PRESS RELEASE

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DIBORIDE CONDUCTORS in new BRITISH FAULT CURRENT LIMITER PROJECT

Following the successful conclusion of a £1m, three and a half year research project, Rolls Royce plc have asked Diboride Conductors to provide expertise and superconducting wire for a new £2.5m programme to produce a prototype machine.

The global market for Fault Current Limiters (FCLs) may be worth up to €3billion ($5b) per year according to some in the industry.

Fault Current Limiters are a new type of device that instantly cuts very high electrical currents caused by accidents or faults. Since all grid-connected equipment has to be scaled to handle such currents, being able to reduce fault levels means that smaller and more efficient transformers and switchgear can be employed. The capital savings may be between 5x and 10x the cost of the FCL for some applications.

Grid blackouts in Europe in 2005, and in the USA in 2003 (which affected 50m people), are partly a result of 30 years of underinvestment in electricity grid infrastructure. This is now being addressed, and several hundred billion dollars is expected to be spent on electrical switchgear and transformer upgrades in developed economies over the next 20 years; and a similar amount on new infrastructure in the developing world.

The new £2.5m FCL and intelligent grid management project is lead by Rolls Royce Electrical Systems and Strategic Research Centre, with the finished machine expected to be installed at Scottish Power's test facility; the project involves Diboride Conductors, the University of Manchester, Strathclyde University, Hyper Tech Research (Ohio) and Scientific Magnetics (Oxford). The machine will be a 3-phase FCL using magnesium diboride superconductor and operating at distribution grid voltages.

The successful £1m project which finished earlier in 2007 developed a single-phase 220V/1kA FCL using an innovative solid-state and cryocooler cooling system, operating at 24-30K. It validated current sharing between parallel superconducting wires during FCL operation, and showed that high resistance monocore diboride wire was superior to heavily-stabilised multi-filament magnet wire for FCL operation at the first peak. The simplicity and stability of the system showed that the base technology is capable of supporting a number of different FCL designs with different operational characteristics for different markets and applications.

Philip Sargent (managing director of Diboride Conductors) said, "We are extremely pleased to be participating in this important project. Our company is particularly focussed on providing high-resistance wire specifically for fault current limiters (FCLs) and current leads. It is a great pleasure to see our expertise in FCLs recognised in this way."

About Fault Current Limiters

Superconducting fault current limiters have been researched in laboratories for over 30 years, with a surge in interest when the oxide superconductors were discovered in the late 1980s. However, it is only with the discovery of Mg2 in 2001 that affordable FCLs have become practical. Because of the very great commercial leverage of an FCL in an electrical grid, even the expensive oxide ceramics are being developed for FCLs; but while they are perhaps an improvement on not having an FCL at all, they are expected to be significantly more expensive than an MgB_2 FCL, especially at transmission voltages (132kV and more) where substantial quantities of superconducting material are required.

The simplest FCL design is the most reliable: the resistive FCL. This is also the type for which MgB_2 is a natural fit. The machine consists of a length of superconducting wire inside a refrigerated container through which the 50Hz or 60Hz alternating current passes. A refrigeration system keeps it cool and the power required for this is minimal. When there is a fault, the high current immediately and automatically forces the superconductor into its normal resistive state within microseconds. No relays or electronics is required: it is an intrinsic physical property of the superconductor. Because the wire is quite long, it now has a resistance, typically designed to be between one and ten Ohms and of a similar order to the impedance of the rest of the power system. This limits the current before it reaches dangerous levels.

Depending on the detailed design of the FCL, it may limit the current to between a tenth of the ordinary level of operation, or up to double or triple the ordinary level so that older equipment can recognise that a fault has occurred and take appropriate action. A tenth of a second later, cheap slow-acting circuit breakers may isolate the fault by breaking the circuit, or, with some designs of resistive FCL, if the fault current has dropped back to pre-fault levels, the FCL may recover and superconduct again with no control input or additional equipment needed whatsoever.

A superconducting FCL is a very simple, reliable and failsafe device. If the cooling system fails, it warms up and cuts the power. In ordinary operation, it has near-zero resistance so little power is lost. Because it relies on the intrinsic physics of solid wire, it has many fewer failure modes than complex electronic control systems using power transistors. A resistive FCL is also faster and less dangerous than a pyrotechnic fuse.

