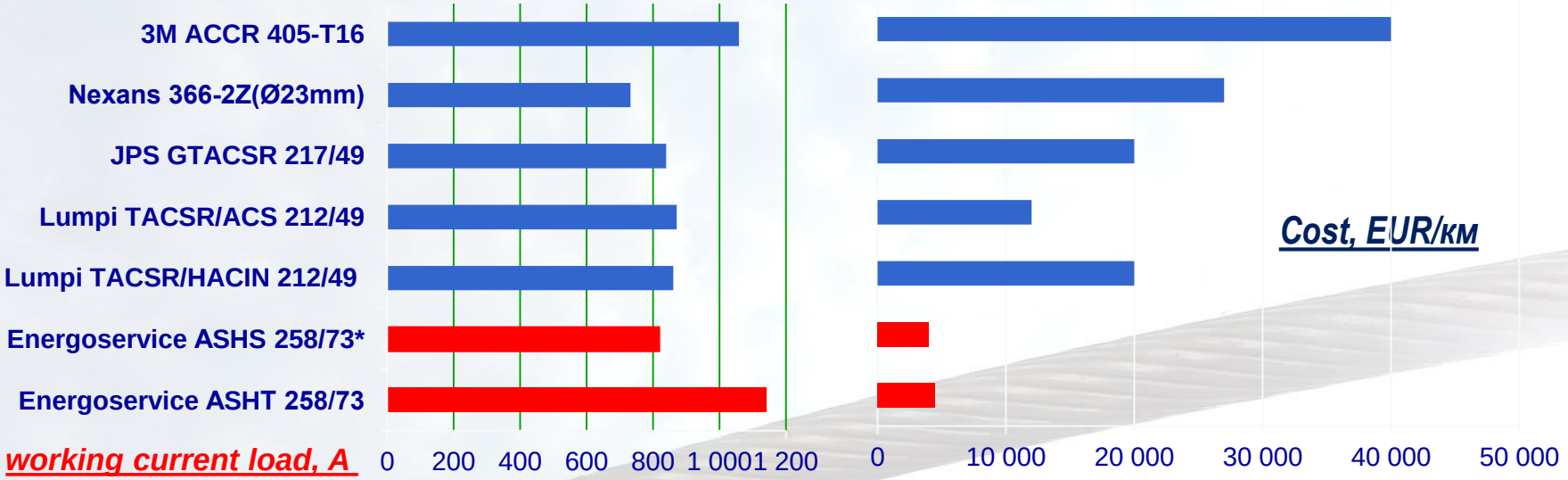
ANHS

Conductor made of high-strength aluminum alloy with no core. For overhead power lines 6 - 110 kW. (t_{max}=90°C)

Comparative analysis of PJSC "Rosseti" (State Russian Grid Company)

The fundamentally new technology provides costs on conductors ASHS/ASHT and refurbishment of overhead line with these conductors almost in same extent as similar costs in using conventional conductors, with worst characteristics.

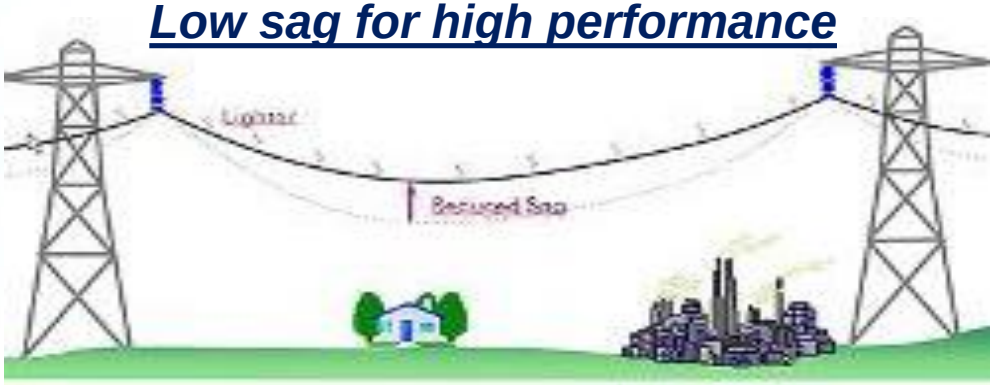
Comparison of conductors Ø 21mm, with similar characteristics.



