

Compact bare wires for overhead power lines.

Bare wires KUSIL-A, -AS, -TAA in accordance with TU 3511-032-76960731-2014 including high temperature performance and compacted ones, for overhead power lines.



Compact wire KUSIL-AIS with trapezoidal conductor and steel core.



Compact wire KUSIL-AIS-Z with Z-shaped conductor and steel core.

Wires are the part of overhead power lines, they are conducting electric current. Due to a light weight and high electric conductivity Aluminum has become the major material for wire manufacturing. Generally for the overhead power lines with the rated voltage over 35 kV non-insulated aluminum and steel-aluminum wires with the round conductors are applied (see Figure 1). Aluminum conductors determine the electrical properties of the wire, and the steel core assures its tensile characteristics.

The main issues while overhead power lines operating:

- The greater the outer diameter of the wire, the greater the loss of corona discharge. Therefore, for voltages exceeding 220 kV, it is necessary to choose a larger wire gauge as compared with optimal one, which impairs the economic performance of the overhead power line.
- Due to the large wire diameter the sag and wind load are increased, as a result - the short distance between the transmission towers is required.
- Another problem is the line wires icing (see. Figure 2). In the mountain areas the icing on the wires can be up to a thickness of 150-200 mm. So icing caused the accidents of power lines – due to broken wires, damaged towers.

In 2016 SPE "Gerda" has mastered the production of a compact bare wire KUSIL-AI based on the trapezoidal conductors (see. Figure 3) wires and Z-shaped conductors (see. Figure 4). The wire surface is smooth; the grooves between the upper conductors are practically absent.

Profiled conductor (trapezoidal and Z-shaped) is made of the following materials:

- Aluminum alloy (KUSIL-AI) – operating temperatures up to 90°C;
- Aluminum-zirconium alloy AT-1 (KUSIL-TAA-1) – operating temperatures up to 150°C (180°C within 400 hours);
- Aluminum-zirconium alloy AT-3 (KUSIL -TAA-3) – operating temperatures up to 210°C (240°C within 400 hours).

Core of the wires with profiled conductors may be made of the following materials:

- steel «S» (KUSIL-ApS);
- steel reinforced «Su» (KUSIL-ApSu);
- composite "K" based on the carbon fibers (KUSIL-ApK).

The wires on the basis of the trapezoidal conductors (KUSIL-Ap) and Z-shaped conductors (KUSIL-Ap-Z) have a distinct advantage over traditional wires with round conductors.

Advantages

- KUSIL-Ap and KUSIL-ApZ wire allows with smaller diameter to transmit power corresponding to the same round conductor wire with a larger cross-section and weight;
- Lighter wind load due to smaller diameter and smooth surface;
- Decreased icing and snow aggregating - due to smooth surface and absence of the grooves between upper conductors;
- Overlapping of Z-shaped conductors of the upper lay (KUSIL-Ap-Z wire) forms a barrier for added water resistance;
- Low probability of wires "dancing", that occurs generally due to icing;

- Less corona loss;
- Low acoustic noise at the line;
- High-temperature performance wires made of aluminum-zirconium alloy assure reliable operation while significant excesses on current load;
- Low sag allows to increase the distance between the towers (span length).



Design of KUSIL-TAApS -1 240/39 wire (TU3511-032-76960731-2014)

Nominal wire cross-section, number and nominal diameter of round conductors or equivalent diameter of profiled conductors (trapezoidal or Z-shaped), the number of coils of wires and nominal outside diameter of the wires should be as set out in Tables 1-4.

Table 1. KUSIL -(A, -AKP, -AA, -AAKP, -TAA-1, -TAAKP-1, -TAA-3, -TAAKP-3)

Nominal wire cross-section, mm ²	Number of conductors	Nominal diameter of conductors, mm	Number of coils	Nominal outside diameter of the wire, mm	Design length, m, above
16	7	1,7	1	5,1	4 500
25	7	2,13	1	6,39	4 000
35	7	2,5	1	7,5	4 000
50	7	3	1	9	3 500
70	7	3,55	1	10,65	2 500
95	7	4,1	1	12,3	2 000
120	19	2,8	2	14	1 500
150	19	3,15	2	15,75	1 250
185	19	3,5	2	17,5	1 000
240	19	4	2	20	1 000
300	37	3,15	3	22,05	1 000
350	37	3,45	3	24,15	1 000
400	37	3,66	3	25,62	1 000
450	37	3,9	3	27,3	1 000
500	37	4,15	3	29,05	1 000
550	61	3,37	4	30,33	1 000
600	61	3,5	4	31,5	800
650	61	3,66	4	32,94	800
700	61	3,8	4	34,2	800
750	61	3,95	4	35,55	800

Table 2. KUSIL-(AS, -ASKP, -AAS, -AASKP, -TAAS-1, -TAASKP-1, -TAAS-3, -TAASKP-3)

