DEFENCE AGAINST EXTREME SOLAR WEATHER EVENTS

The UK should plan now to mitigate the effects of a rare but potentially serious solar superstorm, according to a report published on 7th February by the Royal Academy of Engineering. Although the UK is better prepared than many countries, there are areas where the nation needs to improve its resilience.

The Academy’s report, *Extreme space weather: impacts on engineered systems and infrastructure*, was drawn up with the help of experts from many different disciplines. It is the UK’s first in-depth assessment of the potential impacts of solar superstorms.

Explosive eruptions of energy from the Sun that cause minor solar storms on Earth are relatively common events. Superstorms, by contrast, occur very rarely – perhaps once every century or two. Most superstorms miss the Earth, travelling harmlessly into space. Of those that do travel towards the Earth, only half interact with our environment and cause damage. The last true solar superstorm – known as the Carrington event was in 1859.

However, a solar superstorm is inevitable at some point and will degrade the performance of the electricity grid, satellites, GPS systems, aviation and possibly mobile communications.

The Academy recommends that a UK Space Weather Board be initiated within government to provide overall leadership of UK space weather activities – this board must have the capacity to maintain an overview of space weather strategy across all government departments.

More research is needed into the full effects of solar superstorms. The Engineering and Physical Sciences Research Council (EPSRC) should ensure that its research programmes recognise the importance of extreme space weather mitigation and EPSRC should be fully integrated into any research council strategy.

In some respects UK planning is well advanced – for example the National Grid has already taken measures to harden the electricity grid against such disruption and has an active mitigation strategy in place. This should be continued, combining appropriate forecasting, engineering and operational procedures.

The Academy recommends that all terrestrial mobile communications networks with critical resiliency requirements should be able to operate without global...
navigational satellite systems (GNSS) timing for up to three days. This should include network upgrades, including those associated with the new 4G licences, and particularly upgrades to emergency services communications.

The report finds that a solar superstorm might render GPS and Galileo partially or completely inoperable for between one and three days due to disruption of radio transmission paths between the satellites and the ground. Such a loss of navigational aids could potentially affect aircraft and shipping. Today’s aircraft navigation systems are not wholly dependent on GNSS and their use is generally backed up by other navigation aids; it is important that these alternative navigation options remain available in the future.

In a solar superstorm of the size of the Carrington event, air passengers and crew already airborne would be exposed to a one-off dose of radiation. The radiation doses received would result in a marginal increase in cancer risk. The same radiation may also upset the electronics on aircraft, but design practices will keep the risks to a minimum.

The report recommends that ground-, space - and even airborne-derived radiation alerts should be considered for provision to aviation authorities, operators and pilots to allow them to minimise and quantify the risk. Consideration should also be given to classifying solar superstorms as radiation emergencies for air passengers and crew, although the radiation levels concerned are borderline.

Satellites will also be affected by the solar superstorm and we expect around one in ten satellites to be fully or partially inoperative for a period of a few days. A small number will never recover. More broadly the satellite fleet will be aged significantly, necessitating an accelerated satellite launch programme to compensate.

Professor Paul Cannon FREng, Chair of the Academy’s working group on extreme solar weather, said, “The UK is one of a small number of countries taking this risk seriously. The two challenges for government are the wide spectrum of technologies affected today and the emergence of unexpected vulnerabilities as technology evolves. The Academy recommends that government sets up a space weather board to oversee these issues across government departments.

“Our message is: Do not panic, but do prepare – a solar superstorm will happen one day and we need to be ready for it. Many steps have already been taken to minimise the impact of solar superstorms on current technology and by
following the recommendations in the report we anticipate that the UK can further minimise the impact.”


The report was prepared by an Academy working group comprised of the following individuals:

- **Professor Paul Cannon FREng** (report Chair) QinetiQ and University of Birmingham
- **Dr Matthew Angling** University of Birmingham and QinetiQ
- **Professor Les Barclay OBE FREng** Consultant
- **Professor Charles Curry** Chronos Technology Ltd
- **Professor Clive Dyer** University of Surrey
- **Robert Edwards** Aero Engine Controls
- **Graham Greene** CAA
- **Professor Michael Hapgood** RAL-Space
- **Professor Richard Horne** British Antarctic Survey
- **Professor David Jackson** Met Office
- **Professor Cathryn Mitchell** University of Bath
- **John Owen** DSTL
- **Keith Ryden** QinetiQ/University of Surrey
- **Dr Andrew Richards** National Grid
- **Christopher Rogers** National Grid
Dr Simon Saunders  
Real Wireless

Professor Sir Martin Sweeting  
CBE FREng FRS  
Surrey Satellites

Dr Rick Tanner  
Health Protection Agency

Dr Alan Thomson  
British Geological Survey

Professor Craig Underwood  
University of Surrey

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