# Water Mist Fire-Suppression Experiment (STS-107)
# Studying Fire in the Sky

## Misting Fires Isn't a Foggy Idea

We all know that water puts out common fires, but it can also damage computer, papers, and other valuables. Water in the form of mist, however, has recently become an important area of study as a fire-suppression system since bromine-based chemical agents (e.g., halons) were banned by international agreement in 1995. Fine water mist has many advantages, including low toxicity, low cost, and proven fire-suppression capabilities.

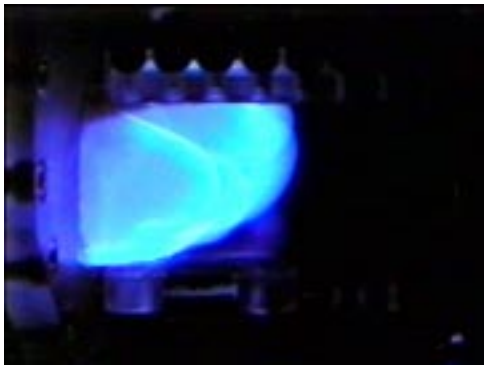
A CM-2 engineer inspecting an experiment mounting structure in Combustion Module-2.

Although much is known about these systems, more research is needed to fully understand the exact methods by which water mist extinguishes a flame. And it's important to study this phenomenon in microgravity so that gravity-induced effects can be reduced or eliminated. Mist scientists will study the interaction of water droplets, like those in a fine fog, with flames, without the distorting effects of buoyancy on the flame and settling of the droplets due to gravity.

The Center for the Commercial Applications of Combustion in Space (CCACS) at the Colorado School of Mines, in conjunction with NASA-Glenn, is investigating the properties of mist fire suppression in microgravity. These experiments consist of varying water droplet sizes and water mist concentrations applied to flame fronts of different propane/air mixtures. Observations from these tests will provide valuable information on the change of flame speed in the presence of water mist.

## Science Objectives

The primary goal of the Mist experiment is to measure the extinguishing capability of water mist on a premixed flame propagating inside a tube. It is expected that the results of the experiment will provide a better understanding of the water mist fire-suppression phenomena, and that this knowledge will be used to design and manufacture more effective mist fire-suppression systems.



Robust Mist flame propagating, from left to right, through a flame tube during 1-g testing at NASA-Glenn Research Center.

The purpose of the experiment is to study how the following affects the speed of a flame in a tube:

- Droplet diameter
- Water concentration
- Equivalence ratio (the ratio of fuel to oxygen)

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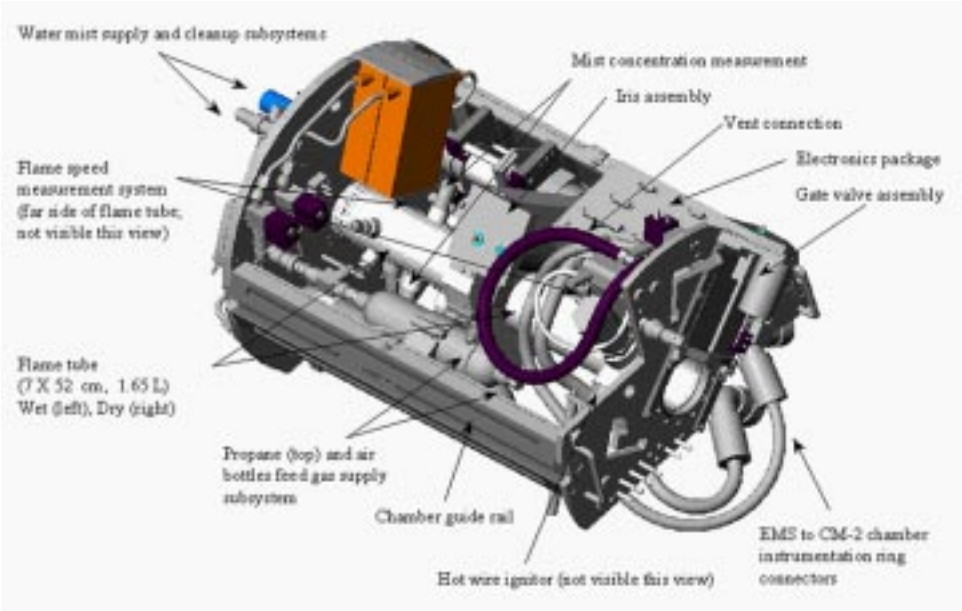
For more information, please visit the NASA-Glenn Microgravity Combustion web site at **http://microgravity.grc.nasa.gov/combustion/**

