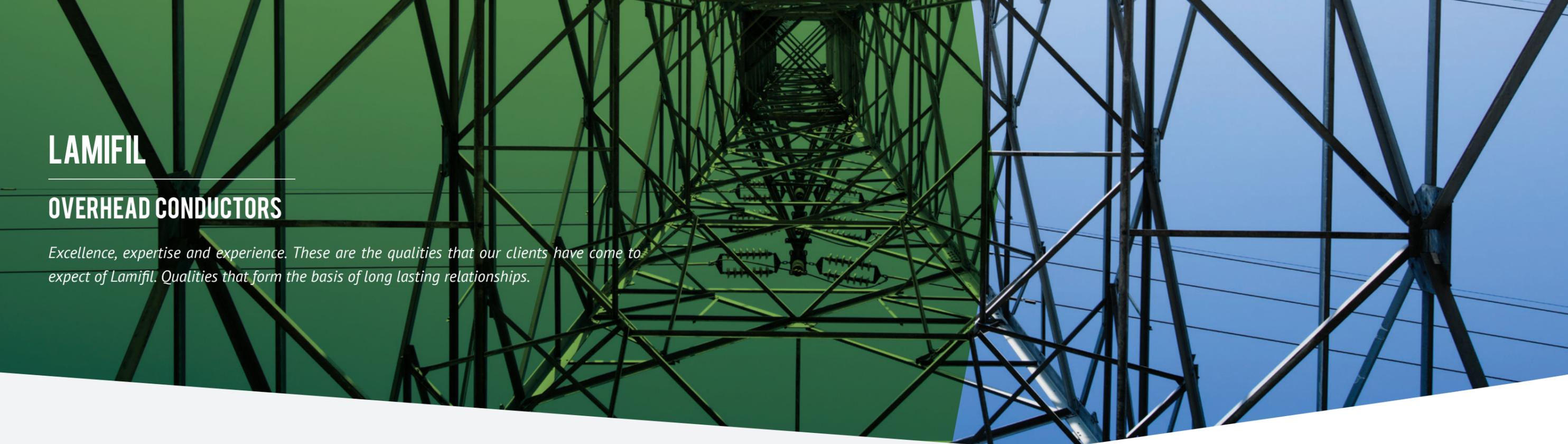


LAMIFIL



OVERHEAD CONDUCTORS

SOLUTIONS FOR POWER TRANSMISSION
AND DISTRIBUTION



LAMIFIL

OVERHEAD CONDUCTORS

Excellence, expertise and experience. These are the qualities that our clients have come to expect of Lamifil. Qualities that form the basis of long lasting relationships.

WE ARE A SOLUTIONS COMPANY

Every client's requirements are different. And that is why every Lamifil client receives a unique and tailor-made solution, specific to their needs.

From increasing the capacity of conductors to responding to environmental concerns, our overhead conductors improve efficiency and reduce losses, whatever challenges you may face.

We design, develop, manufacture and innovate conductors to your requirements, even developing new alloys when required. Lamifil is able to adapt or produce designs to respond to special conditions such as heavy ice loads, wind, or long river crossings. You will find our solutions always embody excellence, quality and high standards of performance. These are backed by test results from an independent lab ensuring that your conductors meet or surpass your expectations.

Providing turnkey solutions, we source fittings and accessories when required, as well as offering training and on-site supervision during installation to ensure stress-free implementation. Even our packaging, shipping options and logistics are designed to meet your needs and your timetable. Which is exactly what you should expect from a company that draws on 85 years of experience and expertise to offer you excellence in electrical conductors.

We invite you to enter into a partnership with Lamifil.

ARE YOU LOOKING FOR A PARTNER WHO

- > DESIGNS OVERHEAD CONDUCTORS ACCORDING YOUR SPECIAL PROJECT NEEDS?
- > USES INNOVATIVE SOLUTIONS TO INCREASE CAPACITY AND REDUCE LOSSES?
- > OFFERS SOLUTIONS FOR BUDGET LIMITATIONS AND REFURBISHMENT POSSIBILITIES?
- > HAS EXPERTISE WITH ISSUES SUCH AS ICE LOAD, LONG CROSSINGS AND WIND?
- > CAN DEVELOP NEW ALLOYS IN-HOUSE OFFERING GREATER PERFORMANCE?
- > WILL ALWAYS FIND THE BEST SOLUTION FOR YOU?