VDE Testing and Certification ***Tested in Germany for compliance with DIN EN 50540, DIN EN 62004, 48207, 62568, IEC 61284, 61854, Cigré 426, DIN EN 62568, IEEE 1138***

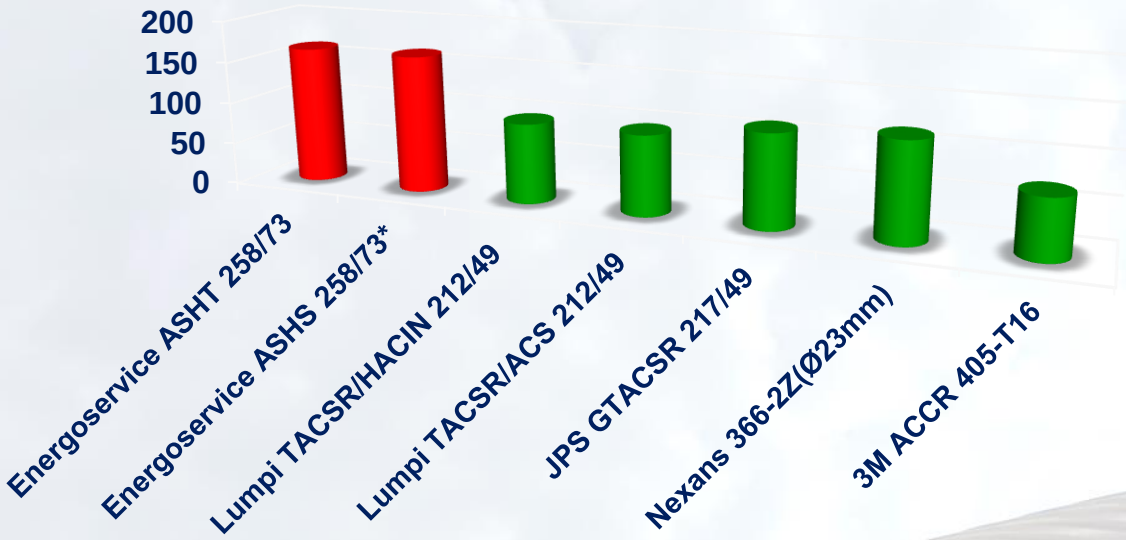
Low sag for high performance

- ✓ **ASHS and ASHT conductors are expand designing of HV power lines and allow dealing with the goals that used to be unpractical or used to require great efforts and costs.**



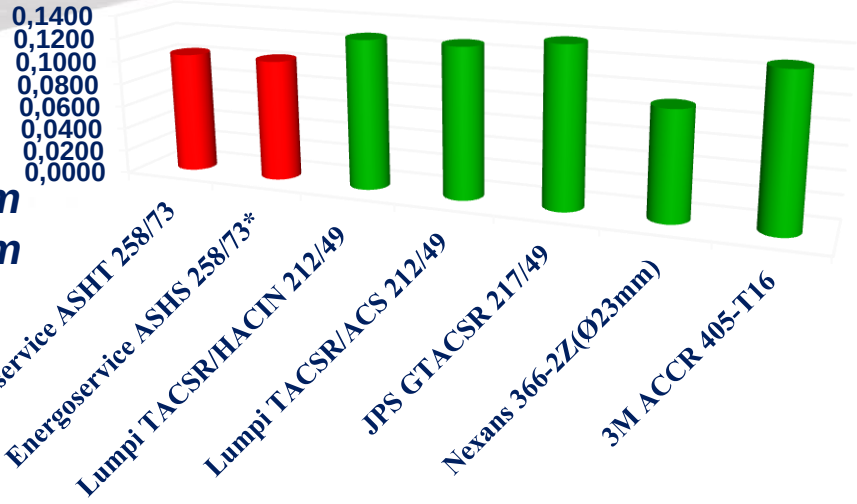
Comparison of conductors Ø 21mm, with similar characteristics

Breaking load, кN



ASHT conductors on the complex technical and economic characteristics are superior to all similar articles.

Electrical resistance of 1 km of conductor DC at 20 ° C, Ohm



Design provides increased fill factor of up to 95–97 %, a significant improvement of strength and cross-section for the same cable diameter, the reduction of aerodynamic loading (20-35 %) and icing (25-40%).

