Energoservis Engineering Company

Best Implemented Project for Russian States Grid company «Rosseti»

Complex innovative products for overhead power lines of 35–750 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 cables (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

Inhaber/Inhaberin:
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 18,000 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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The general technological principle - plastic deformation

Tested in Germany (in SAG & FGH) under the control of VDE for compliance with DIN EN 50540, DIN EN 62004, 48207, 62568, IEC 61284, 61854, Cigré 426, DIN EN 62568, IEEE 1138

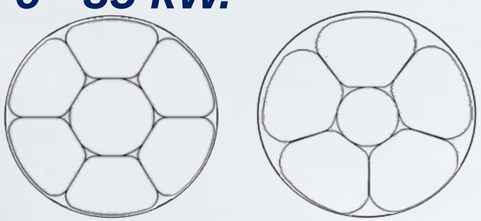
Products for new overhead power lines (OHL)

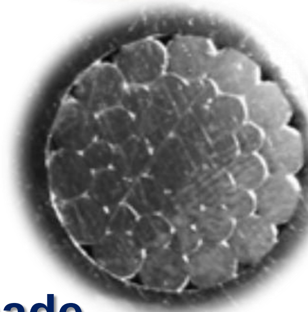
Products for reconstruction of old OHL without replacement of supports

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.



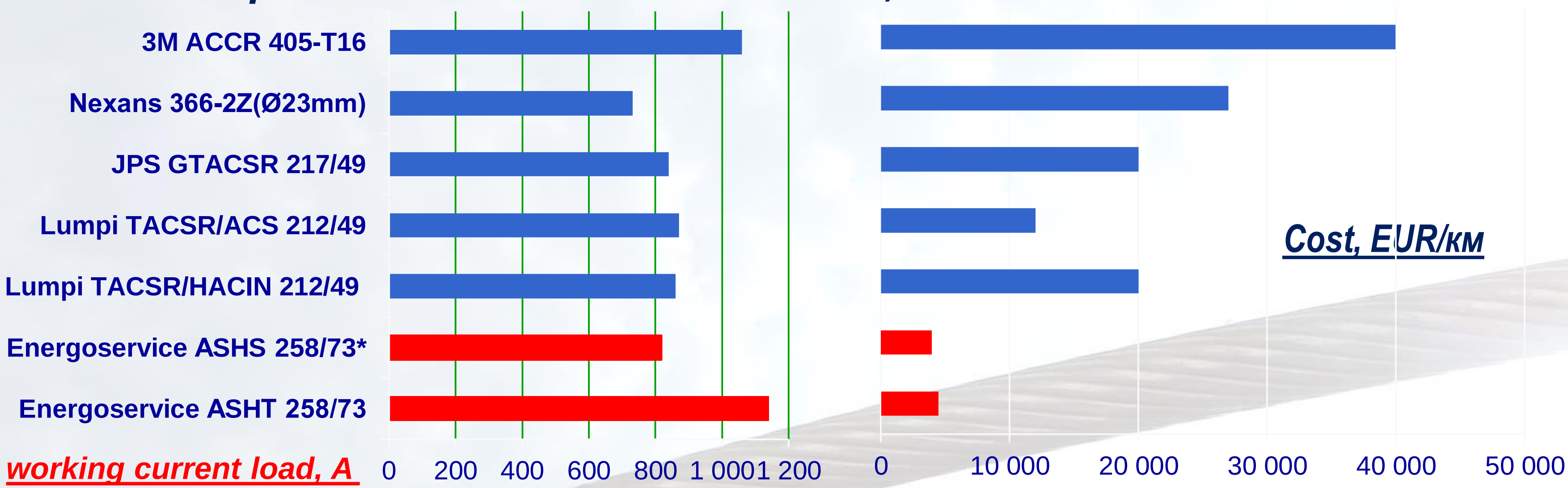


ANHS

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

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.



