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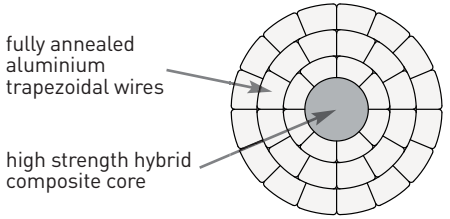
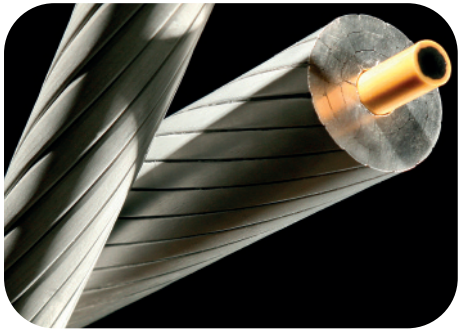
# ACCC® conductors

## The technology

Built on the highly evolved foundation of aerospace derived carbon fibre hybrid composites, the ACCC® conductor utilizes a high strength, light weight and dimensionally stable single strand composite core that is stranded with trapezoidal shaped aluminium wire. ACCC® conductor offers superior performance and capacity compared to conventional conductors of the same diameter and weight.

The production of ACCC® conductor's composite core has been ISO certified since November of 2006 and is currently certified to ISO 9001:2008 standards. ACCC® conductor, ACCC® core, and associated hardware produced by CTC Cable Corporation and its authorized licensees are protected by patents and pending patent applications in over 70 countries throughout the world.



## ACCC® conductor advantages

■ **Increase line capacity**
ACCC® conductor can carry up to twice the current of conventional steel-reinforced conductors due to its high temperature capability.

■ **Mitigate thermal sag**
ACCC® conductor's carbon composite core has a much lower coefficient of thermal expansion compared to steel, aluminium, or other core materials.

■ **Reduce line losses**
Under equivalent load conditions, ACCC® conductor reduces line losses by 30 to 40% compared to steel-reinforced conductors of the same diameter and weight.

■ **Improve system efficiency**
ACCC® conductor's additional annealed aluminium content improves conductivity and reduces line losses, which can improve overall system efficiency.

■ **Decrease project costs**
ACCC® conductor can reduce the cost of upgrading existing lines or new corridors due to its greater strength, reduced sag, and increased capacity.

■ **Reduce generation requirements, conserve fuel & reduce emissions**
ACCC® conductor's ability to reduce line losses can provide significant reductions in fuel consumption and their associated emissions for fossil fuel sources or improve the overall efficiency and economic performance of renewable resources. Increased power delivery can also reduce the demand for new sources of energy.

■ **Reduce electro magnetic field level**
ACCC® conductor's smaller thermal elongation coefficient may result in a reduction of the magnetic field under the line due to its maintaining greater clearance distance at the same current level.

## ACCC® conductor applications

■ **Upgrade the capacity of existing lines**
ACCC® conductors can be used to increase the throughput of existing lines with little or no modifications to the structures due to its greater capacity under similar tower loading conditions.

■ **Improve the performance and economics of new lines**
ACCC® conductor's greater strength, improved sag characteristics, and higher electrical capacity can improve the performance and reduce the costs of new transmission and distribution lines by delivering more power with less losses and reducing structural costs. ACCC® conductor can be installed without special equipment or tools and with minimal training.

■ **Accommodate long spans and river crossings**
ACCC® conductor can accommodate long spans and river crossings due to its higher strength, greater thermal stability, and improved self-damping characteristics.

■ **Connect renewable resources more efficiently**
ACCC® conductor can be used to connect renewable resources more efficiently by reducing structural costs through increased spans, while also delivering more power by reducing line losses, which can improve initial and overall project economics.

■ **Reduce maintenance costs and improve longevity**
ACCC® conductor's non-corrosive composite core resists environmental degradation and can also reduce costs associated with vegetation maintenance due to its reduced sag; and under severe weather conditions, such as ice and wind load events resists failure due to its greater strength.