## Mist Hardware

The Mist Experiment Mounting Structure (EMS) is comprised of the following five main compoments:



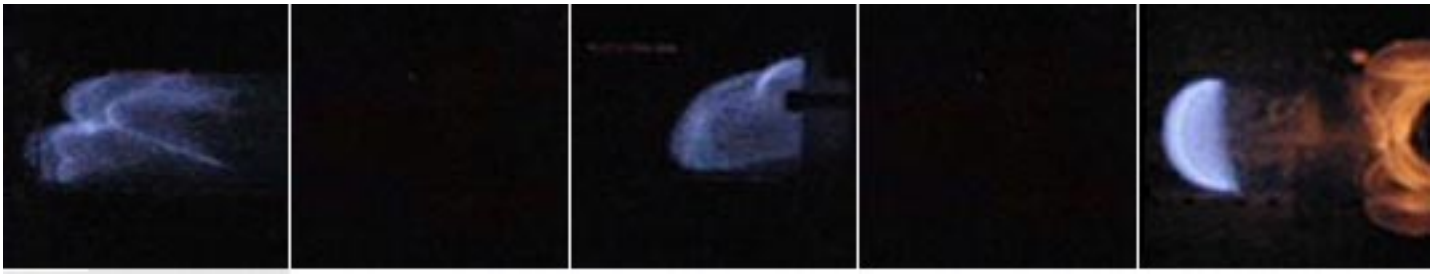

A 3-D schematic of the Mist EMS, with its elements identified.

- Water Mist Supply Subsystem—A water-filled syringe driven by a pump which feeds a fluid line.
- Gas Supply Subsystem—Air and fuel bottles (volumes of 0.5 and 0.3 liters, respectively), mass flow controllers, a static mixer, and various fluids components for pressure monitoring and relief.
- Flame Tube Subsystem—A clear polycarbonate tube approximately 52 cm long and 7 cm in outside diameter, with a volume of about 1.65 liters.
- Vent/Clean-up Subsystem—The Mist EMS has a direct connection to the CM-2 chamber vent, which in turn leads to the overboard vent out of the SPACEHAB module and into space. By opening all the valves in between, this mechanism is used to pull all the gas out of the Mist flame tube.
- Electronics Subsystem—An electronics control box that controls all of the electronics in each subsystem.

## Mist Operations in Space

The Mist EMS, which carries the experiment-specific hardware, operates while it is installed in the CM-2 combustion chamber. The experiment's dry atomizer will be primed (with water) and the flame tube filled with a mixture of fuel and air. The tube is divided into two equal sections and separated by an iris mechanism. One section will be filled with a fine water mist. Within a few seconds, the dry end of the tube will open (to the CM-2 chamber), the iris will open, and the mixture will be ignited by a hot wire in the dry end of the tube. The flame will quickly move through the tube toward the misted section (it will take less than one second to several seconds, depending on the mixture of fuel and oxygen). When the flame hits the mist, it will slow and it may be extinguished. The flame speed will be measured by an EMS photodiode array and the flame activity will be recorded by four CM-2 cameras.

After the burn, the carbon monoxide and water will be removed from the post-combustion gasses by the Mist clean-up system. Finally, the tube will be closed-off again and evacuated in preparation for the next test.



This panel of images (with empty panels to suggest distance and the passage of time) shows the Mist flame entering the flame tube on the right, encountering water mist in the middle frame, and slowing down and breaking up in the far left frame.