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

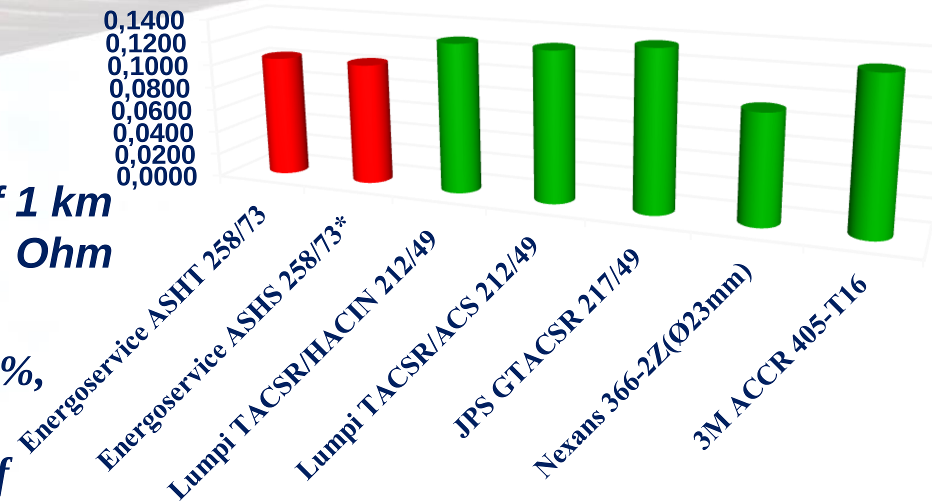
Low sag for high performance

- ✓ **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

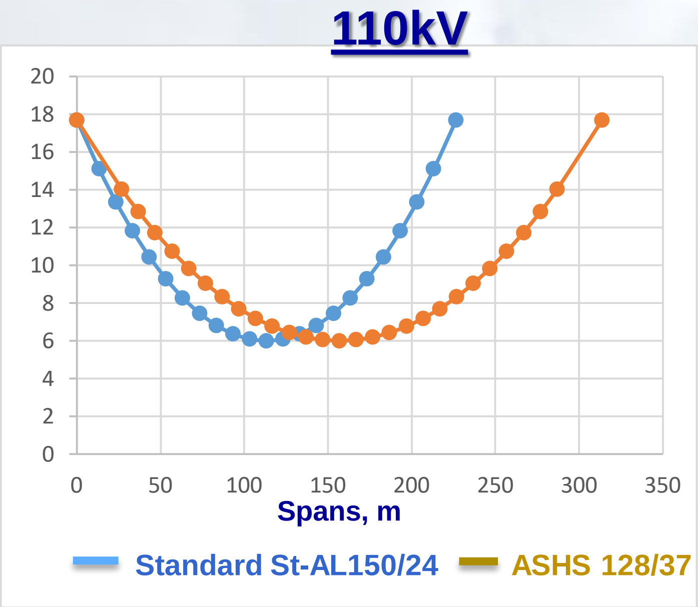
ASHT conductors on the complex technical and economic characteristics are superior to all similar articles.



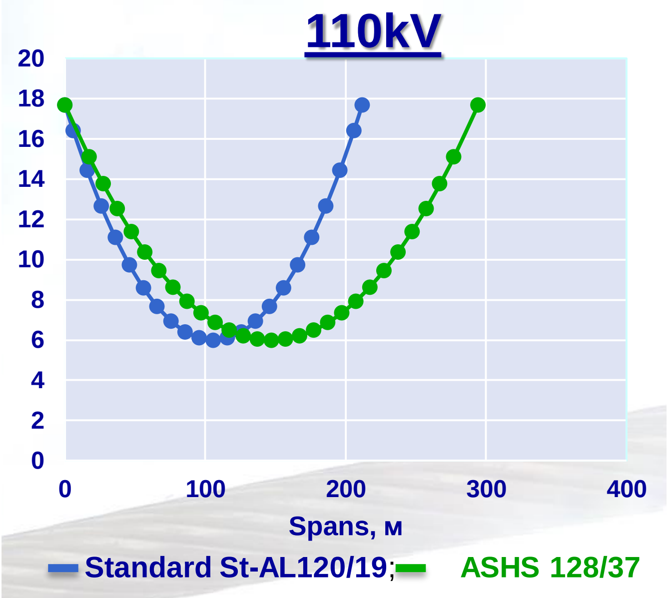
Electrical resistance of 1 km of conductor DC at 20 ° C, Ohm