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# ACCC® conductors

## Technical summary

| | | ACCC Helsinki 160 | ACCC Copenhagen 230 | ACCC Reykjavik 235 | ACCC Monte Carlo 240 | ACCC Glasgow 245 | ACCC Casablanca 285 | ACCC Lisbon 325 | ACCC Oslo 325 | ACCC Amsterdam 380 | ACCC Brussels 430 | ACCC Stockholm 470 | ACCC Stockholm 3L 470 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nominal aluminium equivalent area** | $mm^2$ | 158,8 | 230,4 | 233,8 | 241,7 | 247,8 | 285,9 | 329,2 | 328,2 | 383,7 | 439,4 | 482,7 | 476,1 |
| **Nominal cross sectional area of aluminium** | $mm^2$ | 153,7 | 223,0 | 226,2 | 233,9 | 239,8 | 276,7 | 318,6 | 317,7 | 371,3 | 425,3 | 467,2 | 460,7 |
| **Number of aluminium wires** | # | 16 | 16 | 16 | 28 | 16 | 16 | 16 | 20 | 20 | 20 | 20 | 36 |
| **Equivalent diameter of trapezoidal aluminium wires** | mm | 3,50 | 4,21 | 4,24 | 3,26 | 4,37 | 4,69 | 5,04 | 4,50 | 4,86 | 5,20 | 5,45 | 4,03 |
| **Minimum filling factor of the aluminium cross section** | % | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 |
| **Overall diameter** | mm | 15,65 | 18,29 | 18,82 | 20,79 | 19,53 | 20,50 | 21,80 | 22,40 | 23,55 | 25,14 | 26,40 | 26,40 |
| **Diameter of core** | mm | 5,97 | 5,97 | 7,11 | 10,54 | 7,75 | 7,11 | 7,11 | 8,76 | 7,75 | 8,13 | 8,76 | 8,76 |
| **Rated tensile strength of conductor*** | kN | 69,0 | 72,9 | 98,5 | 201,5 | 115,2 | 101,3 | 103,7 | 148,0 | 122,6 | 135,4 | 156,4 | 156,1 |
| **Extreme load safety strength of conductor**** | kN | 64,0 | 65,6 | 91,0 | 193,8 | 107,3 | 92,2 | 93,2 | 137,6 | 110,4 | 121,9 | 141,1 | 141,0 |
| **Nominal mass per unit length - total** | g/m | 479,7 | 669,7 | 702,4 | 813,9 | 749,8 | 842,7 | 956,6 | 991,5 | 1112,5 | 1275,3 | 1405,5 | 1387,3 |
| **Nominal mass per unit length - aluminium** | g/m | 425,7 | 615,7 | 626,4 | 649,9 | 663,4 | 766,6 | 880,5 | 878,5 | 1026,1 | 1177,4 | 1292,4 | 1274,2 |
| **Nominal mass per unit length - core** | g/m | 54 | 54 | 76 | 164 | 86 | 76 | 76 | 113 | 86 | 98 | 113 | 113 |
| **Coefficient of linear expansion above thermal kneepoint** | $10^{-6}\ K^{-1}$ | 1,61 | 1,61 | 1,61 | 1,61 | 1,61 | 1,61 | 1,61 | 1,45 | 1,61 | 1,61 | 1,45 | 1,45 |
| **Coefficient of linear expansion below thermal kneepoint** | $10^{-6}\ K^{-1}$ | 17,3 | 18,7 | 17,5 | 13,9 | 17,0 | 18,3 | 18,8 | 17,0 | 18,7 | 18,8 | 18,5 | 18,4 |
| **Modulus of elasticity of the core** | GPa | 112,3 | 112,3 | 112,3 | 112,3 | 112,3 | 112,3 | 112,3 | 116,0 | 112,3 | 112,3 | 116,0 | 116,0 |
| **Modulus of elasticity below thermal kneepoint** | GPa | 65,1 | 62,9 | 64,9 | 71,6 | 65,7 | 63,5 | 62,8 | 66,1 | 62,9 | 62,6 | 63,4 | 63,4 |
| **Nominal DC resistance at 20 °C (nominal)** | Ohm/km | 0,1824 | 0,1254 | 0,1236 | 0,1202 | 0,1169 | 0,1013 | 0,0878 | 0,0882 | 0,0754 | 0,0659 | 0,0600 | 0,0608 |
| **DC current rating at 175 °C*** ** | A | 813 | 1024 | 1039 | 1085 | 1081 | 1177 | 1286 | 1294 | 1420 | 1546 | 1645 | 1633 |

