

# Aircraft Chemical Sensor Arrays for Onboard Engine and Bleed Air Monitoring, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)



## ABSTRACT

Makel Engineering Inc. (MEI), proposes to develop flight capable chemical microsensor arrays for in-situ monitoring of high temperature bleed air and turbine exhaust in jet engines. The proposed chemical sensor probes will be a new class of on-board engine instrumentation for real time monitoring of engine and bleed air system operation in flight. Sensor arrays developed by MEI have been demonstrated for ground tests usage to quantify composition of critical constituents in turbine engine exhaust products, e.g., CO, CO<sub>2</sub>, NO<sub>x</sub>, O<sub>2</sub> and HC (unburned hydrocarbons). There currently is no flight capable instrumentation for real time measurement of high temperature gas streams from engine bleed air or the turbine exhaust. Ground test demonstrations with high temperature capable (500 to 600 (deg) C) solid-state chemical microsensors have shown the potential value for engine health monitoring and detection of engine faults or abnormal operations from ingestion of high moisture levels or particulate from volcanic emissions. The development of flight qualified engine sensors which can measure key chemical species will enable a new level of aeronautical vehicle health management.

## ANTICIPATED BENEFITS

### To NASA funded missions:

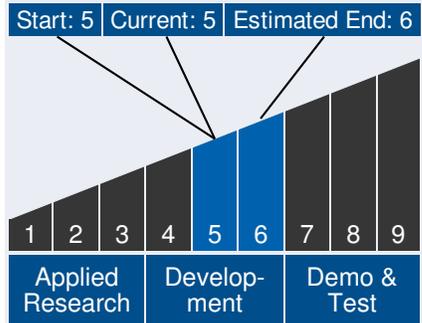
Potential NASA Commercial Applications: This proposal targets the improvement of NASA's ground and flight test aeronautics testing capabilities. Potential end users within NASA include ground test facilities such as Western Aeronautical Test Range (WATR) and Flight Loads Laboratory (FLL), as well as flight facilities such as AFRC with both piloted and unmanned systems. Real-time, in-flight data regarding combustor condition and emissions species can provide a previously unavailable test capability for NASA. Monitoring of bleed air for contaminants and fuel backflow is also an area of interest. The sensor probe systems proposed in this project are aligned with the next step



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## Technology Maturity



## Management Team

### Program Executives:

- Joseph Grant
- Laguduva Kubendran

### Program Manager:

- Carlos Torrez

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testing which has been proposed for the VIPR program. Potential VIPR 4 or 5 activities could include measurements of the bleed air and engine exhaust using on-board chemical sensors. Presently no such sensors exist and they would need to be developed along the lines proposed in this project.

## To the commercial space industry:

Potential Non-NASA Commercial Applications: All commercial passenger aircraft manufacturers are highly interested in sensors for monitoring bleed air quality to avoid exposure of harmful or noxious gases to passengers and crew. MEI is currently in discussions with The Boeing Company looking at sensor approaches for bleed air monitoring. MEI has been working Cobham PLC on pilot breathing air quality monitoring for the Air Force for aircraft which use OBOGS systems to supply pilot breathing air. Cobham is a major US Defense contractor has approximately 70% of the world wide OBOGS market. Cobham is currently seeking chemical sensing technology for OBOGS monitoring. A multi-species, on-engine capable, exhaust or combustor sensor is a product desired and sought after by the engines companies including Rolls Royce, GE, and Pratt & Whitney. A similar product is the expressed interest of stationary gas turbine manufacturers including GE and Siemens.