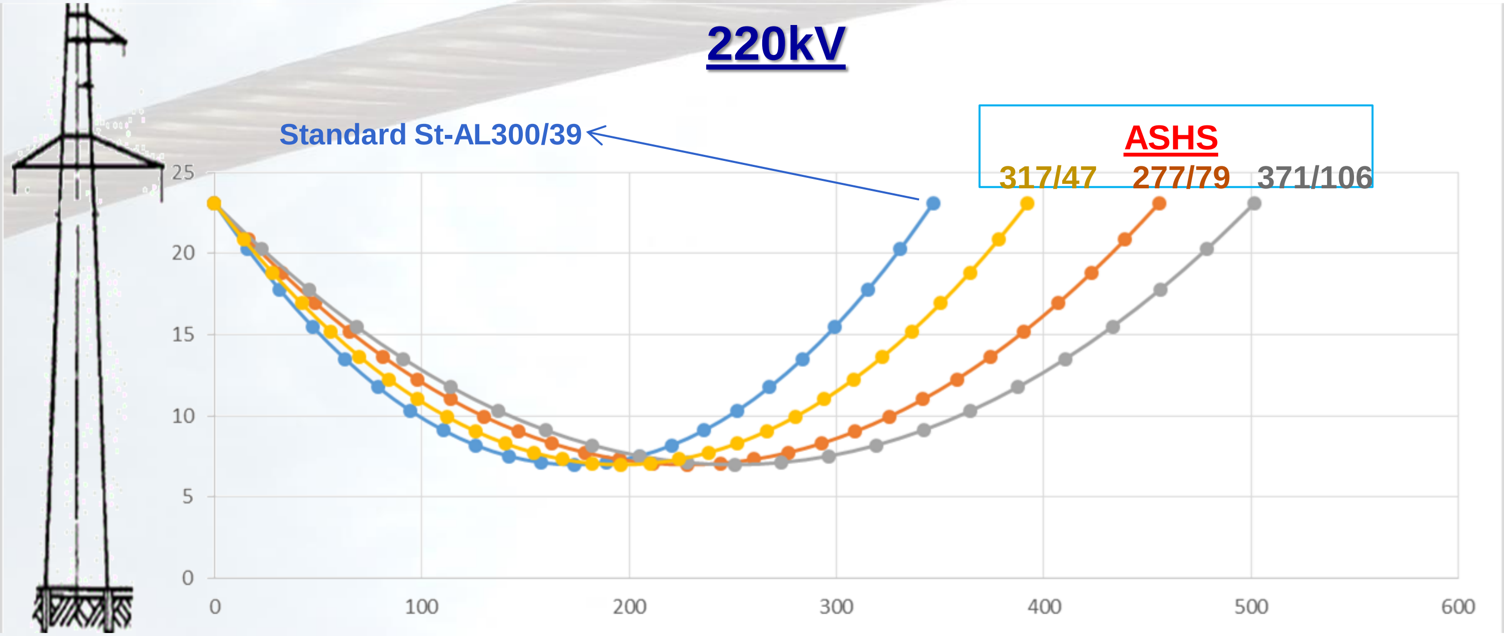
Design provides increased fill factor of up to 95–97 %, a significant improvement of strength and cross-section for the same cable diameter, the reduction of aerodynamic loading (20-35 %) and icing (25-40%).

Comparison spans with new (ASHS/ASHT) and standard conductor. Projects for OHL of different voltage classes