Possibilities of solving the main problems of overhead lines construction and operation through the joint use of compacted conductors

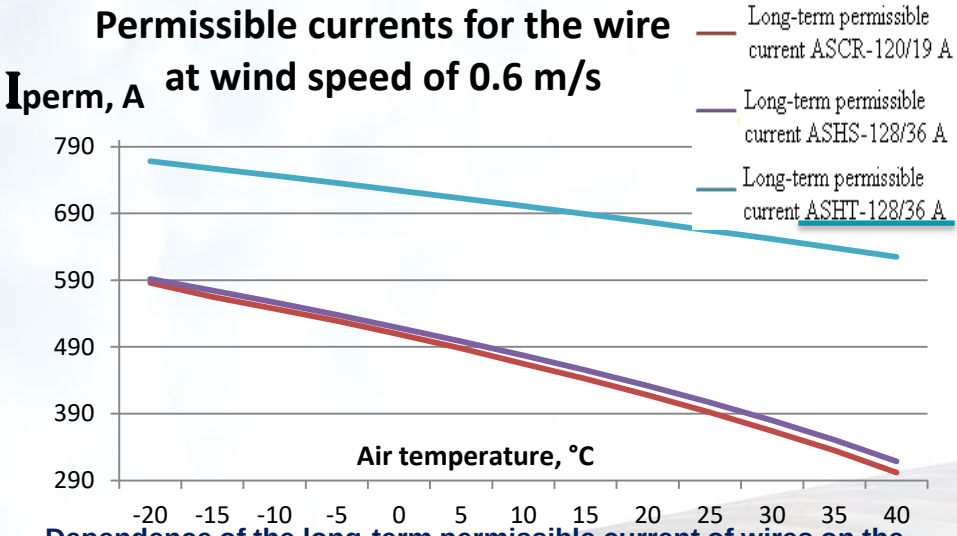
Problem	Solution based on classical ACSR application	Solution based on ASHS/ASHT conductors application	Confirmation
Reducing corona losses and noise level, without increasing conductor's diameter	-	+	Experimental confirmation of "R&D Center "FGC UES", JSC and VDE (Germany)
Increasing lightning protection and resistance to short circuit currents	-	+	Experimental confirmation of "R&D Center "FGC UES", JSC and VDE (Germany)
Significant reduction of elongation in operation	-	+	Experimental confirmation of "R&D Center "FGC UES", JSC
Reducing vibration, galloping and oscillations selfdamping while keeping conductor diameter	-	+	Experimental and computational confirmation of VSTU, JSC "VNIIZHT" and MPEI
Increasing span length and (or) sags, without increasing conductor's diameter	-	+	Design solutions
Replacing the conductor on the existing transmission poles, decreasing the load on all elements of overhead line and (or) increasing its transmission capacity	-	+	Design solutions
Decreasing wind pressure while keeping conductor diameter	-	+	Computational confirmation of VSTU and MPEI
Replacing the conductor in the ring networks and decreasing conductor diameter	-	+	Design solutions
Reduction of icing, while keeping conductor diameter	-	+	Computational confirmation of VSTU and MPEI
Keeping transmission capacity in areas with high air temperatures and solar activity, without increasing conductor's diameter	-	+	Design solutions and computational confirmation of VSTU and MPEI

Period of maximum electricity loads is change from winter to summer

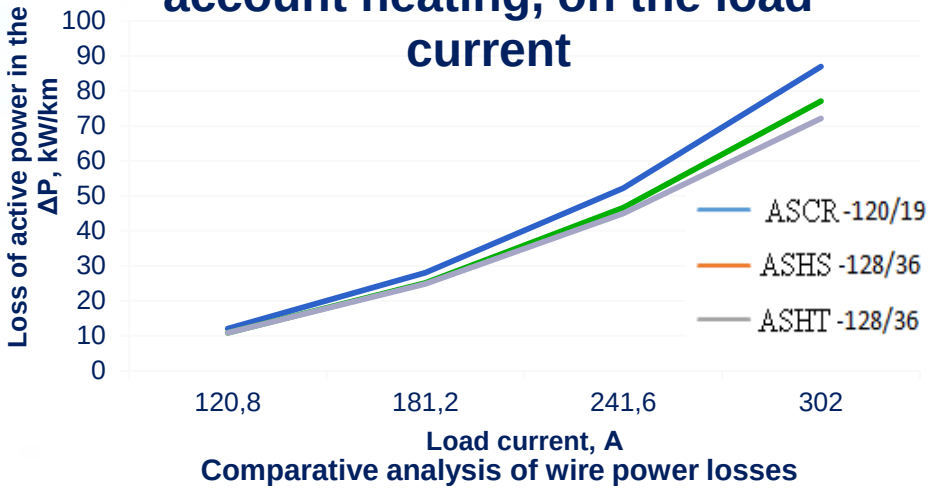
Climate change may constrain **future electricity supply adequacy by reducing electric transmission capacity** and increasing electricity demand. **The carrying capacity of overhead power lines decreases as ambient air temperatures rise**; similarly, during the summer peak period, electricity loads typically increase with hotter air temperatures due today. Period of maximum is change from winter to summer. The use of plastically compressed high-temperatures conductors is justified for the case with high ambient temperatures. In turn, the resulting effect in reducing technical losses allows us to talk, among other things, about decarburization and reduction of the carbon footprint, since it is required to produce less electricity in order to compensate for technical losses in electrical networks and as a result, emissions into the environment are reduced.

