

## The UMR Center of Excellence for Aerospace Propulsion Particulate Emissions Research

A university/industry Center of Excellence (COE) for Aerospace Propulsion Particulate Emissions Research was created at UMR by a congressional appropriation of \$3.15M in the spring of 2003. The COE is an outgrowth of the continued research efforts of the Cloud and Aerosol Sciences Laboratory led by Professors **Don Hagen** (Physics) and **Phil Whitefield** (Chemistry). The appropriation was spearheaded by Senator **Christopher Bond** and is administered through



*UMR mobile lab at Wright Patterson Air Force Base*

NASA. The COE will develop tools to measure and characterize particulate emissions from current aircraft propulsion systems and predict emissions from future aircraft. These tools will be validated in realistic laboratory test environments that integrate propulsion altitude cells with state-of-the-art diagnostic systems and numerical modeling, and will be used as much-needed standards for current and future engine design. The consortium consists of UMR, the Massachusetts Institute of Technology, the Boeing Company, Aerodyne Research Inc., the University of Illinois, and Georgia Tech.

There is an immediate need to characterize particulate emissions from aircraft engines and auxiliary power units associated with the commercial fleets, and to support the development of predictive tools for propulsion emission-reduction strategies. These emissions are poorly understood, but are a critically important component of aircraft exhaust that affects all aircraft operations.

These emissions represent:

- (1) Through impact on local air quality, a factor that limits the continued operation and proposed expansion of existing airports, the development of new airports in the US and continued access for US airlines and US-manufactured aircraft to foreign airports, especially those in Western Europe.



*UMR students in the field, Farnborough UK*

- (2) A potentially damaging influence on the meteorology and climatology of our global flight corridors. Aircraft emit particles directly into their flight corridors, where they have an uncertain but potentially adverse influence on

atmospheric composition. It is estimated that burning one gallon of aviation fuel at 30,000 ft. has twice the environmental impact of burning it at sea level. This impact is largely driven by contrail formation arising from particulate production.

- (3) A readily detectable signature of an aircraft that betrays the flight paths of both civilian and military aircraft. These emissions are capable of seeding visible contrails, rendering all aircraft susceptible to detection without the use of sophisticated detectors.



*COE team visiting replica of famous UMR landmark*

The need to characterize aircraft emissions and to develop predictive tools for future propulsion emission reduction strategies has not escaped the attention of our international competitors. A substantial research effort, addressing the characterization issue and sponsored by the EEC, continues in Western Europe, with annual expenditures in excess of \$20M.

Initial research efforts at the COE will focus on the following goals:

- (1) The development of standardized particulate emissions characterization and measurement methodologies to meet the needs of NASA, the US aerospace industry, regulatory bodies such as the EPA and FAA, and the DOD.
- (2) The development of standardized techniques for measuring particulate formation and growth outside the engine but in its exhaust plume.
- (3) Characterization and measurement of the particulate emissions of commercial aircraft, both in service and in development.
- (4) The development of predictive tools for future emissions reductions strategies by creating validated models of particulate production in the hot sections of turbine engines and in their exhausts.



*UMR aerosol probe about to test a B-52 engine*

With this critical investment, congress has enabled UMR to become the clear international leader in the field of particulate emissions reduction. A multi-agency roadmap is currently being developed to secure the required resources from federal agencies such as NASA, FAA, DOD, and the EPA. The focal point of the research is UMR's Center of Excellence. This research effort will help the U.S. maintain its major market share in the competitive aerospace economy of the 21<sup>st</sup> century.