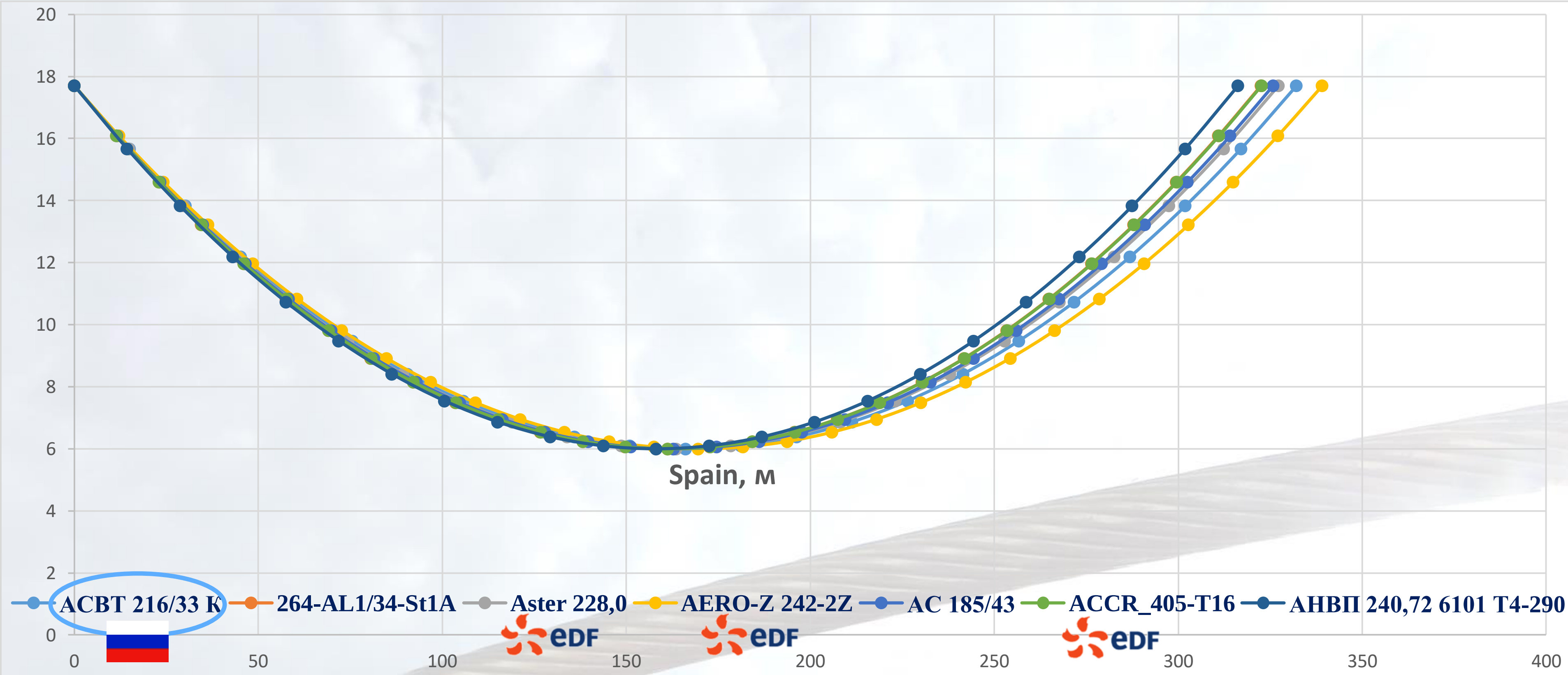


- Increase in the span of 38%
- Increase working current
- Resistance reduction
- Reduction of diameter





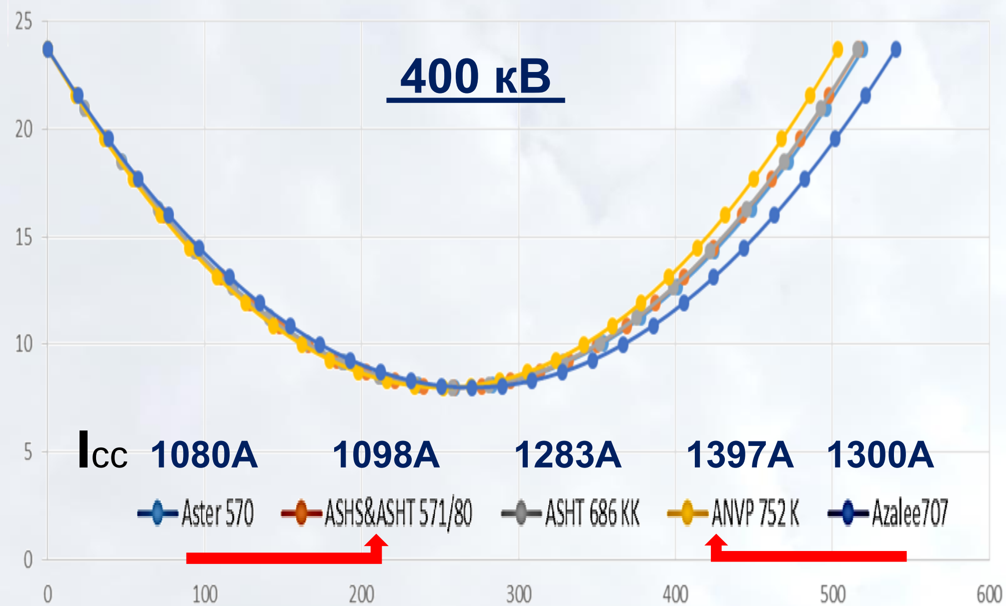
Comparison of test pilot wire in Germany with wires used by TenneT and FDF

