MORE CAPACITY

Increase transmission performance with
thermal resistant overhead conductors

THERMAL RESISTANT
OVERHEAD CONDUCTORS

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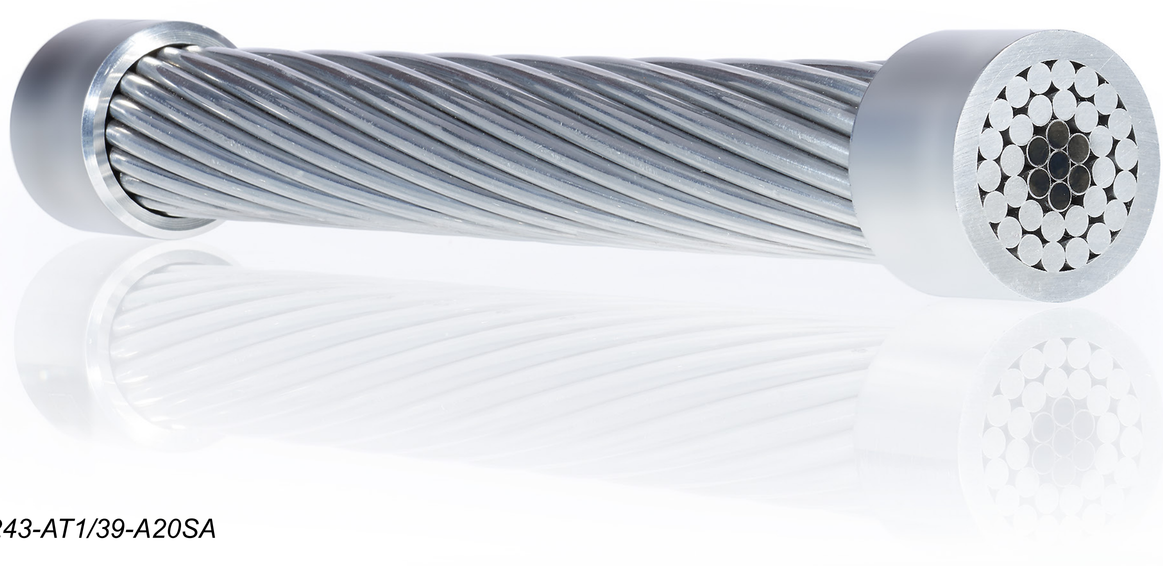
INCREASE TRANSMISSION PERFORMANCE WITH THERMAL RESISTANT OVERHEAD CONDUCTORS

To keep pace with increased demand for energy and production from alternative sources, power grids are having to constantly expand. Given the lack of space available for new overhead line routes, it is becoming more and more important to uprate existing overhead lines.

The transmission capacity of the overhead lines must also be boosted significantly to cover peak power requirements. Generally speaking, higher operating voltages, larger conductor cross-sections and bundled conductor arrangements are not all that easy to achieve.

Specialising in thermal resistant overhead conductors (HT/HTLS - **H**igh **T**emperature **L**ow **S**ag), LUMPI-BERNDORF is able to provide a fully developed and cost-effective solution.



243-AT1/39-A20SA

There are three levels of capacity increase:

1

CONDUCTORS WITH UP TO 50% HIGHER CAPACITY

Thanks to their aluminium zirconium alloy, these conductors allow the operating temperature to be increased to 150°C, resulting in a continuous current-carrying capacity that is around 50% higher.