MARKET TRENDS AND NEEDS

As the global population grows, the demand for electricity also increases. New networks need to be built, and older networks need to be upgraded and improved. At the same time, energy production methods need to limit CO₂ emissions and the networks themselves need to become more efficient. It's a huge challenge. Which is why every element in the transmission network becomes increasingly more important.

INCREASING ENERGY DEMAND

In growing economies, the demand for electricity is increasing rapidly. The need for new infrastructure to supply that electricity is the primary objective. Meanwhile, in mature economies, the need to replace ageing power lines and adapt the existing networks to allow the integration of renewable energy sources is the main priority.

It is estimated that on a global scale, 98% of the transmission growth is for overhead lines, with underground and undersea conductors making up the remainder. This huge need for overhead conductors drives our quest to continually develop better and more efficient conductors for our clients on most continents.

GREENER SOLUTIONS

Increasingly, the objective of power grids is to reduce CO₂ levels. Besides methods of producing energy (which have moved from fossil fuels towards renewable energy), the transmission lines themselves have come to play an important role.

More efficient conductors result in less wasted energy and thus a lower need for energy production. The related saving is also beneficial to network owners and society as a whole. Through design and metallurgy, we use our expertise and experience in aluminium, copper and their alloys to ensure greener solutions are always being developed.

INTEGRATION OF RENEWABLE ENERGY

As we increasingly build more sources of renewable energy, the need to set up a grid network to connect those energy sources will drive the demand for conductors and cables.

With the growth of offshore wind farms requiring high-capacity connectors, many interconnected grids have reached the maximum transmission capacities for which they were designed.

In the future, the need for cross-border bulk power transfers are expected to increase, and therefore the need for high capacity, high efficiency conductors will become ever more important.

MARKET NEEDS

INCREASED CAPACITY

Upgrade the transmission capacity of existing lines by replacing conductors, whilst keeping existing infrastructure.

REDUCE LOSSES

Better designed transmission lines reduce losses and increase efficiency, which contribute to lowering your Total Cost of Ownership.

REDUCE TOTAL PROJECT COSTS

Reduce the number or height of towers in new-build projects with innovative new conductors.

SOLUTIONS FOR SPECIAL CONDITIONS

Tailored designs for heavy ice loads, special wind conditions, long crossings and other particular circumstances.

MORE OPTIMISED PROJECT COSTS

Use new installation methods and reduce installation times.



CONDUCTOR DESIGN

Every project is different, with unique challenges and parameters. After careful examination of these factors, we define and develop the ideal solution for your specific project. The specifications of conductors are determined by **three elements**: the conductive alloy and its production method, the core, and the conductor design.

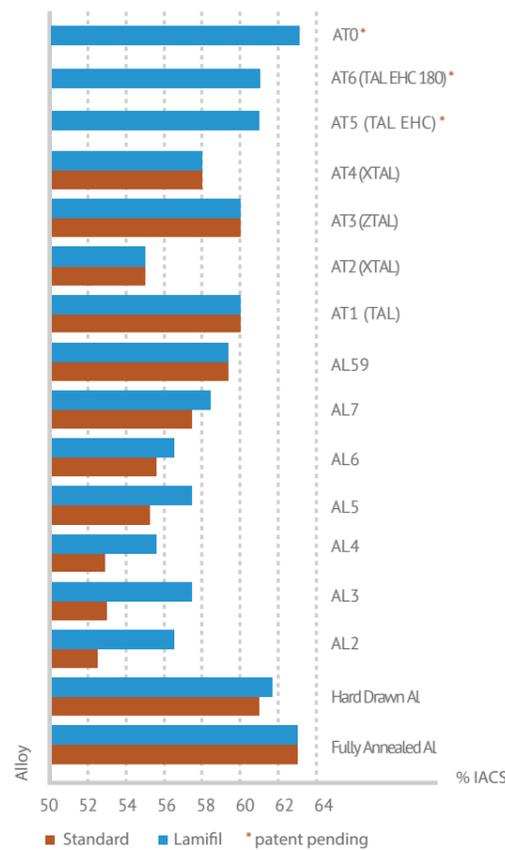


INNOVATIVE ALLOYS AND PRODUCTION METHODS

As one of the world's leading manufacturers of aluminium and aluminium alloy conductors, Lamifil supplies and manufactures a wide range of products to **international standards**. Furthermore, we have used our expertise, experience and production facilities to design alloys that surpass those standards. For example, conductors with **high conductivity alloys** that result in reducing losses by up to almost 9%, compared to standard alloys.

