Large-scale Spacecraft Fire Safety Tests

Urban, David L.; Ruff, Gary A.; Ferkul, Paul; Olson, Sandra; Fernandez-Pello, A. Carlos; T'ien, James S.; Torero, Josw L.; Cowlard, Adam; Rouvreau, Sebastien; Minster, Olivier; Toth, Balazs; Legros, Guillaume; Eigenbrod, Christian; Smirnov, Nickolay; Fujita, Osamu; Jomaas, Grunde

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
The experiment is an international collaboration between numerous space agencies. The collaboration is managed by an International Topical Team including participation by NASA and ESA, plus a group of international scientists (pictures below). It aims to revolutionize spacecraft fire safety designs for next-generation space vehicles and habitats. It will feature a validation experiment in the pressurized interior environment of the unmanned Cygnus vehicle (Orbital Sciences) after it has completed its supply mission to the International Space Station. Currently, three flights are scheduled (Saffire I-III, corresponding to Orbital 5-7).

### Sample Layout Flights I and III

The samples in Saffire I and III will be 46.0 cm by 94.0 cm of cotton / fiberglass blend (Sibal cloth) 75% cotton by weight (18.05 mg/cm²)

Embedded thermocouples at 0, 0.3 and 0.8 cm above the surface in 2 locations to estimate the flame position and the standoff distance in order to compare with the video footage.

### Nomex Ignition Testing

Tests have been conducted with Nomex HT90-40 to find the limiting oxygen concentration (LOC) for flame spread as a function of ambient pressure in a quiescent environment. The igniter was a hot wire: 18 V at 5A. The results with Nomex HT90-40 revealed that having a forced flow, or mixed flow over the fabric surface versus a quiescent environment resulted in different LOC values. The strong dependence on pressure suggests other kinetic effects or flow effects.

### Effect of Surface Structures

As compared to a flat plate, a sharp edged groove can retard or enhance flame propagation - dependent on width.

### Sample Layout Flight II

Samples are 5 cm x 30 cm

### Problem Identification

Full scale fire testing complemented by computer modeling has substantially improved our understanding of the risk, prevention and suppression of fire in terrestrial systems (cars, ships, planes, buildings, mines, and tunnels). In comparison, no such testing has been carried out for manned spacecraft due to the complexity, cost and risk associated with operating a material flammability experiment of a relevant size and duration in microgravity. Therefore, there is currently a gap in knowledge of fire behavior in spacecraft.

### Vehicle Configuration

A detailed three-dimensional transient concurrent flame spread model, featuring an adaptive mesh refinement method that will resolve in detail the spreading flame base and pyrolysis front, will be employed to predict recent ISS experiences and future saffire tests.

### Numerical Modeling

A detailed three-dimensional transient concurrent flame spread model, featuring an adaptive mesh refinement method that will resolve in detail the spreading flame base and pyrolysis front, will be employed to predict recent ISS experiences and future saffire tests. The first step is to provide a predictive tools that will integrate fire safety into design and management of space vehicles. Such tools will integrate a wide range of design issues including, but not limited to, safety into design and management of space vehicles. Such tools will substantially improve our understanding of the risk, prevention and mitigation of fire in terrestrial systems (cars, ships, planes, buildings, mines, and tunnels).

### Contact Information

Contact David Urban (david.urban@nasa.gov) and/or Grunde Jomaas (grujo@byg.dtu.dk) for more information or to express interest in participation.