Standard applied for conductor manufacturer: EN50182

Maximum allowable continuous operating temperature (surface) 175 °C

Maximum allowable continuous operating temperature (core) 180 °C

* RTS as per ASTM B 857 - ASTM calculates aluminium strength at 96% of the minimum Tensile Strength of the aluminium wire

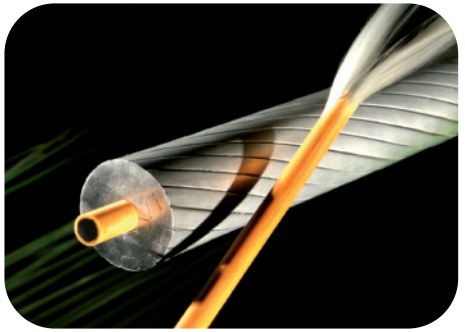
** With 40% of the aluminium strength this safety strength is recommended where sustained loads of over 80% of the RTS are expected for prolonged periods. For further information, please see the ACCC Conductor Technical Note TN-750-001.

*** At maximum continous surface operating temperature (calculated with nominal DC resistance at 20 °C). Conditions: Wind: 0,6m/s; emissivity=abs.Coef.=0,5; sun radiation: 1000W/$m^2$; Ambient temperature: 25 °C

For long spans and river crossings, a range of specific ACCC® designs has been developed.

# ACCC® conductors

| ACCC Warsaw 530 | ACCC Dublin 540 | ACCC Hamburg 570 | ACCC Milan 590 | ACCC Rome 610 | ACCC Vienna 650 | ACCC Budapest 690 | ACCC Prague 710 | ACCC Munich 760 | ACCC London 780 | ACCC Paris 840 | ACCC Antwerp 970 | ACCC Madrid 1050 | ACCC Berlin 1050 | ACCC Athens 1470 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 531,7 | 546,4 | 571,8 | 593,8 | 619,5 | 657,4 | 697,8 | 720,9 | 772,3 | 791,5 | 848,0 | 983,6 | 1057,7 | 1049,3 | 1470,3 |
| 514,5 | 528,8 | 553,4 | 574,7 | 599,5 | 636,2 | 675,3 | 697,7 | 747,3 | 766,0 | 820,7 | 951,9 | 1023,6 | 1015,5 | 1423,0 |
| 36 | 22 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 54 | 46 | 68 |
| 4,27 | 5,53 | 4,42 | 4,51 | 4,60 | 4,74 | 4,89 | 4,97 | 5,12 | 5,20 | 5,39 | 5,80 | 4,91 | 5,30 | 5,16 |
| 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 |
| 27,72 | 28,15 | 28,62 | 29,10 | 29,89 | 30,42 | 31,50 | 31,77 | 32,85 | 33,40 | 34,17 | 36,85 | 38,20 | 38,20 | 44,75 |
| 8,76 | 9,53 | 8,76 | 8,76 | 9,53 | 8,76 | 9,53 | 8,76 | 9,53 | 9,78 | 8,76 | 9,78 | 9,78 | 10,54 | 10,54 |
| 159,1 | 183,5 | 161,3 | 162,5 | 187,5 | 165,9 | 191,8 | 169,4 | 195,8 | 205,2 | 176,3 | 215,6 | 219,7 | 245,5 | 268,4 |
| 142,2 | 166,2 | 143,1 | 143,6 | 167,8 | 145,1 | 169,6 | 146,5 | 171,3 | 180,0 | 149,4 | 184,4 | 186,1 | 212,1 | 221,7 |
| 1538,8 | 1594,8 | 1646,3 | 1705,1 | 1793,1 | 1871,7 | 2002,7 | 2049,7 | 2209,2 | 2267,3 | 2385,3 | 2778,9 | 2976,4 | 2973,7 | 4102,1 |
| 1425,7 | 1463,0 | 1533,2 | 1592,0 | 1661,3 | 1758,6 | 1870,9 | 1936,6 | 2077,4 | 2124,3 | 2272,2 | 2635,9 | 2833,5 | 2809,7 | 3938,1 |
| 113 | 132 | 113 | 113 | 132 | 113 | 132 | 113 | 132 | 143 | 113 | 143 | 143 | 164 | 164 |
| 1,45 | 1,61 | 1,45 | 1,45 | 1,61 | 1,45 | 2,00 | 1,45 | 1,61 | 1,61 | 1,45 | 1,61 | 1,61 | 1,61 | 1,61 |
| 18,8 | 18,5 | 19,1 | 19,2 | 18,9 | 19,5 | 19,0 | 19,7 | 19,6 | 19,5 | 20,2 | 20,1 | 20,3 | 19,9 | 20,7 |
| 116,0 | 112,3 | 116,0 | 116,0 | 112,3 | 116,0 | 112,3 | 116,0 | 112,3 | 112,3 | 116,0 | 112,3 | 112,3 | 112,3 | 112,3 |
| 62,7 | 63,2 | 62,3 | 62,1 | 62,4 | 61,7 | 61,8 | 61,1 | 61,2 | 61,5 | 60,6 | 60,6 | 60,4 | 61,0 | 59,8 |
| 0,0545 | 0,0530 | 0,0507 | 0,0488 | 0,0468 | 0,0440 | 0,0416 | 0,0403 | 0,0376 | 0,0366 | 0,0342 | 0,0295 | 0,0274 | 0,0276 | 0,0197 |
| 1749 | 1783 | 1831 | 1875 | 1930 | 2001 | 2081 | 2118 | 2214 | 2255 | 2351 | 2589 | 2716 | 2679 | 3360 |