Which together provides reliable solutions for the transition to **low-carbon energy of the future**.

The complex correct use of plastically compressed wires during the construction of new 6-750 kV overhead lines can significantly increase their reliability when exposed to the entire range of climatic loads, increase throughput, and reduce final capital costs.

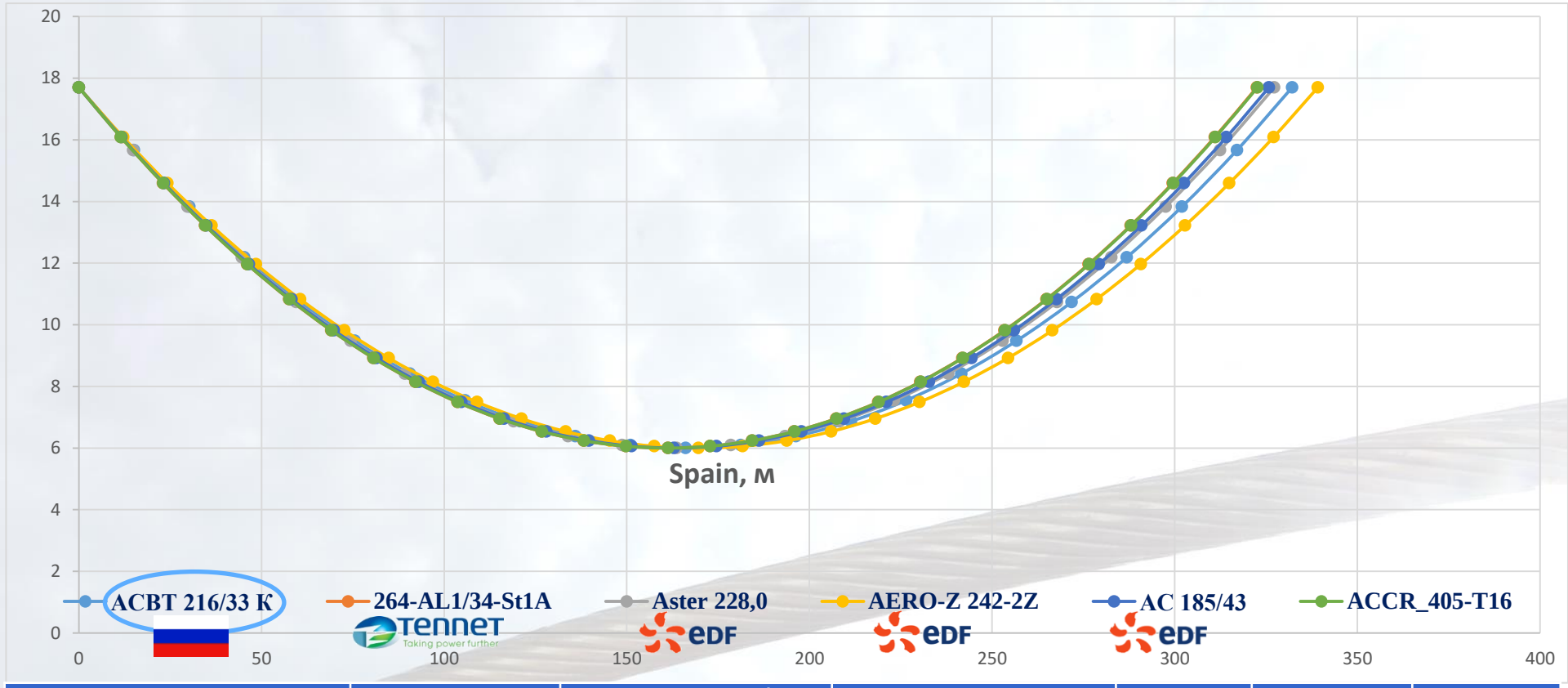


Dependence of the long-term permissible current of wires on the ambient temperature