Nominal wire cross-section, mm ²		Wire is partially made of aluminum or aluminum alloy			Steel core			Nominal outside diameter, mm		Design length, m, above
		Number of conductors	Nominal diameter of conductors, mm	Number of coils	Number of conductors	Nominal diameter of conductors, mm	Number of coils	wire	core	
10/	1,8	6	1,5	1	1	1,5	-	4,5	1,5	3 000
16/	2,7	6	1,85	1	1	1,85	-	5,55	1,85	3 000
25/	4,2	6	2,3	1	1	2,3	-	6,9	2,3	3 000
35/	6,2	6	2,8	1	1	2,8	-	8,4	2,8	3 000
50/	8	6	3,2	1	1	3,2	-	9,6	3,2	3 000
70/	11	6	3,8	1	1	3,8	-	11,4	3,8	2 000
70/	72	18	2,2	1	19	2,2	2	15,4	11	2 000
95/	16	6	4,5	1	1	4,5	-	13,5	4,5	1 500
120/	19	26	2,4	2	7	1,85	1	15,15	5,55	2 000
120/	27	30	2,2	2	7	2,2	1	15,4	6,6	2 000
150/	19	24	2,8	2	7	1,85	1	16,75	5,55	2 000
150/	24	26	2,7	2	7	2,1	1	17,1	6,3	2 000
150/	34	30	2,5	2	7	2,5	1	17,5	7,5	2 000
185/	24	24	3,15	2	7	2,1	1	18,9	6,3	2 000
185/	29	26	2,98	2	7	2,3	1	18,82	6,9	2 000
185/	43	30	2,8	2	7	2,8	1	19,6	8,4	2 000
205/	27	24	3,3	2	7	2,2	1	19,8	6,6	2 000
240/	32	24	3,6	2	7	2,4	1	21,6	7,2	2 000
240/	39	26	3,4	2	7	2,65	1	21,55	7,95	2 000
240/	56	30	3,2	2	7	3,2	1	22,4	9,6	2 000
300/	39	24	4	2	7	2,65	1	23,95	7,95	2 000
300/	48	26	3,8	2	7	2,95	1	24,05	8,85	2 000
300/	66	30	3,5	2	19	2,1	2	24,5	10,5	2 000
300/	67	30	3,5	2	7	3,5	1	24,5	10,5	2 000
330/	30	48	2,98	3	7	2,3	1	24,78	6,9	2 000
330/	43	54	2,8	3	7	2,8	1	25,2	8,4	2 000
400/	18	42	3,4	3	7	1,85	1	25,95	5,55	1 500
400/	51	54	3,05	3	7	3,05	1	27,45	9,15	1 500
400/	64	26	4,37	2	7	3,4	1	27,68	10,2	1 500
400/	93	30	4,15	2	19	2,5	2	29,1	12,5	1 500
450/	56	54	3,2	3	7	3,2	1	28,8	9,6	1 500
500/	26	42	3,9	3	7	2,2	1	30	6,6	1 500
500/	64	54	3,4	3	7	3,4	1	30,6	10,2	1 500
550/	71	54	3,6	3	7	3,6	1	32,4	10,8	1 200

Table 3. KUSIL (-ApS, -TAApS-1, - TAApS -3)

Nominal wire cross-section, mm ²		Wire is partially made of aluminum or aluminum alloy		Steel core			Nominal diameter, mm		Design length, m, above
		Number of conductors and equivalent diameter, mm	Number of coils	Number of conductors	Nominal diameter of conductors, mm	Number of coils	wire	core	
120/	19	8(2,78) + 12(2,78)	2	7	1,85	1	13,78	5,55	2 000
150/	24	8(3,11) + 12(3,11)	2	7	2,1	1	15,57	6,3	2 000
150/	34	8(3,11) + 12(3,11)	2	7	2,5	1	15,97	7,5	2 000
185/	24	8(3,45) + 12(3,45)	2	7	2,1	1	16,88	6,3	2 000
185/	29	8(3,45) + 12(3,46)	2	7	2,3	1	17,11	6,9	2 000
185/	43	8(3,47) + 12(3,45)	2	7	2,8	1	17,77	8,4	2 000
240/	32	8(3,93) + 12(3,94)	2	7	2,4	1	19,23	7,2	2 000
240/	39	8(3,93) + 12(3,93)	2	7	2,65	1	19,52	7,95	2 000
300/	39	8(4,39) + 12(4,43)	2	7	2,65	1	21,46	7,95	1 800
300/	67	8(4,43) + 12(4,38)	2	7	3,5	1	22,53	10,5	1 800
330/	43	8(4,60) + 12(4,60)	2	7	2,8	1	22,53	8,4	1 700
400/	51	8(5,06) + 12(5,10)	2	7	3,05	1	24,77	9,15	1 500
500/	64	8(5,67) + 12(5,71)	2	7	3,4	1	27,69	10,2	1 400

Table 4. KUSIL-(3APS, -3TAApS-1, - 3TAApS -3)

Nominal wire cross-section, mm ²		Wire is partially made of aluminum or aluminum alloy		Steel core			Nominal diameter, mm		Design length, m, above
		Number of conductors and equivalent diameter, mm	Number of coils	Number of conductors	Nominal diameter of conductors, mm	Number of coils	wire	core	
185/	22		2	7	2	1	17,82	6	2 000
210/	32		2	7	2,4	1	19,04	7,2	2 000
240/	32		2	7	2,4	1	20,56	7,2	1 800
265/	43		2	7	2,8	1	22,69	8,4	1 800
310/	43		2	7	2,8	1	24,42	8,4	1 800
370/	80		2	7	3,8	1	27,34	11,4	2 000
410/	50		2	7	3	1	27,59	9	2 000
435/	50		2	7	3	1	28,8	9	2 000
550/	50		2	7	3	1	29,3	9	1 800