However, our R&D team is always developing **innovative new alloys** that respond to client-specific challenges.

Our three new temperature-resistant AlZr alloys that offer very real advantages compared to the conventional AT1 alloys, were engineered from customer requirements for heavy ice and wind conditions. Allowing increased conductivity, operating at higher temperatures, with less weight and sag, they are both unique solutions for their environment.



PERFORMANCE COMPARISON BETWEEN LAMIFIL ALLOYS AND INTERNATIONAL STANDARDS

CONDUCTOR CORE

To answer various demands regarding sag, density, E-modulus, tensile strength, load carrying capacity, CTE, weight or temperature, we can provide a large range of core solutions like:

- > EHS (Extra High Strength) steel core
- > UHS (Ultra High Strength) steel core
- > MHS (Mega High Strength) steel core
- > Light and low CTE composite core
- > Homogeneous aluminium conductor - No core
- > Hollow conductor

For example, Lamifil replaced an existing steel-core ACSR conductor with an AAAC conductor (All Aluminium Alloy Conductor).

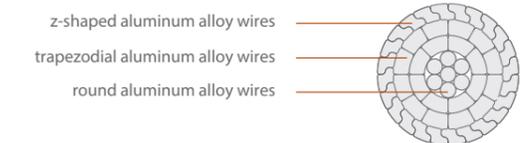
The benefits were truly remarkable: the AAAC conductor is just as strong as the ACSR but is 30% lighter, so no tower reinforcements were required, and has lower resistance.

CONDUCTOR DESIGN

Lamifil can replace traditional round wires with shaped wires such as **Z-shaped wires and trapezoidal wires** to create Smooth Body Conductors with up to 98.5% compaction. This results in either smaller diameter conductors (attractive for conditions with high wind and ice loads), or to achieve greater current carrying capacity with the same diameter. An extra advantage of Z-shaped wires is that in case of conductor breakage, the outer layer wires interlock, preventing the wire from unwinding.

Lamifil can apply **surface treatments** that increase the emissivity of high capacity conductors in order to reduce their temperature and consequently increase their efficiency. Similar treatments have a beneficial effect on the Corona behaviour.

Sag behaviour can be partially influenced by designing the conductor in such a way that the kneepoint is low.

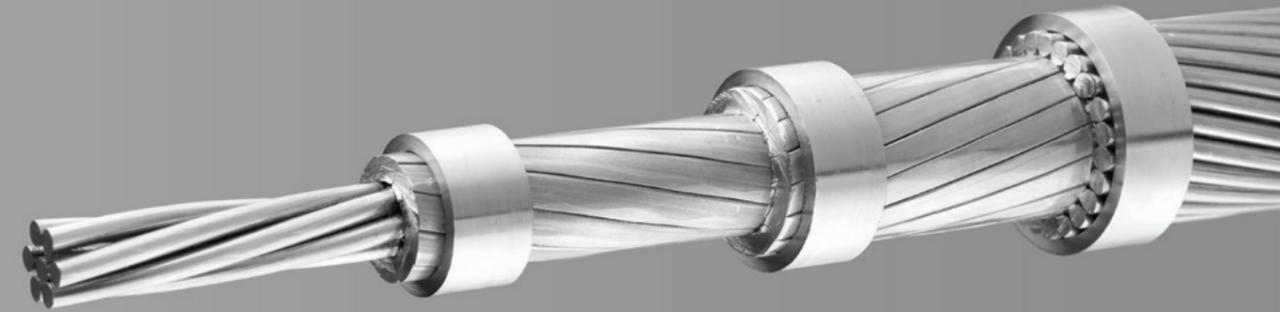


Lamifil designs and manufactures conductors using innovative alloys and the most suitable core to suit your needs”

AAAC UHC

ALL ALUMINIUM ALLOY CONDUCTORS ULTRA HIGH CONDUCTIVITY

AAAC UHC (All Aluminium Alloy Conductor Ultra High Conductivity) conductors are one of the most efficient conductors available in the market today. Lamifil have been developing Ultra High Conductivity alloys for over 10 years and clients favour its superior conductivity, remarkable reduction in energy losses and lower Total Cost of Ownership.