2

CONDUCTORS WITH UP TO 100% HIGHER CAPACITY

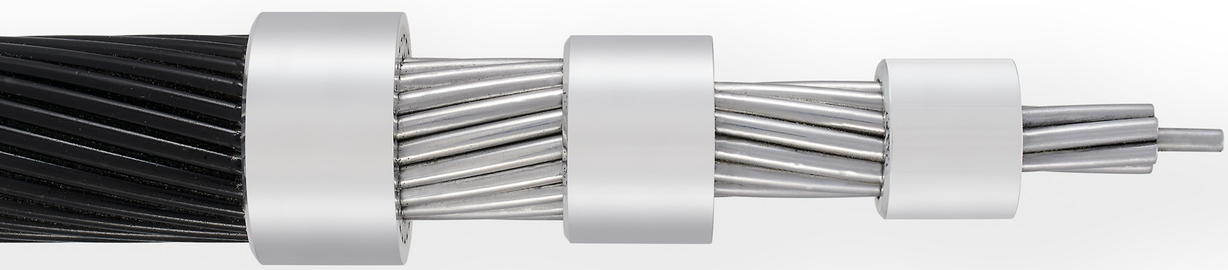
These conductors also incorporate an aluminium zirconium alloy, but allow the operating temperature to be increased to an amazing 210°C, resulting in a continuous current-carrying capacity that is around 100% higher.

3

SPECIAL BLACK COATING

Applying a black coating to the conductor surface increases heat emission so that even more energy can be transmitted, i.e. the continuous current-carrying capacity can be improved by another few per cent.

LUMPI-BERNDORF'S special conductor designs for constructing new overhead lines and uprating existing ones are currently the most cost-effective choice for meeting electrical energy and data transmission requirements.



DEVELOPMENT OF THE THERMAL RESISTANT OVERHEAD CONDUCTORS

As a material for manufacturing overhead conductors, aluminium has to meet a set of specific requirements:

- maximum conductivity
- maximum strength
- controlled ageing and temperature resistance

However, these requirements conflict with one another. Optimum conductivity values can only be achieved by using high purity aluminium, but this reduces the strength quite considerably.

To keep the strength roughly the same, dispersion-strengthened materials have to be considered. With this in mind, aluminium zirconium alloys are one way to create thermal resistant conductors of this kind.

Zirconium enables a higher recrystallisation temperature while at the same time increasing the strength of the conductors.

Apart from the fact that their conductivity is slightly lower, the AT1 and AT3 alloys have virtually identical properties to pure aluminium. In the case of the AT2 alloy, the reduction in conductivity was a deliberate trade-off in return for higher strength.

This is clearly illustrated by the following comparison of the characteristic values:

	Unit	AL1	AT1 [1]	AT3 [2]	AT2 [3]
Conductivity	Sm/mm²	35,38	34,80	34,80	31,90
Tensile strength	daN/mm²	16 - 20	15,9 – 17,1	15,9 – 17,6	22,5 – 24,8
Modulus of elasticity	daN/mm²	6000	6000	6000	6000
Coefficient of expansion	E-05/°C	2,3	2,3	2,3	2,3
Continuous operating temperature	°C	80	150	210	150
Short-time temperature (30 min)	°C	--	180	240	180
Short-circuit temperature (1 s)	°C	130/160	260	280	260

[1] AT1 according to EN62004/2009 = TAl
[2] AT3 according to EN62004/2009 = ZTAl
[3] AT2 according to EN62004/2009 = KTAl

From these properties, it immediately becomes clear why densely populated countries such as Japan have been using this technology for years in order to transmit more energy along the same routes.

COMBINATIONS OF MATERIALS AND APPLICATION AREAS FOR THERMAL RESISTANT OVERHEAD CONDUCTORS

T-AAC

Just like aluminium conductors, T-AAC (without any steel reinforcement) are primarily used in substations.

TACSR/ACS

To make them suitable for use in overhead lines, TAl wires are combined with aluminium clad steel. Although it is possible to use galvanised steel, this is not advisable because of the anti-corrosion agent (conductor grease) that is required and the high dripping point associated with this.

KTACSR/ACS

If a stronger conductive material is required for use in overhead lines (e.g. on hilly or mountainous terrain), the KTAl version can be used.

TACSR/ACI

To further improve the sag properties of the conductors, a special INVAR alloy (nickel steel alloy) was incorporated into the product range.

