DESIGN OF LOW-GRAVITY FIRE-SUPPRESSION EXPERIMENTS: APPLICATION TO SPACE AND EARTH-BASED AGENT DEVELOPMENT

Dr. James J. Reuther
Battelle
505 King Avenue
Columbus, Ohio 43201

HALON ALTERNATIVES TECHNICAL WORKING CONFERENCE

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SPACECRAFT FIRE SUPPRESSION

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- "Probably no greater fear exists in manned spacecraft than onboard fire."
- "There have not been proven technologies developed to extinguish fires in space."
- "Almost all techniques for fighting fire in space are based on assumptions that cannot be proven or tested without microgravity combustion experiments."

FIRE-SUPPRESSION DILEMMA

- The Earth's natural atmosphere, like the Space Station Freedom's manmade one, is now recognized as being confined.
- Halon fire suppressants are not compatible with the environmental life support and control system on Earth or in spacecraft.
- Future fire suppression must be Halon-free.

NASA PROJECT OBJECTIVE

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- Define in-space experiments that would identify and evaluate effective, practicable fire suppressants that quickly and permanently extinguished (most-probable) smoldering combustion at low-gravity spacecraft conditions, with the action taken being no more life-or mission-threatening than the fire itself.

THE DESIGN PROBLEM

- Development of unambiguous guidelines for the experimental evaluation of safe and effective terrestrial fire suppressants remains a difficult scientific challenge, even after decades of effort.

- Results of many tests are often design, device, methodology, and/or application-specific, which leave data open to interpretation, at best, and suspicion, at worst.

- Is it better to design experiments that sacrifice control and variability of parameters in favor of realism, or is it better to sacrifice realism via simulation and specify and vary experimental parameters independently?

IN-SPACE SMOLDER-SUPPRESSION EXPERIMENT

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- Local, near-quiescent application of CO_2 or N_2 as gases, or of H_2O as a mist, to deep-seated smoldering combustion.

CRITICAL EXPERIMENT PARAMETERS

- Fuel (on-board flammable material)
- Oxidant (manned-spacecraft habitat)
- Fuel/oxidant supplies (finite or replenishable)
- Fuel/oxidant mixing rate (quiescent or ventilated)
- Ignition event and mode (one time or continuing)
- Reignition tendency (none, immediate, or delayed)
- Fire zone size (millimeters, centimeters, or meters)
- Fire conditions (smoldering and/or flaming)
- Fire lifetime (seconds or minutes)
- Fire consequences (heat and combustion byproducts)
- Suppressant delivery (volume, direction)
- Diagnostics (preflame, flame, post-flame)