CLIENT ADVANTAGES

⚡ INCREASED CAPACITY

Replacing existing ACSR conductors with AAAC UHC can increase capacity by up to 35% while maintaining the existing infrastructure (no tower modifications are needed) and using the same installation method.

↘ REDUCED LINE LOSSES

AAAC UHC reduces line losses by up to 9% compared to conventional AAAC conductors of the same size and weight. Lower line losses mean that less power generation is required and thus less CO₂ is generated to deliver the same load. This allows grid operators to reduce the Total Cost of Ownership. For a 100 km twin bundle double circuit this could result in a saving of 2.5m Euro per year*

* based on 9% loss reduction and 0.35kg CO₂ per kWh of electricity produced

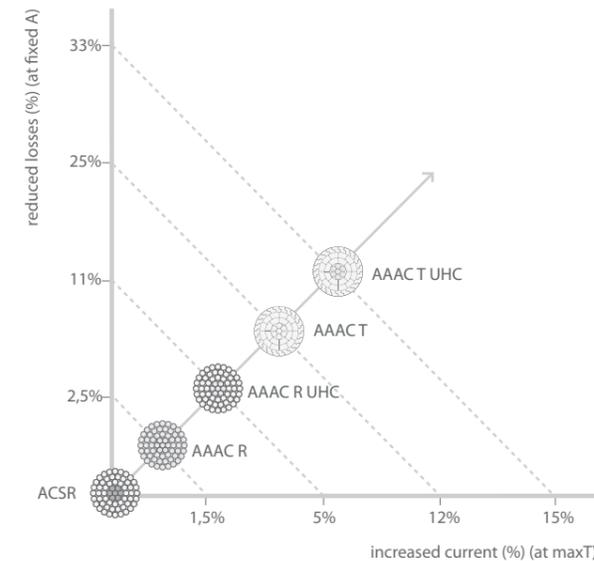
🏗️ REDUCED TOTAL PROJECT COSTS

This conductor is also very well suited to replace most conventional ACSR conductors, particularly those with steel sections below 15%.

Due to higher strength, higher conductivity and lower weight for comparable diameter, initial sag can be reduced, taking full advantage of increased capacity and conductivity.

❄️ SOLUTIONS FOR SPECIAL CONDITIONS

AAAC UHC can be designed using a mix of round and shaped wires. Combining the design with our Ultra High Conductivity alloys results in truly superior conductors, unique in today's market.



EVOLUTION FROM ACSR TO AAAC TO AAAC UHC + BETWEEN EACH CONDUCTOR SHOWS THE INCREASE IN CONDUCTIVITY AND DECREASE IN LOSSES.

REFERENCES

“By replacing about 700 km of existing ACSR Bobolink conductor with AAAC UHC Bobolink conductor, TenneT TSO was able to reduce energy losses by 19%, resulting in an estimated annual saving of 678 000 Euro.”

TenneT TSO, Netherlands
over 1700km AAAC UHC
(installed since 2010)

National grid, UK
over 16.000km AAAC UHC
(installed since 1996)

Elia, Belgium
over 650km AAAC UHC
(installed since 2016)

More references can be found at www.lamifil.be/casestudies

ACCC[®] CONDUCTORS

ALUMINIUM CONDUCTOR COMPOSITE CORE

Built on the highly evolved foundation of aerospace-derived carbon fibre hybrid composites, the ACCC[®] conductor uses a high-strength, light-weight and dimensionally stable single strand composite core. This is stranded with fully annealed trapezoidal-shaped aluminium or aluminium alloy wire. The result? Superior performance and capacity, compared to conventional conductors of the same diameter and weight, whilst being one of the most efficient conductors on the market.



CLIENT ADVANTAGES

⚡ INCREASED CAPACITY

Due to their higher capacity under similar tower loading conditions, ACCC[®] conductors can be used to increase the throughput of existing lines with little or no modification to the structures. In Belgium, 125 km of ACSR 298 was replaced with Lamifil ACCC[®] Lisbon, resulting in an increase in current capacity of 100% (662A to 1380A). By using ACCC[®] conductors, only 5% of the infrastructure had to be modified.