We call this **ACI**, which stands for „High-strength“ **A**luminium-**C**lad **I**nvar’. The key benefits of this base material are that its thermal coefficient of expansion is three to four times lower than that of conventional base materials, and that the aluminium layer ensures excellent corrosion resistance.

TACSR/ACI EXHIBIT MUCH LOWER LEVELS OF EXPANSION, WHICH RESULTS IN SIGNIFICANTLY BETTER SAG PROPERTIES.

KTACSR/ACI

This type is ideal for use in situations where reduced sag is required in conjunction with stronger aluminium.

ZTACSR/ACI

This alternative can increase the continuous current by up to 100%. The ACI prevents any significant increase in sag, meaning that the necessary safety distance can be adhered to.

IDEAL AREAS OF APPLICATION FOR THERMAL RESISTANT OVERHEAD CONDUCTORS

SUBSTATIONS
OVERHEAD EARTH CONDUCTORS
PHASE CONDUCTORS

Use in substations

Thanks to the short spans, no sag issues occur in spite of the high temperatures involved. T-AAC can be used here without any problems. The performance of existing installations can be boosted by 50%, simply by replacing the conductors.

In contrast to conventional uprating measures, there is no need to modify the poles and extend the foundations. Experience has also shown that the same fittings can be used as before. Thanks to their large mass and surface area, the conductor clamps reach much lower temperatures than the conductors themselves.

Use in overhead earth conductors

The excellent temperature resistance of ‘hot’ conductors that rely on aluminium clad steel or ACI as the base material support short-circuit temperatures of up to 280°C (for 1 s), which means they can absorb much higher short-circuit currents than conventional conductors.

Up until now, very high short-circuit currents were a commonly occurring problem 1–2 km upstream of the substation because they often meant that conductors in the next size up had to be installed. Our conductors are an easy and cost-effective way to resolve this issue. There is no need to change the conductor size and the fittings can be retained.

Use in phase conductors

Several parameters must be taken into account within this context. Due to the increased sag that occurs at high temperatures, each project must be analysed and planned individually.

To get the very best from thermally resistant conductors, the following issues must be clarified before embarking on any project:

- What territorial, governmental and legal regulations are there to consider?
- For how many years is this upgrade and – in turn – increase in performance intended to last?
- What level of continuous current is required?
- Materials and dimensions of existing conductor?
- Is there any spare capacity in terms of the poles?
- Is there a sag buffer?

Various alternative technical quotes can then be prepared on the basis of this data.

Technical comparison of base materials:

	Unit	Galv. steel 1	Aluminium clad steel 2	ACI 14SA 3
Modulus of elasticity	daN/mm²	20700	16200	14100
Coefficient of expansion	E-05/°C	1,15	1,30	0,45 (15-230°C)
Tens. stress / 1% elongation	Mpa	1100 - 1170	1100 - 1200	990 - 1070
Tensile strength Rm	Mpa	1300 - 1400	1070 - 1340	1065-1160
Elongation to 250 mm	%	3,0 - 4,0	1,5	1,5
Density	g/cm³	7,78	6,59	6,94

[1] Galvanised steel according to EN 50189/2000, ST1A
[2] Aluminium clad steel according to EN 61232/2000, 20SA type A
[3] ACI 14SA according to LUMPI-BERNDORF specifications

It is clear that thermal resistant conductors can be used to increase transmission perfor-mance. Not only that, but the characteristics of the **ACI** base material have an extremely positive effect on the strength of the conductors and the sag at high temperatures - as a result, users can either opt for huge financial savings through continued use of existing routes and the associated infrastructure (pylons, etc.) or for considerably higher transmission performance through the construction of new lines.