Comparative analysis of wire power losses

Comparison of test pilot wire in Germany with wires used by TenneT and FDF



	Section Al, мм^2	Resistance 20)C, Ом/км	Current at nominal mode at J=1,1 А/мм^2, А	Current at 80^{0}C*	Current at 90^{0}C*	Current at 150°C*
ASHT 216/33	235,5	0,13	259,05	627	699	1010
264-AL1/34-St1A	263,7	0,1095	290,0	687		
ANVP 240,72 6101 T4-290	240,72	0,106	264,8	708		
AERO-Z 242-2Z	241,98	0,139	266,2	610		
ACCR 185/43	185,0	0,1559	203,5	589		
ACCR_405-T16	205,0	0,146	225,5			1100
Aster 228,0	288,34	0,115	317,2			

Given the difference of aluminum sections of our products are comparable or superior to counterparts in the EU

Additional economic benefit due to high breaking strength:

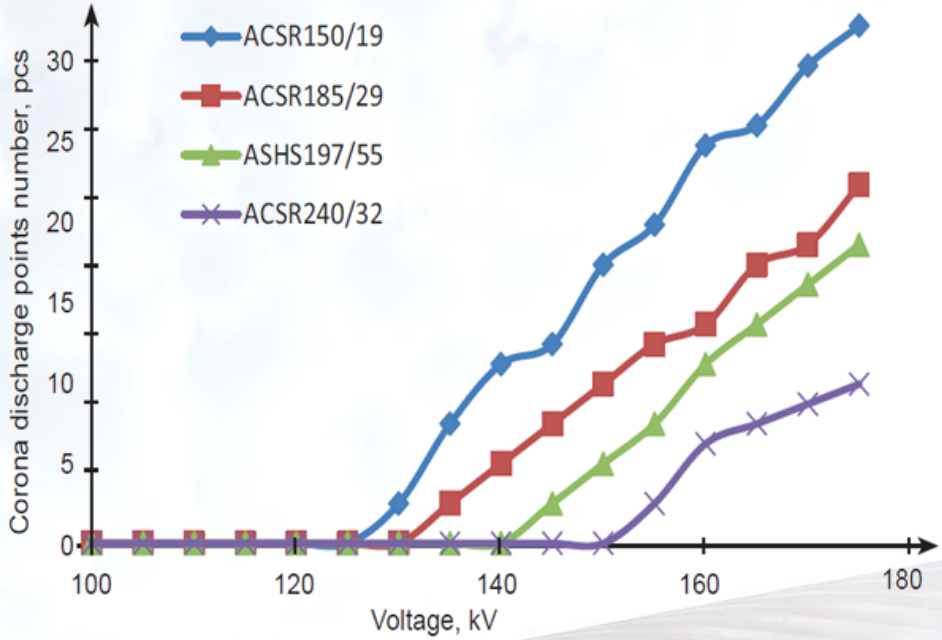
- ***decrease in the number of supports and reduce sag;***
- ***the reduce level of internal corrosion in the conductor;***
- ***the intensity of the formation of ice due to the surface shape;***
- ***the reduce amplitude of pitching conductors.***
- ***Significantly lower operating elongation***
- ***The application of plastic compression ASHS or ASHT conductors makes it possible to reduce the wind load by 25-35% compared to conventional wires with similar values of the area of aluminum layers.***
- ***In case of application for repair/upgrading works at the old OHL, new conductors in high-temperature execution are optimum, especially considering their rather low cost.***
- ***Practically standard fittings***

- **By results of the conducted comparative researches of conductors of identical diameter critical corona voltage for ASHS/ASHT Increase relative to the standard steel-Aluminum conductos.**
- **In the same time the corona-induced acoustic noise are reduction.**

Testing of corona discharge

ASHS 197/55 wire manufactured by compacted technology has corona discharge voltage 142.2 kV by 5.7% higher than ACSR 185/29 conductor 134.5 kV with the same diameter 18.8 mm

Conductors	Average annual losses, change, %
ASCR 240/32 ∅ 21,6 мм	+ 26,67%
ASCR 300/39 ∅ 24,0 мм	0,00%
ASCR 330/43 ∅ 25,2 мм	-13,33%
ASHS 317/47 ∅ 22,3 мм	-13,33%
ASHS 295/44 ∅ 21,5 мм	-6,67%