⚡ REDUCED LINE LOSSES

Under equivalent load conditions, ACCC[®] conductors reduce line losses by 30 to 40% compared to conventional steel-reinforced conductors of the same diameter and weight. Furthermore, Lamifil's annealed aluminium alloys improve conductivity and increases overall system efficiency. Lamifil also uniquely produce their ACCC[®] conductors with 0.6 emissivity which reduces overall temperature by 10°C or more.

🏗️ REDUCED TOTAL PROJECT COSTS

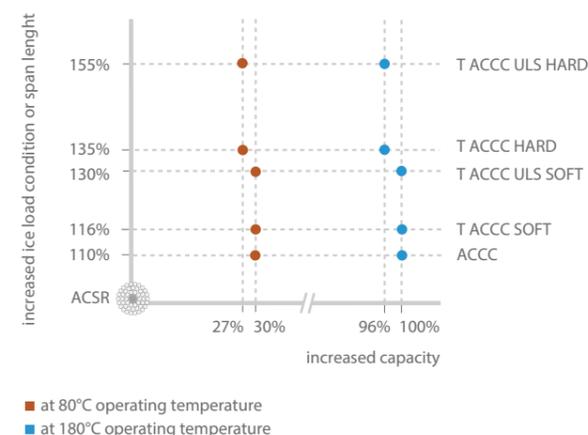
Because ACCC[®] conductors can be strung at relatively higher tensions than conventional conductors, sag can be reduced significantly (even at normal temperatures), making it possible to reduce tower heights, increase spans or reduce magnetic field strengths. This facilitates building permissions, increases efficiency and drastically reduces implementation time and cost.

❄️ SOLUTIONS FOR SPECIAL CONDITIONS

To improve the ACCC[®] performance under high ice loading, an Ultra Low Sag (ULS) core can be employed. High temperature alloys ("Softal"*) have been developed that have a similar effect without influencing the resistance of the conductor. However, the combination of both can bring improvements of up to 25%, whilst all other characteristics of the conductor stay unchanged.

Large crossings are also possible, but are limited by the strength of the largest ULS core diameter. To overcome this, hard heat-resistant alloys can be utilised which can increase the conductor strength by 35%. This comes at the cost of a slightly reduced conductivity and an increased high temperature sag behaviour.

*patent pending



EFFICIENCY AND CURRENT CARRYING CAPACITY FOR DIFFERENT TYPES OF CONDUCTOR OF THE SAME WEIGHT

REFERENCES

"To meet the growing demand for energy, minimise the environmental impact and guarantee network reliability, Elia searched for a cutting-edge solution. ACCC[®] was the answer."

City Power, South Africa
378km ACCC[®] Lisbon (in 2009)

Electricity North West, UK
360km ACCC[®] Helsinki (in 2015)

Elia, Belgium
384km ACCC[®] Antwerp
(between 2014 – 2016)

RWE Group, Germany
110km ACCC[®] various types
(between 2009 to 2013)

More references can be found at www.lamifil.be/casestudies

Do your overhead lines suffer under heavy ice load and severe wind conditions? Ask our advice!

GAP CONDUCTORS

(G(Z)TACSR CONDUCTORS – GAP (SUPER) THERMAL RESISTANT ALUMINIUM CONDUCTOR STEEL REINFORCED

Gap conductors consist of layers of shaped, temperature-resistant Al Zr (Aluminium Zirconium) wires around a very high strength steel core, separated by a gap. This allows the aluminium wires to move freely over the core, giving the conductor its special characteristics, like thermal sag reduction, unique strength characteristics and increased capacity.



CLIENT ADVANTAGES

⚡ INCREASED CAPACITY

GAP conductors are able to carry up to almost twice the current of conventional ACSR conductors under similar tower-loading and sag conditions. For example, upgrading an existing ACSR 500/65 line to a GAP590/45 resulted in a 90% performance improvement at high load, high temperature conditions.

⚡ REDUCED LINE LOSSES

The design of a conductor must always aim for the lowest operating temperature for any given electrical load. To this end, Lamifil have engineered some special developments:

- > Additionally high conductive, high-temperature alloys
- > Mega High Strength (MHS) steel that allows the maximisation of aluminium sections within a given weight
- > Emissivity of the surface of 0.6 or higher from Day 1

The combination of these three elements result in Lamifil GAP conductors that operate up to 15°C lower than other GAP conductors.