## Management Team (cont.)

### Principal Investigator:

- Susana Carranza

## Technology Areas

### Primary Technology Area:

Science Instruments, Observatories, and Sensor Systems (TA 8)  
└ In-Situ Instruments and Sensors (TA 8.3)

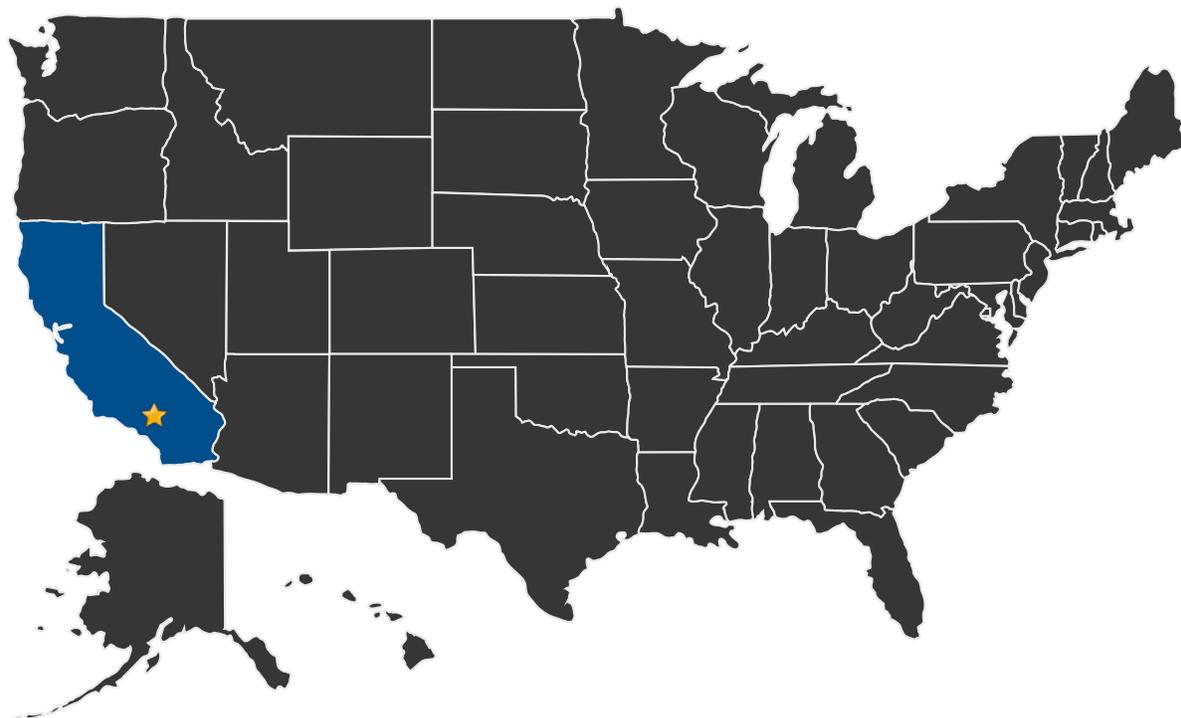
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## U.S. WORK LOCATIONS AND KEY PARTNERS

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■ U.S. States With Work

★ Lead Center:

Armstrong Flight Research Center

### Other Organizations Performing Work:

- Makel Engineering, Inc. (Chico, CA)

## PROJECT LIBRARY

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### Presentations

- Briefing Chart
  - (<http://techport.nasa.gov:80/file/23150>)

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## IMAGE GALLERY



*Aircraft Chemical Sensor Arrays for Onboard Engine and Bleed Air Monitoring, Phase I*

## DETAILS FOR TECHNOLOGY 1

### Technology Title

Aircraft Chemical Sensor Arrays for Onboard Engine and Bleed Air Monitoring, Phase I

### Potential Applications

This proposal targets the improvement of NASA's ground and flight test aeronautics testing capabilities. Potential end users within NASA include ground test facilities such as Western Aeronautical Test Range (WATR) and Flight Loads Laboratory (FLL), as well as flight facilities such as AFRC with both piloted and unmanned systems. Real-time, in-flight data regarding combustor condition and emissions species can provide a previously unavailable test capability for NASA. Monitoring of bleed air for contaminants and fuel backflow is also an area of interest. The sensor probe systems proposed in this project are aligned with the next step testing which has been proposed for the VIPR program. Potential VIPR 4 or 5 activities could include measurements of the bleed air and engine exhaust using on-board chemical sensors. Presently no such sensors exist and they would need to be developed along the lines proposed in this project.