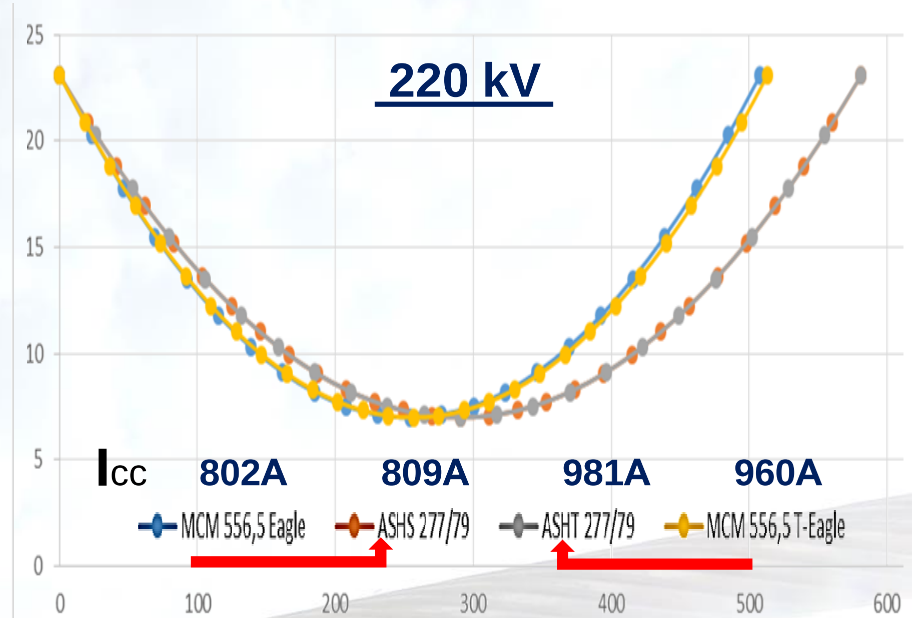


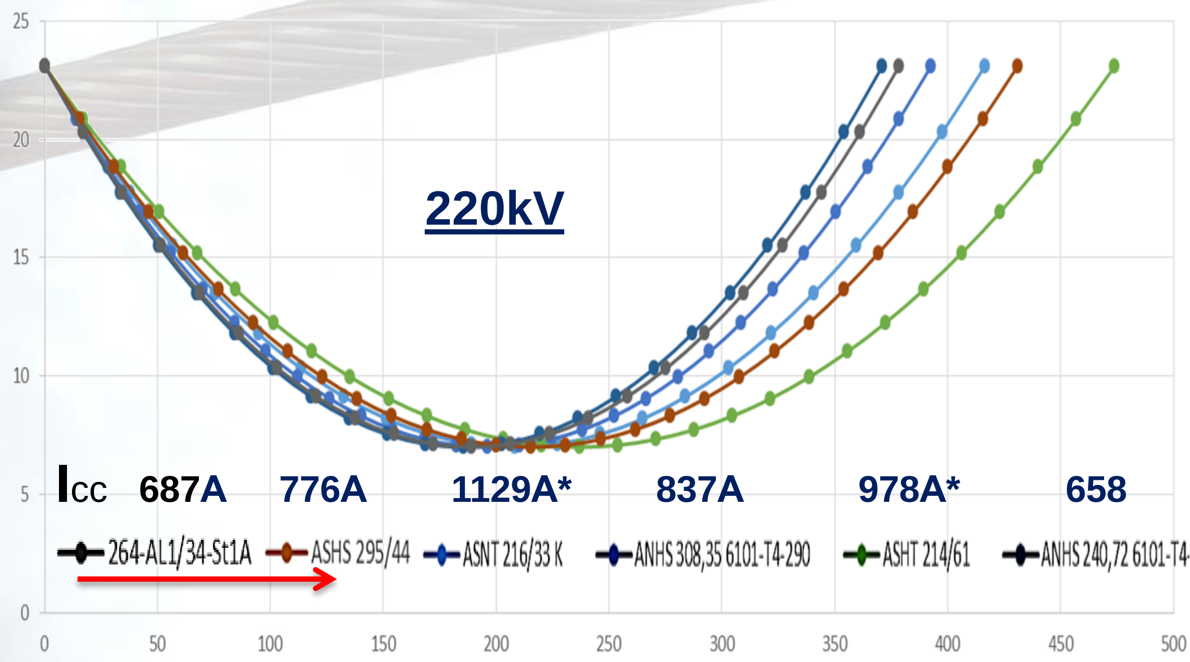
	Section Al, мм²	Resistance 20⁾C, Ом/км	Current at nominal mode at J=1,1 А/мм², А	Current at 80⁰С*	Current at 90⁰С*	Current at 150°С*
ASHT 216/33	235,5	0,13	259,05	627	699	1010
264-AL1/34-St1A	263,7	0,1095	290,0	687		
ANVP 240,72 6101 T4-290	240,72	0,106	264,8	708		
AERO-Z 242-2Z	241,98	0,139	266,2	610		
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 EEC

