MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

Author: Dr. David Urban
NASA Glenn Research Center, United States

Dr. Gary Ruff
NASA Glenn Research Center, United States
Dr. Olivier Minster
European Space Agency (ESA), The Netherlands
Dr. A. Carlos Fernandez-Pello
UC Berkeley, United States
Prof. James T'ien
Case Western Reserve University, United States
Prof. Jose Torero
University of Edinburgh, United Kingdom
Prof. Guillaume Legros
Université Pierre et Marie Curie (UPMC), France
Mr. Christian Eigenbrod
University of Bremen, Germany
Prof. Nickolay N. Smirnov
Lomonosov Moscow State University, Russian Federation
Prof. Osamu Fujita
Hokkaido University, Japan
Dr. Adam Cowlard
University of Edinburgh, United Kingdom
Dr. Sebastien Rouvreau
Altran France, France
Dr. Balazs Toth
European Space Research and Technology Centre, ESA-ESTEC, The Netherlands
Prof. Grunde Jomaas
Technical University of Denmark (DTU), Denmark

# ATV EXPERIMENTS ON SPACECRAFT FIRE SAFETY

**Abstract**

Full scale fire testing complemented by computer modelling has provided significant knowhow about 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 long duration material flammability experiment of a relevant size in microgravity. Therefore, there is currently a gap in knowledge of fire behaviour in spacecraft. The entire body of low-gravity fire research has either been conducted in short duration ground-based microgravity facilities or has been limited to very small fuel samples. Still, the work conducted to date has shown that fire behaviour in low-gravity is very different from that in normal-gravity, with differences observed for flammability limits, ignition delay, flame spread behaviour, flame colour and flame structure. As a

result, the prediction of the behaviour of fires in reduced gravity is at present not validated. To address this gap in knowledge, a collaborative international project, Spacecraft Fire Safety, has been established with its cornerstone being the development of an experiment (Fire Safety 1) to be conducted on an ISS resupply vehicle, such as the Automated Transfer Vehicle (ATV) after it leaves the ISS and before it enters the atmosphere. A computer modelling effort will complement the experimental effort. Although the experiment will need to meet rigorous safety requirements to ensure the carrier vehicle does not sustain damage, the absence of a crew removes the need for strict containment of combustion products. This will facilitate the possibility of examining fire behaviour on a scale that is relevant to spacecraft fire safety and will provide unique data for fire model validation. This unprecedented opportunity will expand the understanding of the fundamentals of fire behaviour in spacecraft. The experiment is being developed by an international topical team that is collaboratively defining the experiment requirements and performing supporting analysis, experimentation and technology development. The technology development efforts being conducted in the Fire-Safety-1 project include: continued quantification of low- and partial-gravity maximum oxygen concentrations of spacecraft-relevant materials; development and verification of sensors for fire detection and post-fire monitoring; development of standards for sizing and selecting spacecraft fire suppression systems; and demonstration of post-fire cleanup strategies. This paper presents the objectives, status and concept of this project.