ADVANTAGES OF THERMAL RESISTANT ALUMINIUM ALLOYS

- Cost-effective renovation of existing installations thanks to increased capacity plus the ability to make use of existing routes and the associated infrastructure such as pylons and their foundations.
- Creation of outage reserve capacity
- Continuous current-carrying capacity is approximately 50% to 100% higher than with Al/St conductors with an identical cross-sectional area
- Higher short-circuit current, resulting in higher operational reliability
- Same corrosion resistance as standard conductors
- Same mechanical properties as standard conductors

FITTINGS FOR THERMAL RESISTANT OVERHEAD CONDUCTORS

As part of the process of introducing new conductor materials for overhead line construction, the fittings must also, of course, be thoroughly checked. Ever since high-temperature conductors were first put into operation in Austria and Germany, numerous tests have been carried out to verify the retention force values involved.

These tests have revealed that the conductor clamps reach significantly lower temperatures than the conductors because of their larger mass and surface area.

Example:

Conductor temperature	150°C
Clamp temperature	105°C - 110°C depending on clamp design

THE COST-EFFECTIVENESS OF THERMALLY RESISTANT CONDUCTORS

In order to determine the cost-effectiveness of thermally resistant conductors, users must adopt a much more detailed approach than they would in the case of conventional overhead line construction projects.

To enable a comparison

- the costs of the traditional design and
- the costs of upgrading to the thermal resistant type (max. operating temperature of 150°C)

are identified and compared.

The following aspects can/must be included in this comparison:

- costs of dismantling the existing line
- costs of constructing a new line using the traditional design
- conductor replacement costs
- pylon reinforcement measures/pylon replacement
- reinforcement of the foundations (if necessary)
- installation of intermediate sections
- renovation of poles
- surveying/routing, crop damage and ancillary construction costs
- updated costs of new construction work completed at a later date
- difference in cost losses, etc.

However, the various costs are incurred at different times. It is therefore advisable to use the start of construction as the reference date for the cost comparison. Costs that are incurred at a later date can then be updated by aligning them with the point in time that is under consideration (reduced in accordance with an up-to-date interest rate for investment projects).

The following example is intended to illustrate how cost efficiency calculations can be used to create a sound basis for decisions.

OPTION 1 – CONSTRUCTION OF NEW LINE ALONG EXISTING ROUTE:

• 26 km new construction project involving the use of standard poles and standard two-conductor bundlesl	EUR 6,87 million
• Dismantling of old line	EUR 0,76 million
Cost of new construction project	**EUR 7,63 million**

OPTION 2 – UPGRADE OF CONDUCTORS USING TACSR/ACS

• 26 km circuit replacement	EUR 1.53 million
• Conversion of grillage foundations into block foundations	EUR 0.92 million
• Installation of intermediate sections	EUR 0.15 million
• Renovation of poles	EUR 0.10 million
• Surveying/routing, crop damage, ancillary construction costs etc.	EUR 0.25 million
	EUR 2.95 million
Updated costs of new construction work completed at a later date (EUR 7.63 million x1.08^{-20})	EUR 1.63 million
Difference in cost losses	EUR 1.27 million
Total costs of an immediate upgrade plus new construction work at a later date	EUR 5.85 million

Cost of new construction project	EUR 7.63 million
Cost of upgrading conductors	EUR 5.85 million
Saving achieved by upgrading conductors	EUR 1.78 million

This example clearly shows that it is sometimes worth postponing a new construction project for a period of 15, 20 or 30 years because TACSR/ACS conductors can be used to solve the problem of increased transmission performance in the meantime.

However, there is another important aspect that must be considered as part of this analysis: planning permission. Of course, it is not possible to quantify in figures whether or not planning permission will be granted for a new construction project and so this information cannot be included in a cost efficiency comparison. In turn, this strengthens the case for solving the problem with thermal resistant conductors.

We regard special technical requirements in the area of line construction as an opportunity to show you what we can do.

For further information about this product and to see an overview of all our products, please visit our website at www.lumpi-berndorf.com. We invite you to get in touch with your enquiry, on the basis of which we will be happy to send you some technical documentation or a quote.

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LEADING TECHNOLOGIES IN OVERHEAD CONDUCTORS