Span length with allowable clearance spans for OHL in EU







Additional economic benefit due to high breaking strength:

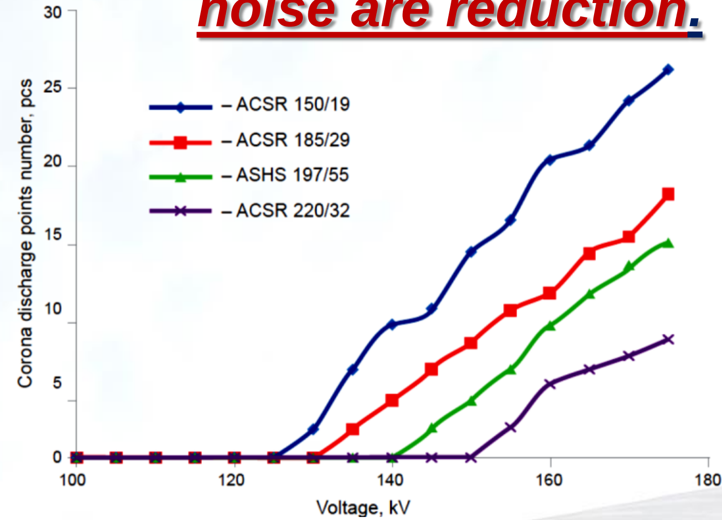
- ***decrease in the number of supports and reduce sag;***
- ***the reduce level of internal corrosion in the conductor;***
- ***the intensity of the formation of ice due to the surface shape;***
- ***the reduce amplitude of pitching conductors.***
- ***Significantly lower operating elongation***
- ***The application of plastic compression ASHS or ASHT conductors makes it possible to reduce the wind load by 10-26% 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 Wire.**
- **In the same time the corona-induced acoustic noise are reduction.**

Same diameter 18.8 mm ASHS 197/55 conductor by "Energoservice", has corona discharge voltage by 5.7% higher than ACSR 185/29

Similar tests were carried out for ASHS 216/33 **Ø18,5 - Ø21,6** ACSR 240/32 have the same corona discharge voltage.

Corona-induced acoustic noise are reduction.



Calculated specific corona losses in good weather (220 kV overhead line)

Phase construction (conductor model; conductor radius r_0, cm)	Annual average losses change, %
ACSR 240/32; Ø 21,6 mm	+ 26,67%
ACSR 300/39; Ø 24,0 mm	0,00%
ACSR 330/43; Ø 25,2 mm	–13,33%
ASHS 317/47; Ø 22,3 mm	–13,33%
ASHS 295/44; Ø 21,5 mm	–6,67%

Calculated specific corona losses in good weather (330 kV overhead line with split phase consisting of 2 conductors with 40 cm spacing)

Phase construction (conductor model; conductor radius r_0, cm)	Annual average losses change, %
2 × ACSR 300/39; Ø 24,0 mm	+ 18,52%
2 × ACSR 400/51; Ø 27,5 mm	0,00%
2 × ASHS 317/47; Ø 22,3 mm	–7,41%
2 × ASHS 295/44; Ø 21,5 mm	+ 3,70%

- **wind loads reduction;**
- **less susceptibility to conductor**
- **galloping and vibrations self-extinction**

Airflow speed v_{AB}, m/s	Wind load acting on the following conductors, N/m					
	ASHS 128/37 (Ø15,2 mm)	ACSR 120/19 (Ø15,2 mm)	ASHS 216/33 (Ø18,5 mm)	ACSR 240/32 (Ø21,6 mm)	ASHS 277/79 (Ø22,4 mm)	ACSR 240/56 (Ø22,5 mm)
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 application of plastic compression products makes it possible to reduce the wind load. Our conductors having streamlined design is lower by 33% on the average.

Reduction of wind load makes it possible to reduce the load on power transmission poles and to mount conductors with greater weight (which more than compensated) on existing towers during capital repairs. Also, the possibility to reduce the load on all elements of overhead line when keeping its transmission capacity appears.