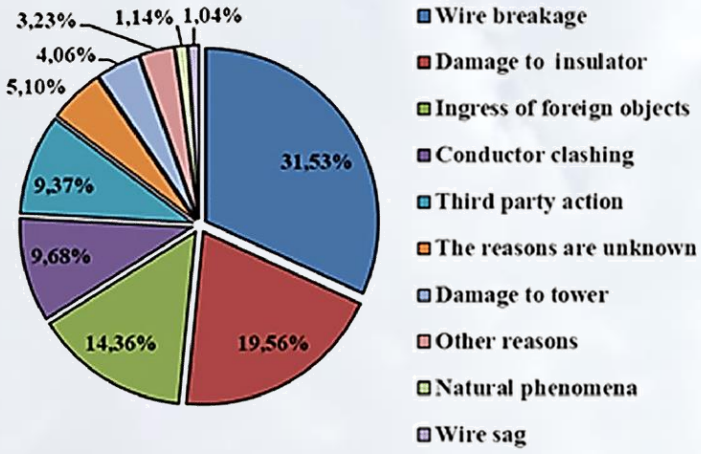


Radio interference voltage test
(FGH Engineering & Test GmbH)

applied voltage kV	measured radio interference voltage		
	decreasing of applied voltage μV	increasing of applied voltage μV	decreasing of applied voltage μV
167,7	25000	25300	27400
153,7	13300	12400	12600
139,7	8750	9500	6600
125,7	84	4500	2066
111,8	79	3000	76
97,8	72	67	63
83,8	58	60	54
70,0	54	52	46
55,9	46	45	42
41,9	42	42	40

According to the conditions of the corona ASHS / ASHT 216/33 - Ø 18.5 mm, comparable to ASCR-240/32 - Ø 21.6 mm

Line accident risk reduction



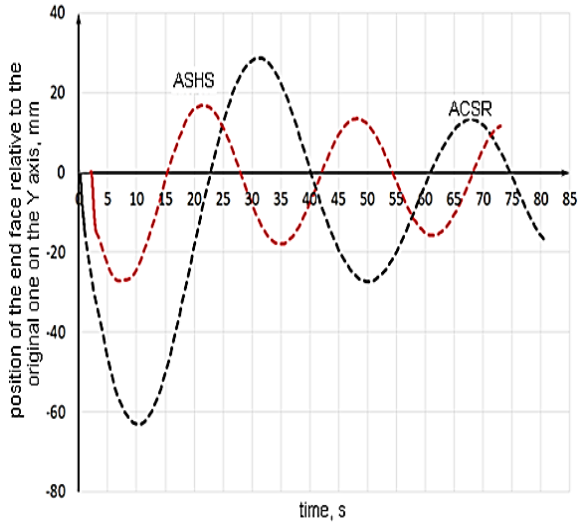
The diagram of the distribution of the causes of technological disruptions on overhead transmission line

►The application of plastic compression products makes it possible to reduce the wind load. Conductors ASHS/ASHT by Energoservice, having streamlined design is lower by 33% on the average.

V, м/с	Wind load on wires, N / m					
	ASHS 128/37	ASCR 120/19	ASHS 216/32	ASCR 240/34	ASHS 277/79	ASCR 240/56
25	3.6	4.8	4.9	6.9	5.2	7.0
32	5.9	7.9	7.8	11.4	8.4	11.5
60	20.8	28.5	28.4	41.5	29.8	41.6

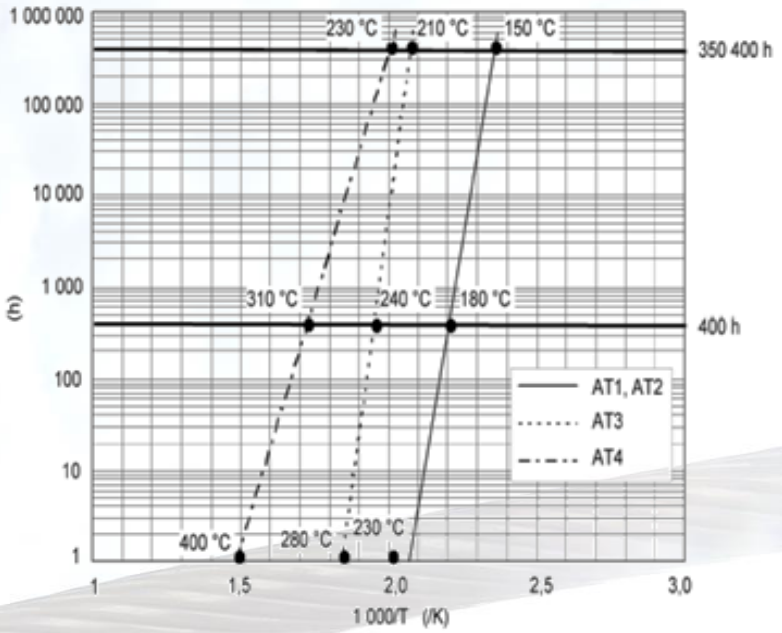
●The design ASHS/ASHT provides:
- Icing reduction - Due to high torsion stiffness and smaller diameter

