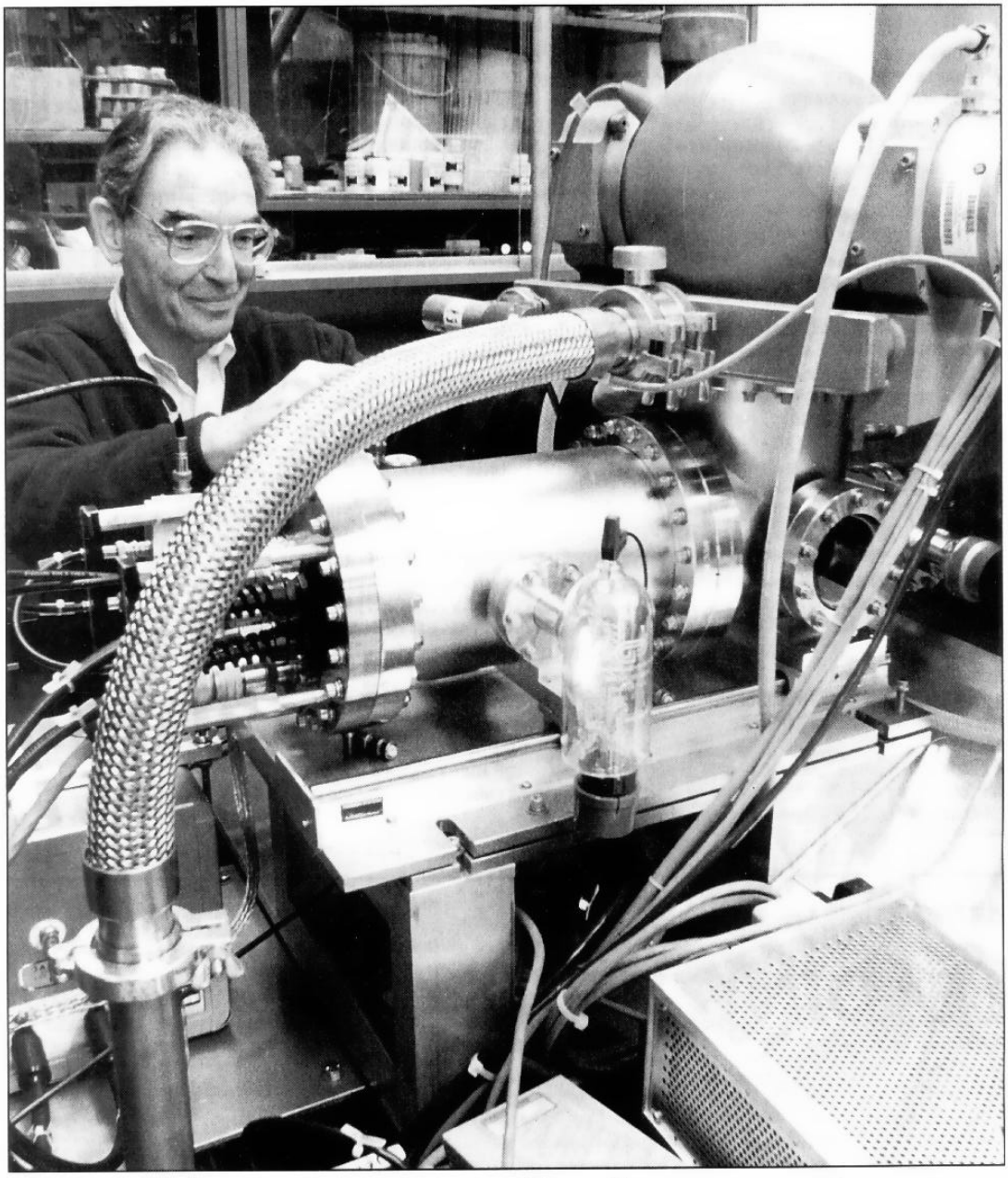
Air Force Systems Command

LEADING EDGE



Mission and clean air

September 1991

Stringent air quality standards could threaten the continuing of important Air Force missions, but scientists have made advances that will let the military and the public breathe easier

CLEAN AIR

by John Edwards
SSD environmental chief

New ways to detect and measure air polluting chemical reactions will help the Air Force keep launching missions into space by meeting stringent clean air requirements.

Spin-offs from these discoveries could be used to fine tune pollutions control devices, such as catalytic converters, that involve burning fuel. This would substantially reduce nitrogen oxide emissions across the country in everything from cars to power plants.

The new technology can be compared to photographing a stream of tap water. A photo taken with a normal camera shows a solid flow of water, but a stop-action camera reveals the individual droplets that make up the flow.

The Flow Tube Combustor with Laser Tomography device directs super heated gasses – similar to an engine's exhaust gas flow – through a glass tube. Laser tomography then provides a stop-action window into the chemical reactions taking place.

