Mystery of magnetism offers a clue to Twin Towers collapse

Press release
Embargoed until Tuesday 9th September 2008

Scientists have identified for the first time the processes that cause the weakening of steel in tall buildings, such as in the World Trade Center fire of September 11th 2001.

With ever taller skyscrapers being planned – the latest being the Mile-High Tower in Saudi Arabia – the information could help develop steels and alloys which can withstand the high temperatures that occurred in the Twin Towers fire.

The new findings are published in two papers by researchers from UKAEA's nuclear fusion laboratory at Culham near Oxford, UK. Materials experts at UKAEA Culham are identifying the principles for designing special steels for use in future fusion power stations. Their work shows that the same microscopic magnetic processes which affect the strength of materials in fusion reactors are responsible for the collapse of tall buildings if the steel structures are exposed to high temperatures.

It is known that steel softens and loses strength at temperatures above 500°C, rather than melts – and that this caused the collapse of the towers in New York, as well as other incidents such as structural damage in the Madrid skyscraper fire of February 2005. However, it had not been understood until now why this happens. The scientists found that magnetic fluctuations which occur at atomic level give rise to fundamental changes in the strength of the steels.

The UKAEA team compared the conditions in a fusion plant with those experienced in the World Trade Center fire. They found remarkable similarities between the tests performed on candidate fusion materials and those on structural steels from the towers.

The conclusions could allow the development of alloys and steels with different chemical compositions that can cope with higher temperatures. Apart from fusion plants and materials for skyscraper design, these steels could be used in other high temperature environments, including nuclear fission reactors and hydrogen production plants.

UKAEA Culham's Dr Sergei Dudarev, who leads the research team, will be outlining the findings at the BA Festival of Science 2008 in Liverpool on Tuesday September 9th at 9.45am. He said:

"Understanding how materials behave means we can find the right 'medicine' to make steel stronger at high temperatures. I thought the Twin Tower structures might be a useful comparison for the fusion data. But I was surprised to find that the graphs showing the weakening of steel fitted almost exactly.

"Materials are a vital part of research into fusion energy. We need to develop metals that can withstand the extreme conditions in nuclear fusion reactors. It is one of the biggest challenges we face in delivering fusion and its promise of clean, abundant energy. So if we are to be successful, we need an accelerated, well-funded and focused materials development programme.

"The new findings show the advances we are making in understanding the materials needed for fusion plants, along with our colleagues at UK universities and at European laboratories.

"And if our work can be used for other applications, such as safeguarding tall buildings against disasters like the Twin Towers collapse, so much the better."

Ends

Dr Sergei Dudarev will be holding a press conference at the BA Festival in the Festival Press Centre, Architecture Building, University of Liverpool, between 9.45-10.15am on Tuesday 9th September.

For more information please contact Nick Holloway, Media Manager, UKAEA Culham on 07932 637470 or email nick.holloway@ukaea.org.uk.

Notes to Editors

SCIENTIFIC PAPERS

- 'Effect of the α-γ Phase Transition on the Stability of Dislocation Loops in bcc Iron'
  (Published in Physical Review Letters 100 (2008) 135503)
  http://prl.aps.org/
- 'Dislocation pile-ups in Fe at high temperature'
  (Published in the Proceedings of the Royal Society London A464 (2008) 2549)
  http://journals.royalsociety.org

FUSION RESEARCH AT CULHAM

Culham Science Centre, operated by the UK Atomic Energy Authority (UKAEA), is the home of the UK's fusion research programme, most notably the Mega Amp Spherical Tokamak (MAST) experiment. This research is funded by EURATOM and the Engineering & Physical Sciences Research Council (EPSRC). Culham also hosts the world's largest fusion experiment, Joint European Torus (JET), which UKAEA operates for its European partners under the European Fusion Development Agreement (EFDA). The research is part of a worldwide programme which is focused on developing a fusion power plant within 30 years.

The materials development programme at Culham is a part of Europe-wide effort on the development of fusion materials coordinated under EFDA. The Culham programme is primarily focused on the development of multiscale mathematical models of materials, including the investigation of structural stability, dynamics, phase stability, properties of radiation defects, and plasticity of materials. The work is performed in close collaboration with several UK universities, including the University of Oxford, Imperial College London, University College London, and also involves major research centres in Switzerland, France, Germany, the US and in Hong-Kong, China. The work is funded jointly by EPSRC and by EFDA.

More information is available at www.fusion.org.uk, www.jet.efda.org, www.iter.org, and www.efda.org.

WHY FUSION IS IMPORTANT

Energy demands will increase even more dramatically over the next fifty years as the developing world comes to expect the same standard of living as the industrialised countries. In addition, the dangers of global warming from the unrestrained use of fossil fuels are generally accepted. Along with renewables, nuclear fusion will be an important long-term carbon-free energy source. Fusion will provide safe and environmentally friendly energy with the advantages of:

- No atmospheric pollution: the fusion reaction produces helium, which is an inert gas;
- Abundant fuels;
- No long-lived radioactive waste;
- An inherently safe system: even the worst conceivable accident would not require evacuation of the surrounding population.

BASIC SCIENCE OF FUSION

In a fusion reaction, energy is produced when light atoms are fused together to form heavier atoms. This process takes place in the Sun and stars.

To utilise fusion reactions as an energy source it is necessary to heat a gaseous fuel to temperatures in excess of 100 million degrees – several times hotter than the centre of the Sun. At these temperatures, the gas becomes a plasma.

Under these conditions, the plasma particles, deuterium and tritium, fuse together to form helium and high speed neutrons, releasing significant amounts of energy. A commercial power station will use the energy carried by the neutrons to heat a blanket surrounding the plasma. This will be used to generate electricity.

The plasma must be kept away from material surfaces to avoid it being cooled and contaminated; magnetic fields are used for this purpose. The most promising magnetic confinement systems are toroidal (doughnut shaped) and the most advanced is called the tokamak. JET is the largest tokamak in the world.

The fuels used are virtually inexhaustible. Deuterium and tritium are both isotopes of hydrogen. Deuterium is extracted from water and in a fusion power station tritium would be generated from the neutrons reacting with the light metal, lithium, which is found all over the world.

One kilogram of fusion fuel produces the same amount of energy as 10,000,000 kilograms of fossil fuel.

BA FESTIVAL OF SCIENCE 2008

The BA Festival of Science will take place in Liverpool from 6-11 September bringing over 350 of the UK's top scientists and engineers to discuss the latest developments in science with the public. In addition to talks and debates at the University of Liverpool, there will be a host of events happening throughout the city as part of the European Capital of Culture celebrations. For more information about the BA Festival of Science, including an online programme, visit www.the-ba.net/festivalofscience.