# ACCC® case study

**Increasing capacity by reconductoring with ACCC® conductor challenge:**
Increase the capacity of an existing 138 kV 65 km line passing through mountainous terrain.

| | Existing Conductor **ACSR 477 Hawk** | Proposed Conductor **ACSR 795 Drake** | **Selected Conductor ACCC® 325 Lisbon** |
|---|---|---|---|
| Weight (kg/km) | 976 | 1627 | 957 |
| Max Current (A) | 717 | 987 | 1188 |
| Conductor Cost (approximate) | | EUR 2,200,000 | EUR 3,000,000 |
| Assumptions regarding structural modifications | | 70% replaced<br>30% modified | 5% modified |
| Structural Modification Costs | | EUR 9,660,000<br>EUR 414,000 | EUR 69,000 |
| Total Project Cost | | EUR 12,274,000 | EUR 3,069,000 |

**Total project savings (not including stringing costs) EUR 9,205,000**

Structural Cost Assumptions:
92 structures, structure replacement cost EUR 150K, structure modification cost EUR 15K (labour included).

# Industry acceptance and independent conductor/hardware testing

ACCC® conductor has been installed in the US, China, Europe, South America, and Mexico in many different, environmentally sensitive, challenging, and extreme conditions. As of June 30, 2010, over 9,300 kilometers of ACCC® conductor are currently ordered or in service at over 140 sites installed using over 15,000 specially designed patented dead-ends and splices. ACCC® conductor has survived heavy ice, wind, cyclic thermal, and documented storm and typhoon conditions when other adjacent lines have failed. Thousands of production tests and hundreds of lab tests, including detailed test programs by independent test labs and utility grid operators, have confirmed ACCC® conductor's improved performance and longevity attributes. A substantial volume of data retrieved from lines being monitored worldwide has also proven that ACCC® conductor outperforms the competition.

If increasing line capacity, improving system efficiency, reducing emissions, or reducing overall project costs are challenges you face, we can help you find an optimized conductor for your next project. Whether it's a reconductor, new line, or other challenging project, you must explore how ACCC® conductor can help your organization meet its strategic objectives and improve efficiency and grid security.

ACCC® conductor datasheets and our other brochures can be downloaded from our website. Lamifil nv is one of a small number of producers of ACCC® conductor under license of CTC Cable Corp.

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