Burning for knowledge: Researchers set to ignite fire in space

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Researchers from Case Western Reserve University, NASA John H. Glenn Research Center and around the world will perform the largest fire-safety experiment ever in space when the unmanned Cygnus cargo module backs a safe distance from the International Space Station (ISS), scheduled for this afternoon.

Small-scale experiments on materials about the size of an index card, done on the ISS, indicate that flames behave differently in microgravity than on Earth. This experiment, called Saffire-I, is expected to show how fire may grow and spread at a size that aerospace researchers consider dangerous.

NASA and other space agencies say this and the series of five more experiments over the next two years are essential to verifying fire-safety protocols or developing new rules and perhaps materials for the ISS and manned flights to Mars.

"Because flames behave so differently in space, we worry about fire safety," said James T'ien, a professor of mechanical and aerospace engineering at Case Western Reserve and member of the research team. "You can't escape fire in space. You can't just jump out a window."

A second use

David L. Urban, branch chief at NASA Glenn, devised the idea to place

the experiment in an unmanned space vehicle that delivers supplies to the ISS and hauls away the station's garbage. The Orbital ATK Cygnus is regularly burned up on re-entry into the Earth's atmosphere over the Pacific Ocean.

The experiment series, called Spacecraft Fire Experiment, or Saffire for short, cost $24 million and includes researchers from European, Japanese and Russian space agencies.

T'ien and Ya-Ting Tseng Liao, an assistant professor of mechanical and aerospace engineering at Case Western Reserve, have recently been running computer simulations of the fire, based on the ISS work and burns lasting about 5 seconds in drop towers that simulate microgravity on Earth.

Their model predicts that, on the large scale, the flame will grow to approximately 6 centimeters in length and spread steadily through the sample.

"The Saffire experiment will provide unique data for us to validate and fine tune parameters of our model," Liao said.

Fire on board

The fire will be contained in a 3-by-5-foot chamber that's subdivided to keep the monitoring and control equipment safely away from the burning material. The experiment was placed aboard the Cygnus before it lifted off to resupply the station in March.

A heated wire will ignite a cloth that's 75 percent cotton and 25 percent fiberglass, 16 inches by 40 inches. The researchers chose cotton because most astronauts like to wear the material in space, Tien said.

On Earth, buoyancy is the force that raises a flame. Because there is no buoyancy in space, fans blowing at one end of the chamber will provide a force, moving air as slow as 5 centimeters per second..

Two video cameras providing a top-down view of the material will help determine the length of the flame. Temperature gauges called thermocouples will trace the temperature changes of the flame, which will be used to help reconstruct the three-dimensional shape.

During the 2½-hour experiment, the researchers will monitor the oxygen and carbon dioxide concentrations and temperatures in the chamber.

Due to the volume of video, transmitting the data to Earth is expected to take up to eight days. The researchers will watch to see how the flame grows and spreads, look for the limit at which a flame forms—or doesn't—and the intensity of the combustion.

The new data will be used to improve the computer model, Liao said. "Once we've validated the model under these conditions, we will begin predicting flame behavior under other conditions and use it as a guide to improve testing on Earth," she said.

In Saffire-II, the international team will test a mix of nine different strips of fabric commonly used in space, including flame-retardant cloths. Saffire-III is similar to Saffire-I but will run at a different flow velocity. Researchers plan to build the rest of the experiments largely on what they learn from the first three.

Provided by Case Western Reserve University