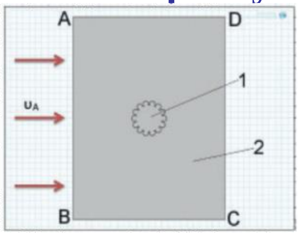
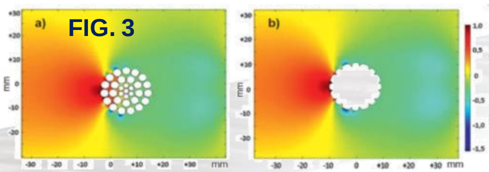
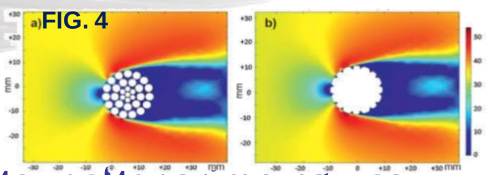


Fig. 2. Geometry of the used model: 1 – conductor cross-section, 2 – airflow

The wind load acting on the conductor across the center was calculated as the sum of pressure X-components: $F = \int n \cdot P\, dl$, where P is pressure, n is the unit vector along the X-axis. The interactions of wind and conductors depending on wind speed and type of conductor's cross-section have been compared. The following conductors with similar diameters and cross-section area have been used for comparison. The calculated wind load differs from P(H/W), standard wind load on conductors and ground wires, determined according to 7-th edition of Electrical Installations Code. The difference takes place due to ignoring the following facts: wind pressure change at various heights depending on terrain, the influence of span length on the wind load, wind pressure non-uniformity along overhead line span. The used approach allows engineers to determine clearly the contribution of conductor's contour to the change of wind load. The view of conductors' contour after crimping was obtained by modeling steel-aluminum conductor plastic deformation process in the Abaqus/Explicit module of the SIMULIA/Abaqus software (Abaqus, Inc., USA). For all our conductors of outer layer are tightly adjacent to each other without gaps. It provides a possibility to simulate the wind impact on a single conductor with one external contour by means of COMSOLMultiphysics. The wind pressure acting on the conductors and air velocity distribution after flowing around ACSR conductors and our conductors are shown in Figures 3 and 4.





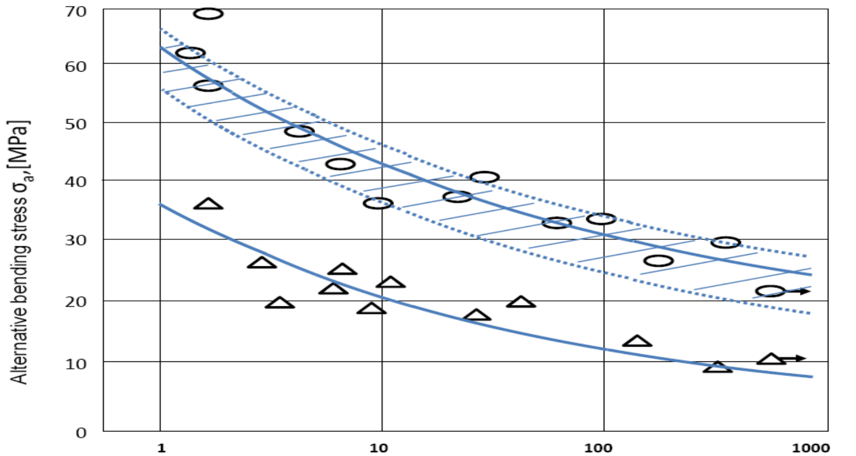
A smoother contour and the smaller diameter of our conductors provide the reduction of pressure zone in front of the conductor (Figure 3b) and the stagnant zone behind it (Figure 4b). The maximum pressure on our conductors is less by 3.5%, while the area with increased pressure is smaller regarding to ACSR conductors or ground wires. The formation of several local areas characterized by air deceleration and reduced pressure is much more visible on the protruding turns of ACSR aluminum wires facing airflow front.

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 added cost.

- **The new conductors are excellent for new construction in regions with excessive wind/ice loads or for extended transition.**
- **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.**
- **In constructing the ring network circuits and network with the possibility of congestion during the post-emergency modes**
- **The most effective integrated use ACHS/ACHT together with Ground-wire cables (OPGW) possessing similar mechanical characteristics.**

❖ **A significant reduction lengthening in operatin 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



Stretching ASHS / ACHT (shaded area). Results for ASVP / ACBT (replacing the signs) and AC conductors (delta) are reproduced on the basis of experiments.

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

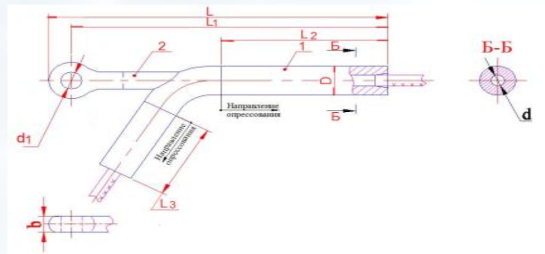
An important task is: to identify where the use of new conductors will be most effective

Parameters of the conductors to be compared	ACSR 150/24	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
Assessment of the relative costs	100 %	100-120 %	

Our conductors don't demand difficult and expensive fittings.