🏗️ REDUCED TOTAL PROJECT COSTS

Eliminating the need to change or modify towers is one of the most efficient ways to reduce total project costs. Gap can easily be used in project refurbishments or new builds. By using the new Lamifil installation method for GAP conductors, TSOs can dramatically cut down on cost and installation time.

❄️ SOLUTIONS FOR SPECIAL CONDITIONS

GAP conductors perform particularly well during heavy load conditions, for example when there are low temperatures, high winds, ice and snow. To cover the complete temperature range, Lamifil are also able to offer Mega High strength galvanised steel cores.

Mega High Strength GAP can be the perfect solution for long crossings. Lamifil is known for employing only high quality grease capable of withstanding all the temperature conditions of the conductor, whilst guaranteeing a long-term corrosion protection of the core.

GAP conductors are an excellent and highly durable solution for the most demanding circumstances and severe conditions.

MATTHEW GZTACSR	RTS KN	RESISTANCE OHM/KM	LOSSES @2034A KW KM	WEIGHT KG/KM	TEMPERATURE @2034A °C
Old	178	0,0478	318	2186	170
New	185	0,0448	293	2188	158
	+4%	-7%	-8%	=	-12°C

REFERENCES

“GAP conductors revolutionised High Temperature Low Sag (HTLS) conductors over 40 years ago. The latest generation of GAP conductors are now here, offering radical new improvements.”

National Grid, UK

3669km GAP Matthew (between 2003 and 2015)

Power Grid, India

1053km GZTACSR Gaya (in 2013)

Sikkim, India

227km GZTACSR (in 2013)

More references can be found at www.lamifil.be/casestudies

GAP CONDUCTORS

LAMIFIL'S NEW INSTALLATION TECHNIQUE

Whilst offering many advantages like cost, capacity and reliability, the installation of GAP conductors requires some special skill and more time to install. Lamifil has innovated a new installation method that reduces extra installation time by up to 60%*.

THE INSTALLATION PRINCIPLE

The installation of the GAP conductor was thoroughly simplified while retaining all the properties. The use of semi-tension sets for installation lengths longer than 2km is no longer required. Lengths of up to 4.5km can be installed in one piece.

Also, the labour-intensive unwinding of the conductor wires prior to the mounting of the dead ends is no longer necessary. The use of a number of simple accessories makes the installation process almost as easy as that of an ordinary ACSR.

In exceptional cases, it may be possible for a conductor to be replaced in under 8 hours. In those cases, there are special installation techniques that allow the job to be done within that timeframe.

The special installation technique makes allowances for short term creep, and eliminates any form of compressive stress in the aluminium.

**patent pending*

INSTALLATION AND CONDUCTOR DESIGN FOR ROUGH TERRAINS

In addition to the swiftness of installation, the new technique is especially useful in rough terrain and areas where access to the towers is difficult. Reducing time required at these locations reduces total project costs directly.

During installation in challenging terrain, it can sometimes happen that the surface of the conductor is exposed to unwanted contact with the ground or other objects. If the conductor is designed with soft wires, it could result in damage that then causes Corona problems.

The surface of Lamifil's new generation GAP conductors has the hardness of hard drawn aluminium and is therefore less susceptible to damage than other HTLS conductors that are making use of soft aluminium.

CUSTOMER BENEFITS

- > Reduced extra installation time of up to 60%
- > Reduced installation costs (less access to sites, less accessories, less tools, etc.)
- > Replacement times of less than 8 hours possible
- > Increased installation lengths of up to 4,5 km, depending on project requirements
- > Lamifil training and customised project manual (access, tooling, terrain) on new installation technique
- > Conventional installation equipment is used (aluminium gripping clamps, steel gripping clamps and pulling eyes)

Please feel free to enquire about this new technique. The Lamifil team is always available.



OTHER CONDUCTOR TYPES

CONDUCTORS FOR NORMAL AND ELEVATED OPERATING TEMPERATURES

The product range that Lamifil manufactures covers the entire spectrum of bare conductors used in power grids. In addition to our more advanced designs, Lamifil also offers the full range of quality conventional conductors. Lamifil owes its unique position in the market to the powerful combination of metallurgical expertise and stranding know-how.