IN-SPACE SMOLDER-SUPPRESSION EXPERIMENT

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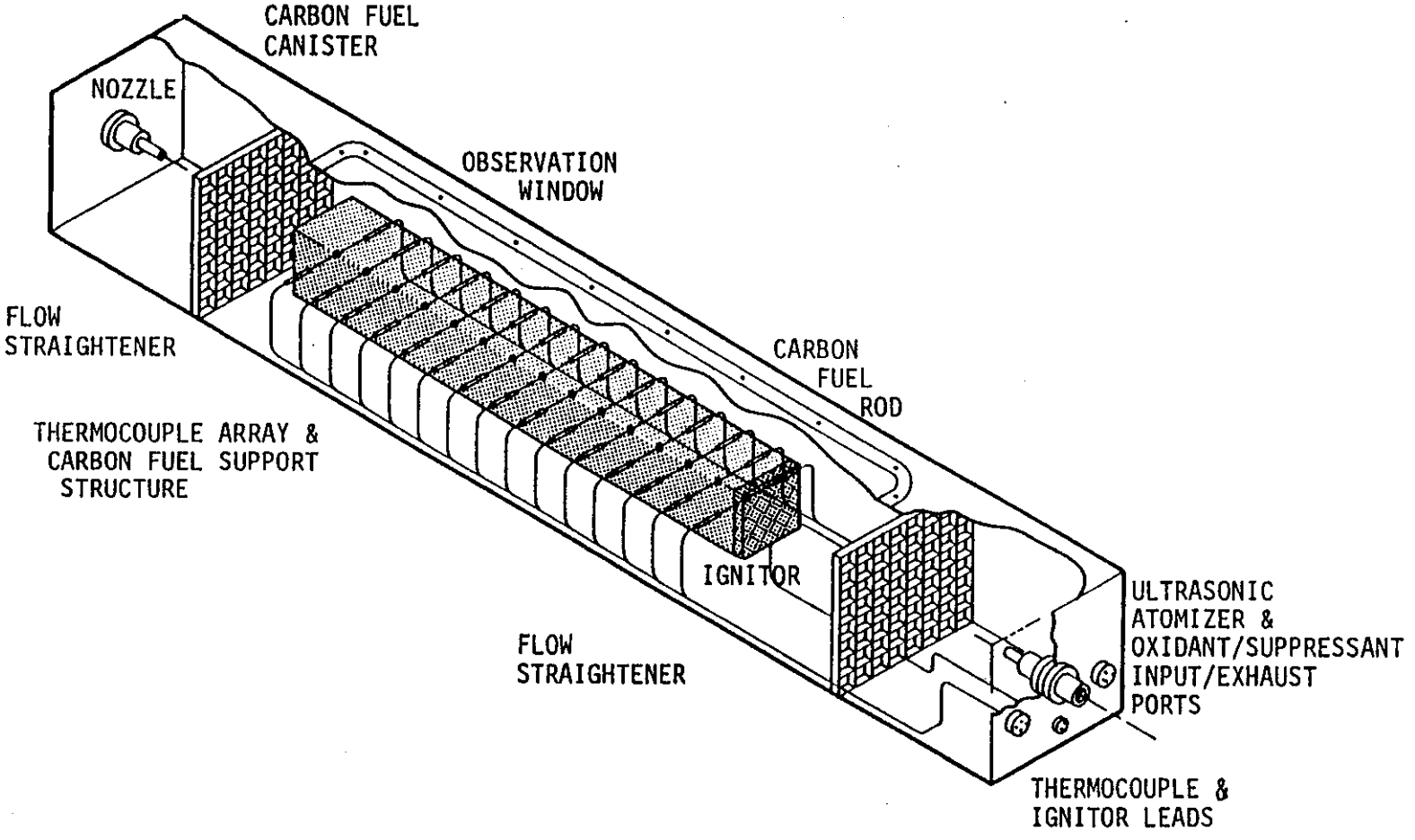
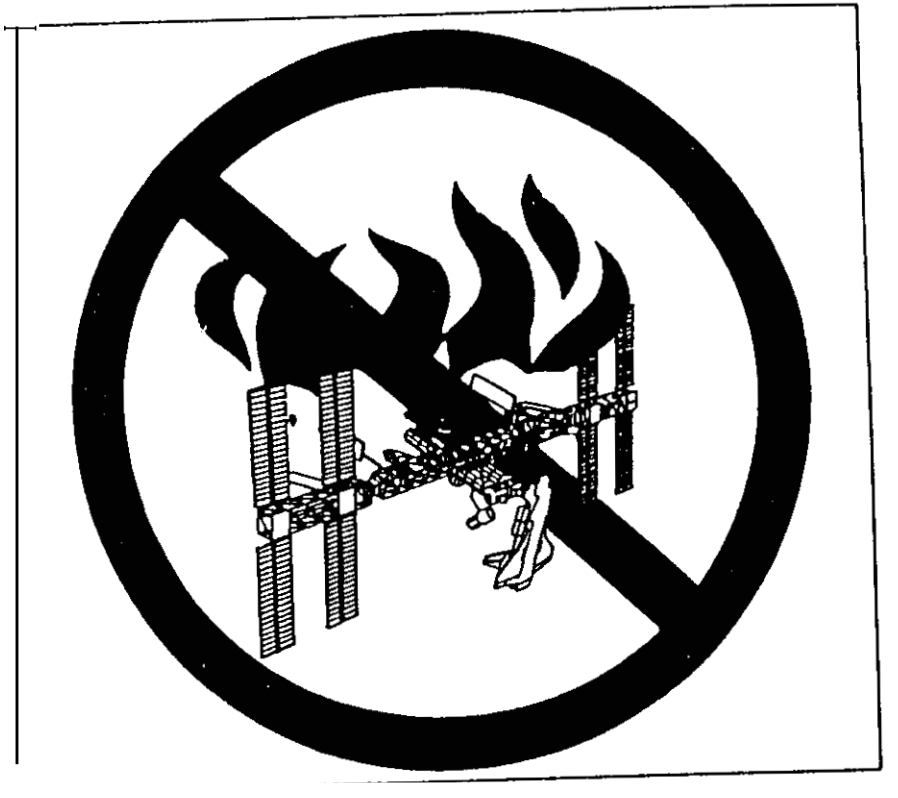


PARADIGM

SUBLIMINAL 1-G BIAS



WHAT IS WRONG WITH THIS PICTURE?

- Until now, because there has been no urgent need to replace, or to improve upon, the inventory of fire suppressants available for decades, much technical history has been forgotten, or is inappropriately remembered, concerning which agents were ever tested, how these agents were tested, whether these tests are still valid, what the test results were, and why these results were interpreted or extrapolated the way in which they were.

EXPECTATIONS

- Because the basis for qualifying or disqualifying various agents, particularly Halons (and CO_2 next?!), has switched from primarily fire suppression effectiveness to environmental compatibility, now is the time to consider conceiving and developing a next-generation of fire suppressants that not only maintains current fire-suppression effectivness, but also performs in a more versatile manner.