住友電工

Low Electrical Power Loss Type Conductor

LL-(T)ACSR/AS

Low Loss type Aluminum (Thermal-Resistant Aluminum Alloy) Conductor,
Aluminum-Clad Steel Reinforced

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Nowadays climate change and global warming pose serious threats to our planet and to the quality of life of next generations. It is imperative to limit the emission in the atmosphere of greenhouse gases (e.g. CO_2, CH_4, N_2O) by reducing fossil fuels power generation. Our Low Electrical Power Loss Type conductor (hereinafter called "Low Loss conductor") can reduce transmission losses by roughly 25%. Transmission lines adopting our Low Loss conductor can operate more efficiently, reducing the need of electricity from fossil power stations. These latter can then reduce their energy generation and the related cost, as well as CO_2 emission.

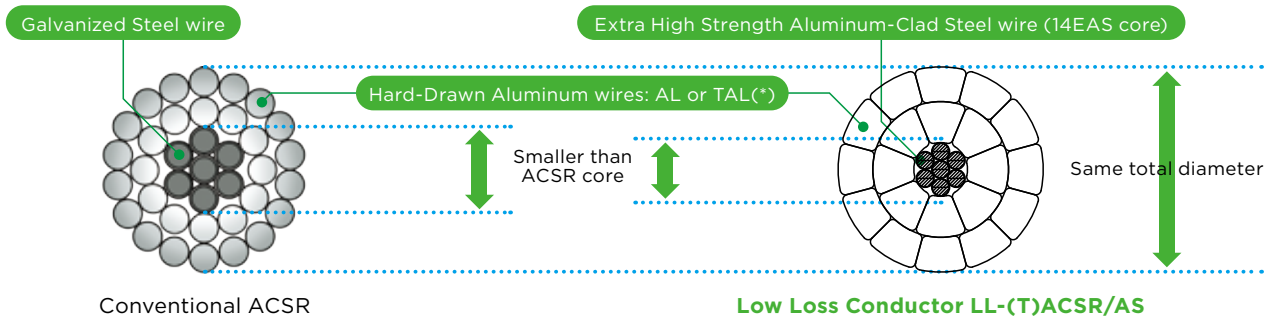
Clear Advantages

- Reduction of line transmission losses **in the range of 10 ~ 25 %**
- Almost the **same tower loading** as conventional ACSR **(same diameter, same tensile strength)**
- Better **corrosion resistance** than conventional ACSR due to Aluminum-Clad Steel (AS) core
- **Same installation and maintenance procedure** as conventional ACSR
- The higher current capacity, thanks to TAL(*), allows an easy implementation of **N-1 system protection**

Technical Construction

The basic design concept of our Low Loss conductor is **"keeping the same diameter and the same rated tensile strength as ACSR, while simultaneously having a DC resistance lower than ACSR"**. To have lower DC resistance, our Low Loss conductor apply Trapezoidal shaped wires in its conductive layers, as well as Extra-high Strength Aluminum-Clad Steel wire (14EAS) in the conductor core.

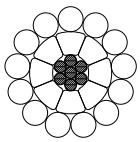
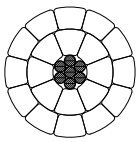
■ Adoption of Trapezoidal shaped wires instead of Round wires:
increase the AL area while maintaining the total diameter of conductor same as conventional ACSR.
■ Adoption of 14EAS (tensile strength: 1770 MPa) instead of normal Galvanized Steel wires (1290-1340 MPa)
decrease core area while maintaining its mechanical strength same as conventional ACSR.



(*): TAL stands for Thermal-resistant Aluminum alloy with maximum allowable operational temperature of 150 °C

Design Type

Low Loss conductor can have two design types, depending on the purpose or specific project requirements.

