



Glenn Research Center



# Combustion Science Research Strategies to Accomplish Program Objectives

## 1996 – 2002 Revolutionize NASA

*Deliver world-class programs and cutting-edge technology through a revolutionized NASA*

## 2003 – 2009 Expand Our Horizons

*Expand our horizons in space and aeronautics to assure continued U.S. leadership*

## 2010 – 2020 & Beyond Open the Frontier

*Open the space frontier to international human expansion and commercial development*

To advance and communicate scientific knowledge and understanding of the Earth, the environment of space, the solar system, and the universe

- Work information exchange and cooperative projects with other US agencies funding combustion research
- Produce intriguing observations from microgravity experiments which will expand and attract a vested research community
- Hold workshops for information dissemination and focusing of activities
- Delineate mechanisms associated with flammability limits and combustion instabilities
- Use ground-based research and limited space experiment results to define a decade of ISS research

- Conduct ISS studies of effects of microgravity on combustion processes, focusing on problems of highest current terrestrial interest
- Use these results to replace and fill in gaps in combustion textbooks
- Develop benchmark data bases on combustion processes against which extensions to and altogether new theories can be developed, enabling a new and broad understanding of combustion science
- Improve understanding of large scale fires with eye to development of means of prevention and suppression

- Complete data collection, reduction, and analysis of data sets to serve as standard references
- Use data sets for development of unified treatments for analysis of combustion processes at all g-levels
- Sustain continued development of fundamental understanding and control of combustion processes
- Develop fundamental understanding of combustion turbulence interactions
- Reduce/eliminate reliance on trial-and-error design procedures for combustion devices

To explore, use and enable the development of space for human enterprise

- Scope potential critical knowledge needs
- Assume responsibilities for space fire safety
- Develop understanding of and characterization methods for detection of fires in microgravity environment and develop tests for characterization of material flammability under ug
- Define effects of reduced pressure and higher oxygen mole fraction on ignition and flamespread over materials for station and other reduced g environments
- Develop agreements with foreign agencies regarding specific areas of cooperation and division of responsibilities

- Expand program to examine ISRU for propulsion, power generation, and combustion synthesis
- Delineate mechanisms controlling material ignitability, smolder, flamespread, and extinction in normal and ug environments, with emphasis on fire safety in reduced or ug environments
- Develop tools permitting accurate prediction of effects of low gravity on combustion processes in space or other extraterrestrial bodies leading to design tools
- Perform in-space demos and validations of combustion-related technologies as preparation for Lunar and Martian habitats

- Develop extraterrestrial laboratories for combustion research and engineering development
- Develop energy conversion processes optimized for use in space applications involving reduced gravity
- Explore combustion processes involving alternative fuels and oxidizers which may have to replace "normal" Earth-based fuels and oxidizers
- Develop, demonstrate, and enable ISRU techniques using combustion technologies for power, propulsion, and ECLSS support of Lunar and Martian habitats

To research, develop, verify, and transfer advanced aeronautics, space, and related technologies

- Steer combustion research efforts into more specific, prioritized subtopic areas
- Expand menu of diagnostic tools with emphasis on direct rather than inferential measurements
- Increase capabilities of ground-based facilities
- Expand research on combustion synthesis processes
- Use ground-based and sounding rocket experimental studies to better scope combustion experiments requiring longer ug durations in preparation for ISS
- Study soot formation, agglomeration, oxidation to define control strategies for Earthbound combustion devices

- Shift emphasis to "hypothesis-driven" combustion research rather than exploratory research
- Increase emphasis on detailed quantitative measurements with emphasis on mechanisms
- Emphasize potential for high economic feedback
- Increase emphasis on combustion synthesis processes for production of novel high-value materials
- Contribute to development of low NOx emission combustors for supersonic combustion devices
- Develop miniaturized instrumentation for sensing and controlling combustor performance; utilize this technology in improving terrestrial combustion processes

- Apply knowledge gained to development of ways for increasing fuel utilization efficiency and reducing pollutant emissions for many processes
- Develop diagnostics/process control combinations to permit continual optimization of combustion devices
- Develop strategies for improving combustion devices via smart sensors, magnetic and electric field utilization, improved mixing technologies, improved atomization, and flame-zone pollution control
- Develop industrial-scale combustion synthesis process