The most immediate value of an FCL is in medium voltage (3kV – 15kV) distribution systems where they can extend the life of existing transformers. Transformers are designed to operate for short periods at 110% of their rated power, but a few hours of this reduces their life equivalent to years of normal use. Installing an FCL allows the deferral of a transformer replacement, and then the FCL – a relatively small device – can be moved elsewhere to delay the replacement of another transformer. The return on investment on the FCL is substantial.

The greatest value of an FCL is that the systems designer now has the freedom to design the network optimally for ordinary operation, without having to worry about the separate issue of fault current control. This extra design flexibility is difficult to value, but is generally thought to be as valuable as all the other benefits of FCLs added together.

About Superconductivity

Superconducting materials carry direct current electricity without resistance: without heating up and wasting power. The first superconductors were discovered in 1911, but it was only in the early 1980s that they emerged from laboratories in the form of hospital MRI (magnetic resonance imaging) machines. A patient in an MRI machine lies inside a cylindrical superconducting magnet made of niobium alloy wire cooled in liquid helium 4 degrees above absolute zero.

In the mid 1980s, a new class of materials were discovered in Zurich which superconduct at much higher temperatures, though still cold: the temperature of liquid air (77K) and nearly that of liquid natural gas (LNG: 112 K). In their normal (non-superconducting state), these materials are insulating oxide ceramics and have not been widely used industrially because of their prohibitive expense. They are known as HTS (high temperature superconductors).

In 2001, magnesium diboride (MgB_2) was discovered to superconduct at an intermediate temperature, up to 40K. Unlike the oxide ceramics, it is a resistive electrical conductor in its normal state, which makes it much better suited to make FCLs (fault current limiters). Magnesium diboride (MgB_2) is also significantly cheaper than the oxide materials, and the equipment needed to make it into wire is very significantly cheaper: between a twentieth and a fiftieth of the capital cost of a contemporary HTS plant.

NOTES TO EDITORS

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Diboride Conductors Limited
Diboride Conductors is a privately funded company founded in September 2001 to develop products using the new superconducting material magnesium diboride (MgB_2) which was discovered by Japanese researchers in January 2001. Diboride Conductors Limited is based in the centre of the city of Cambridge in England.

Logos and images can be downloaded at
www.diboride.biz/images/DiborideLogos.zip (228kB).

Dr. Philip Sargent
Philip Sargent PhD CDipAF MIM MBCS CEng, is the Managing Director of Diboride Conductors Ltd. Originally a metallurgist and materials engineer, Philip Sargent has been instrumental in the growth of several Cambridge high-technology companies and start-ups.. Sargent has a PhD in ceramic plasticity from Cambridge University Materials Science Department. He is a former Royal Society Research Fellow has been a Visitor at the UK national Interdisciplinary Research Centre (IRC) in Superconductivity at the Cavendish Laboratory in Cambridge.

A photograph of Dr. Sargent can be downloaded at www.diboride.biz/images/DiborideLogos.zip (169kB).

Rolls Royce plc
Rolls-Royce, a world-leading provider of power systems and services for use on land, at sea and in the air, operates in four global markets - civil aerospace, defence aerospace, marine and energy. It continues to invest in core technologies, products, people and capabilities with the objective of broadening and strengthening the product portfolio, improving efficiency and enhancing the environmental performance of its products.

Both the Electrical Systems division (“ESys”) and the Strategic Research Centre are based in Derby, UK.

A press pack for Rolls Royce can be downloaded at www.rolls-royce.com/media/packs/

Scottish Power
Scottish Power is the largest integrated (generation and transmission) electricity business in the UK. Scottish Power operate a flexible and diverse electricity generation portfolio and own and operate an electricity transmission and distribution network serving around 3.3 m customers.

The integration of Iberdrola and ScottishPower, successfully completed on 23 April 2007, has created a new Group that is one of the largest electricity groups in Europe with an enterprise value of around €80 billion, a presence in more than 30 countries and 22 million points of supply. The new Group is also the world’s number one renewable energy operator with 7,000 MW of installed capacity and a pipeline of more than 40,000 MW.
A press pack is available at
www.scottishpower.com/MediaContacts.asp