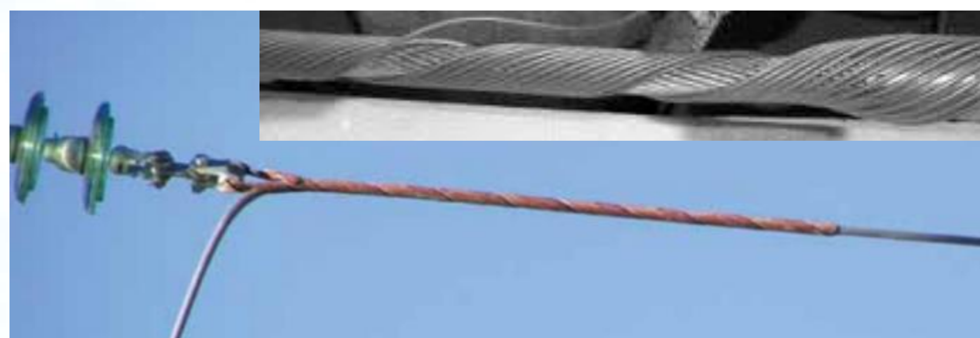
The “conductor-fittings” systems have passed a series of tests in accordance with the rules of PJSC “Rosseti”.

The types of fittings, with which conductors were tested



The pressed fittings

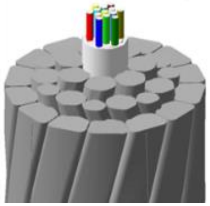
The Spiral fittings



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 following vibration exposure 10^8. After testing, the breaking strength was 100% of it's initial value. The tests were carried out several times with same result.



SAG

Technischer Bericht Nr. 2014-055

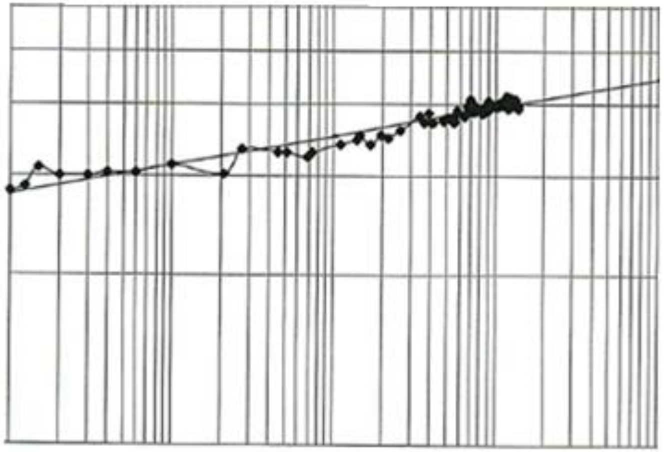
Notwendige Prüfungen eines LWL-Erdseiles zum Nachweis der Funktionsfähigkeit für den deutschen Markt

Auftraggeber:	Energoinse GmbH Alte Jacobstraße 77 CD 10179 Berlin
Gegenstand:	Stahl-Lichtwellenleiter-Erdseil nach Unterlagen der Fa. Energoinse
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

- ➢ <u>**Optimum integrated use of our wires and our ground wire, taking into account the comparability of mechanical characteristics.**</u>
- ❖ <u>The adequacy of the test and parameters for requirements (DIN & IEC), confirmed by SAG Deutschland - Versuchs- und Technologiezentrum</u>
- ✓ **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).**



- ➢ **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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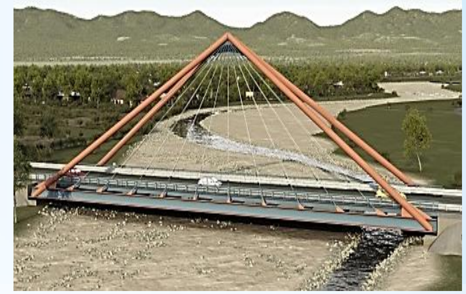
Cable barriers
2013

2001



2011

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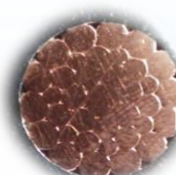

Russian Railways

2012

Deutsches
Patent- und Markenar

ROSPATENT