Type 1	Type 2
Use AL(TAL) round and trapezoidal shaped wires:  ■ **Same diameter** ■ **Same weight** No tower load increase	All aluminum wires are trapezoidal shaped wires:  ■ **Same diameter** ■ **Have maximum aluminum area** Achieve highest power saving
■ Reduce power loss by **roughly 10~15%** ■ No sag increase ■ No need to reinforce nor to modify the existing towers Recommended for re-conductoring of existing lines, or for new lines construction	■ Reduce power loss by **roughly 20~25%** ■ Slight sag increase (because of slight weight increase) ■ Tower reinforcement or modification may be necessary Recommended for construction of new lines

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e Aluminum (Thermal-Resistant Aluminum Alloy) Conductor, Aluminum-Clad Steel Reinforced

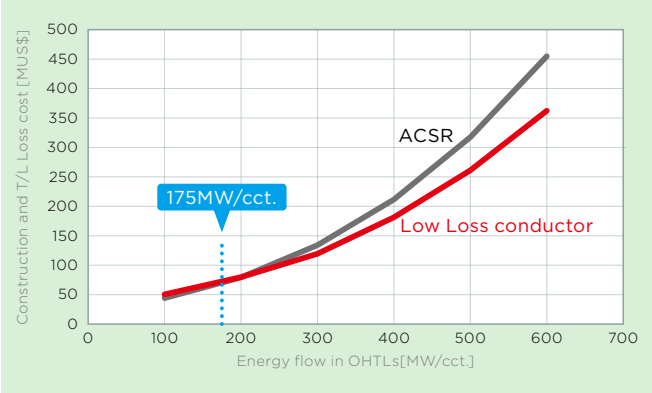
Economic comparison

Conditions of the comparison:

- Line Voltage: 275 kV
- Numbers of circuit: 2
- Bundle: twin conductors/phase
- Power factor: 0.9
- Route length: 100 km
- Load factor: 0.5
- Generation cost: 0.07 USD/kWh

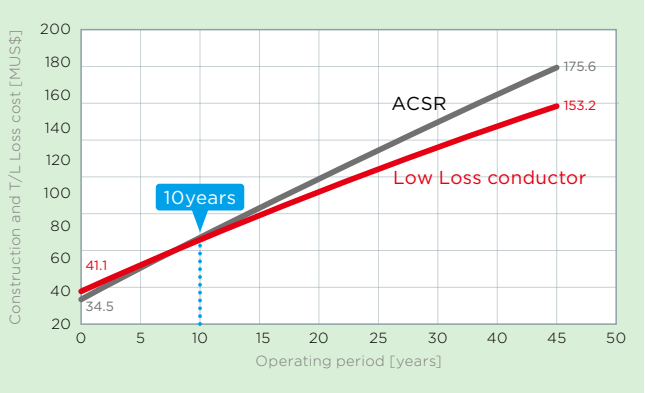
Low Loss conductor price is higher than that of ACSR having the same diameter, due to larger aluminum cross section...

...but this initial cost difference is largely compensated by the significantly lower operational cost of the transmission line!



Cost Comparison for 40 years operation

In case of energy flow in OHTLs of **only 175 MW/cct.,** the Low Loss conductor recovers the higher initial cost in 40 years, which is the usual lifetime of OHTLs.
Larger energy flow in OHTLs (higher than 175 MW/cct.) give to Low Loss conductor an even bigger economic advantage.



Cost Comparison for 350 MW/cct. operation

Low Loss conductor can recover the difference of initial cost in only 10 years if energy flow in OHTLs is 350MW/cct. (in the above conditions).
In case the energy flow in OHTLs is bigger than 350MW/cct., our Low Loss conductor provides an even bigger advantage, because the break-even is reached in a period shorter than 10 years.

Load needed (as % of maximum load of the line) to reach Break-Even

kV	in 40 years	in 20 years	in 10 years	Assumed conductor
110 – 132	31%	43%	60%	ACSR Hawk x 1
220 – 275	32%	45%	62%	ACSR Drake x 2
400 – 500	32%	46%	65%	ACSR Drake x 4

Conditions of the calculation:

- Power factor: 0.9
- Load factor: 0.5
- Generation cost: 0.07 USD/kWh
- Low Loss conductor: Type 2
- Maximum load:
  Based on current capacity of ACSR at 75°C

Accessories

Design concepts and materials used in compression joints for Low Loss conductors are the same as those for ACSR, except for Low Loss conductor with TAL (Thermal-Resistant Aluminum Alloy). Compression joints for LL conductors using TAL need larger and longer aluminum body than those for conventional ACSR in order to maintain the same current density and to achieve better heat radiation. All other accessories are basically the same as accessories for conventional ACSR.

Installation & Maintenance

Installation and maintenance procedure of our Low Loss conductor is exactly the same as that of conventional ACSR conductor.