OHC – NORMAL OPERATING TEMPERATURES

For use at normal operating temperatures, Lamifil manufactures a range of conventional Overhead Conductors (OHC) of either homogeneous or heterogeneous design:

- > AAC - All Aluminium Conductor
- > AAAC - All Aluminium Alloy Conductor
- > ACSR - Aluminium Conductor Steel Reinforced
- > AACSR - Aluminium Alloy Conductor Steel Reinforced
- > ACAR - Aluminium Conductor Alloy Reinforced

OHC – ELEVATED OPERATING TEMPERATURES

Lamifil has developed a full range of high temperature conductors. In several designs, Aluminium Zirconium (AlZr) is used to allow operating temperatures up to 230°C continuously, or 310°C peak. Other designs use fully annealed aluminium.

TACSR - Thermal Resistant Aluminium Conductor Steel Reinforced.

TACSR Conductors are a first step to upgrading overhead lines where ACSR is installed. Care needs to be taken however with respect to sag due to the thermal expansion of the conductor.

ACSS - Aluminium Conductor Steel Supported

While the aluminium in the conductors above is contributing to the strength of the conductor, ACSS conductors rely on a high strength steel core. To obtain good conductivity, fully annealed, trapezoidal, high-efficiency aluminium wires are stranded around the steel core.

See also previous pages where our more advanced conductors are described in detail.

Lamifil owes its unique position to the powerful combination of metallurgical expertise and stranding know-how.



FLEXIBLE SERVICES

MADE TO MEASURE

As a solutions company, we take pride in helping you define your challenges and then developing a solution that best fits your requirements. From custom design, development, manufacture and testing, to packaging, delivery and training supervision for implementation and maintenance, we ensure that our clients get the highest value.

CUSTOM DESIGN

We use our experience and expertise to tailor conductors to your specific requirements. Guided by our metallurgical knowledge forged over 85 years, as well as our continued investment in the latest technology, we are uniquely positioned to offer the ultimate balance of electrical and mechanical performance for your project.

We even develop new alloys should you require. No matter your challenges, we will take the time to find a solution of excellence!

ACCREDITED LAB

Our ISO 17025-accredited, on-site, independent lab gives us the opportunity not only to ensure the quality of products, but to also pursue new innovations.

- > We perform quality checks on samples at every step during production. This ensures full traceability and materials of the highest standards at all times.
- > The lab is ISO 17025 certified and a whole spectrum of lab testing services can be sourced independently of our production.
- > In addition to our standard Factory Acceptance Testing we could also execute type testing.

HTLS CONDUCTOR FITTINGS

We collaborate with approved suppliers of HTLS (High Temperature Low Sag) conductor fittings. This ensures optimal integration and smooth installation. Furthermore, we have developed new methods and systems to ensure more efficient and faster installation of ACCC® and GAP conductors.

TRAINING AND SUPERVISION

Our commitment doesn't end with delivery of your conductors.

We offer specialised training for installation and maintenance, as well as installation supervision, often called for when installing GAP and ACCC® solutions. We offer sessions in classrooms and on-site. Our engineers advise your line crews during installation and implementation, as well as advise with maintenance.

CUSTOMER FOCUS

Do you consider the way in which a company works, is as important as their top quality products? We do, and that is why Lamifil is built around customer needs. We have decades of experience in project work, from small and medium sized projects to participating in global turnkey projects.

Our employees are multilingual, to aid communication, and work in a structured manner with our in-house logistics department so that we can fulfill the most demanding needs. We can also be entrusted with Just In Time schedules, and to deliver in the most challenging of locations.

With the port of Antwerp around the corner, a whole range of shipment possibilities are available, along with our comprehensive packaging methods to further accommodate your requirements.

Of course we also offer full technical support at all stages of your project.



Certificatenr.
494-TEST





LAMIFIL



Lamifil is one of the world's leading manufacturers of overhead conductors, catenary cables, wires and wire-based products of quality in copper and aluminium and their alloys, delivering the highest value to clients.

Combining over 85 years of experience and expertise, Lamifil innovates, designs and manufactures cable and wire products for the railway and power distribution industry, as well as speciality wires for the automotive, aviation and aerospace and steel industry, and a diverse range of consumer goods.

Lamifil has the capabilities to tailor-make new alloys and products specific to every client need, each carefully tested in our ISO accredited lab, and is regarded as a reliable service partner by the industries we work with in all six continents.

Based in Hemiksem, Belgium, in close proximity of the port of Antwerp, we are passionately driven by excellence through expertise and experience.

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