Oscillation: The ASHS wire 128/36 due to the closer contact of the single strands, the initial amplitude and period of oscillation is approximately **1.7 times less** than that of the ACSR wire 120/27 at the same dialed speed of the bent conductor under impulse action. Vibration after the disturbing effect is extinguished due to the expenditure of energy on the internal friction between the strands. In wires that are compacted due to plastic deformation, developed contact areas are obtained both inside the layer and they enter the empty space in neighboring layers, so the displacement of the layers relative to each other is difficult.
Self-quenching of vibrations is provided.



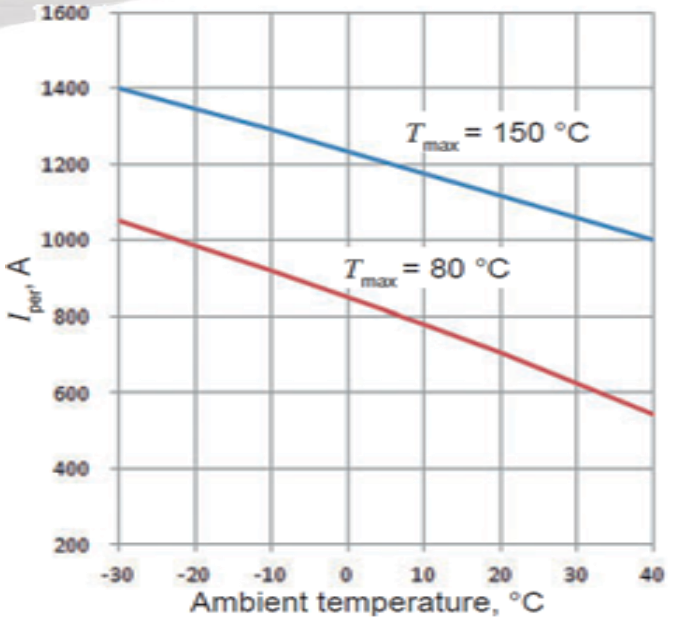
Transmission capacity OHL with high ambient temperature

- Due to its design features, ASHT high-temperature wire is cheaper by several times regarding to analogs with a long-term permissible temperature of 150 °C.
- Continuous permissible current for high-temperature conductor is 30-35% higher than the value for standard conductor of the same diameter.



- A significant reduction lengthening in operating drawing plastically deformed conductors are confirmed by series of experiments.

The correct definition of the conductors creep has recently become one of the important requirements arising from the Exploitation organizations, 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



Comprehensive proper usage of plastically compacted ASHS/ASHT conductors for the new construction and reconstruction of OHL 35-750 kV can significantly increase their reliability when exposed to the entire range of climatic loads, increase throughput, reduce capital and operating costs.

Almost all the exploitation parameters of the new conductors important for the OHL designer do exceed greatly than those for ordinary ones, for a very moderate cost.

- ❖ **The new conductors are excellent for new construction in regions with excessive wind/ice loads or for extended transition.**

- ❖ **The high-temperature execution are optimum for:**
- ✓ **In case of application for repair/upgrading works at the old OHL, new conductors in, especially considering their rather low cost.**
- ✓ **In constructing the ring network circuits and network with the possibility of congestion during the post-emergency modes**
- ✓ **In regions with high air temperatures**

- ❖ **The most effective integrated use ACHS/ACHT together with Ground-wire cables (OPGW) by Energoservice, possessing similar mechanical characteristics.**

Comparison of ASHS and ASHT characteristics with standard conductor Ø 17,1mm

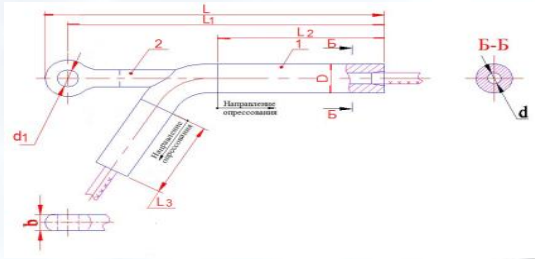
An important task is: to identify where the use of new conductors will be most effective

Parameters of the conductors to be compared	ACSR150/24	ASHS (ASHT) 162/47	
	value	value	Change in percent to ACSR
Core cross section, mm^2	24,2	47,3	+90
Alum cross section, mm^2	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 ^{0}C), Ohm/km	0,2039	0,1780	-12,7

Our conductors don't demand difficult and expensive fittings.