Extra High Strength Aluminum-Clad Steel (14EAS)

14EAS is Aluminum-Clad Steel with 14 %IACS conductivity having a tensile strength which is roughly 30 % higher than conventional ACS and standard galvanized steel.
14EAS significantly improves the corrosion resistance of our Low Loss conductor.

	Tensile strength (MPa)	Conductivity (%IACS)	Density (g/cm^3)	Modulus of elasticity (GPa)
14EAS	1770	14	7.14	170.1
Standard ACS (20SA)	1340	20	6.59	162
Galvanized steel	1290	–	7.78	205.9

Design Examples

Some design examples of possible Low Loss conductors are shown in table below. Other custom-made designs are available for specific projects, upon request from our customers.

Equivalent conventional ACSR			Hawk		Grosbeak		Drake		Curlew	
Type of design			Type 1	Type 2	Type 1	Type 2	Type 1	Type 2	Type 1	Type 2
Size		mm^2	270/30	320	360/40	420	460/48	530	580/53	680
Stranding	Aluminum	No./mm	15/3.65 +8/TW*1	12/TW*1 +8/TW*1	15/4.2 +8/TW*1	12/TW*1 +8/TW*1	16/4.45 +8/TW*1	12/TW*1 +8/TW*1	13/5.95 +8/TW*1	16/TW*1 +12/TW*1 +8/TW*1
	14EAS		7/2.35	7/2.2	7/2.7	7/2.5	7/2.95	7/2.8	7/3.1	7/2.8
Rated tensile strength		kN	87.8	86.8	115.8	113.5	142.5	142.1	165.4	165.9
Diameter	Conductor	mm	21.78	21.78	25.15	25.15	28.13	28.13	31.6	31.6
	14EAS		7.05	6.6	8.1	7.5	8.85	8.4	9.3	8.4
Cross sectional area	Aluminum	mm^2	273.6	315.0	364.9	420.5	461.7	525.2	579.4	677.9
	14EAS		30.36	26.61	40.08	34.36	47.85	43.11	52.84	43.11
	Total		304.0	341.6	405.0	454.9	509.6	568.3	632.2	721.0
Weight		kg/km	972	1065	1294	1413	1617	1765	1977	2189
D.C.Resistance at 20°C		Ω/km	0.1028 (0.1044)*2	0.0905 (0.0918)*2	0.0772 [0.0783)*2	0.0676 (0.0687)*2	0.0609 (0.0621)*2	0.0543 (0.0553)*2	0.0488 (0.0496)*2	0.0422 (0.0430)*2
Current carrying capacity*3	at 90°C	A	631	673	723	806	874	924	1004	1059
	at 150°C		(938)*2	(1000)*2	(1074)*2	(1206)*2	(1311)*2	(1388)*2	(1517)*2	(1595)*2
Modulus of elasticity		GPa	72.6	70.2	72.5	70.0	72.0	70.0	70.9	68.3
Coefficient of linear expansion		10^{-6}/°C	20.4	20.9	20.4	21.0	20.6	21.0	20.8	21.4

Notes
*1: TW stands for Trapezoidal shaped Wires.
*2: Values in brackets are DC resistance and Current Carrying Capacity of Low Loss conductor with TAL (Thermal resistant aluminum alloy).
Low Loss conductor will have high current carrying capacity (approx. twice of ACSR having same diameter), by means of adopting TAL.
*3: Current Capacity calculation conditions: Ambient Temperature: 40 °C ; Wind: 0.5 m/s ; Wind direction: 45 degrees
Solar radiation: 0.1 W/cm^2 ; Absorptivity & Emissivity of conductor surface: 0.5

Supply record

Our Low Loss conductor was developed more than 30 years ago and so far we have supplied more than 15,700km (as of September 2017) in many projects around the world, in very different climatic conditions.

SUMITOMO ELECTRIC

SUMITOMO ELECTRIC INDUSTRIES, LTD.
Head Office (Tokyo)
Akasaka Center Building, 1-3-13, Motoakasaka, Minato-ku, Tokyo
107-8468, Japan
Phone: +81-3-6406-2792, Fax: +81-3-6406-4044

Overhead Transmission Line Department
4-10-1, Kawajiri-cho, Hitachi-shi, Ibaraki, 319-1411, Japan
Phone: +81-294-42-0817, Fax: +81-294-42-8456

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