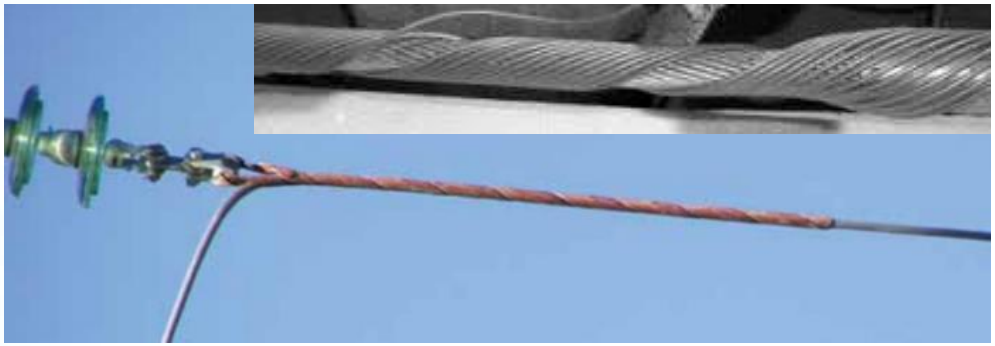
The “conductor-fittings” systems have passed a series of tests in accordance with the rules of PJSC “Rosseti”.

The types of fittings, with which conductors were tested



The pressed fittings

The Spiral fittings



Also vibration quenchers are developed

Ground-wire cable & OPGW

The plastically deformed galvanized ground conductor resistant to lightning strikes with charges 147 ampere-second, and followi vibration exposure 10 . After testing, the breaking strength was 100% of it's initial value. The tests were carried out several times with same result.

- **Optimum integrated use of our wires and our ground wire, taking into account the comparability of mechanical characteristics.**
- The adequacy of the test and parameters for requirements (DIN & IEC), confirmed by SAG Deutschland - Versuchs- und Technologiezentrum
- **The product plated by aluminum has lost mechanical durability after exposure to lighting 85 KL; its actual strength during the test reduced to 32.8 kN (49.6 % of the nominal breaking load).**

Application experience - 18 000 km OHL 110 -500kV

- **The operational stretching of conductors - one of the most important requirements for the overhead lines. Reducing of extraction plastically deformed, galvanized OPGW, confirmed experimentally.**

SOME OTHER PROJECTS IMPLEMENTED

2001г NORILSK NICKEL

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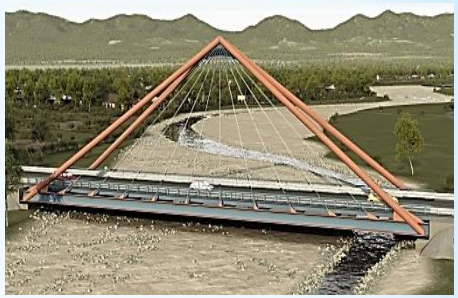
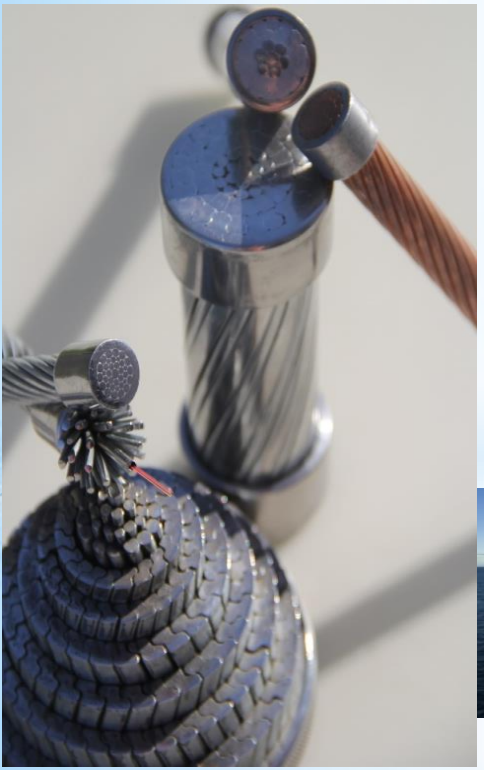
Cable barriers 2013





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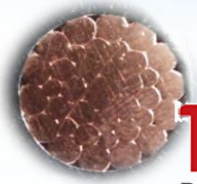

2012

Russian Railways

ROSPATENT

Deutsches Patent- und Markenar

2001