Clear picture of pollution

Previous technology could provide a "blurry snapshot" of chemical reactions in this flow. The new combustor provides a precise picture and exact measurements.

The effort is first looking at reactions of nitrogen oxide, which is produced when any fuel is burned with air. Nitrogen oxide makes smog appear brown, produces ozone and acid rain and is unhealthful to breathe, even in low concentrations.

The technology is being developed at The Aerospace Corporation to help Space Systems Division's programs survive stringent new Clean Air Act Amendments. SSD at Los Angeles AFB, Calif., receives technical support from contractor Aerospace Corporation.

From work of many

Six years ago, Dr. Ron Cohen of the corporation started pioneering work in air pollution control. Recently, the combustor experiment was born out of a "critical mass" of work from scientists with a range of interests including kinetics, mass spectrometry, lasers, engineering and fluid mechanics.

"No one has been able to unravel this maze of reactions before, because the means to measure them didn't exist," said Cohen. "The development of this particular flow tube with its state-of-the-art measurement devices is a substantial breakthrough that will have a major impact on reduction of air pollution from the Air Force, and eventually from industry."

The science team includes Brian Brady, Edward Beiting, Jim Pollard, Tom Spiglanin, Mark Crofton, Jack Syage, Eric Fourneir, Doug Schultess, Seigfried Janson and Sunne Genova.

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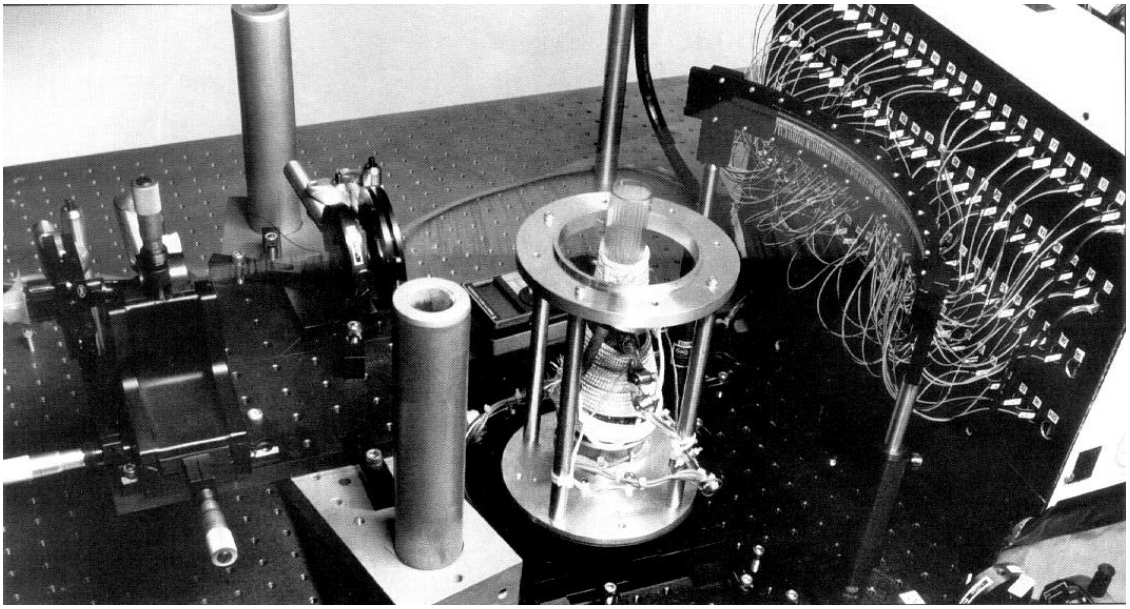

Laser tomography demonstration proves the Flow Tube Combustor theories. Photo by David Ramirez

Brady and Pollard designed the flow tube combustor that is like no other in the world, producing high temperatures and fast flows. Nitrogen oxide is injected into the flow together with another chemical that is being tested, ammonia.

A computer model decides which of the hundreds of small fasts reactions are most important to watch. The progress of the reactions are then followed by the sensors. The key to doing this is the absorption tomography method Beiting invented at Aerospace.

Sensors use laser tomography

Beiting's sensors use laser tomography, which works like the medical CAT scan that produces an image of a slice through the human body. A ring of lasers around the flow tube takes two-dimensional snapshots of chemicals and temperatures so fast that it can see turbulent mixing – a breakthrough. Uneven temperatures and concentrations can be detected and fed into computer models used to optimize commercial pollution control devices.

Origins in chemical disposal

The program traces its origin to an effort to find an environmentally safe way to destroy hydrazine and nitrogen tetroxide. This led to a program for reducing nitrogen oxide emissions.

"Nitrogen oxide reduction is of more general importance to the Air Force because of the need to reduce emissions from power plants and other equipment," Cohen said. The benefits will help industry reduce emissions, too.

The program is first studying chemicals the Air Force must use for rocket launches and satellite operations.

Ozone problem next

Once this is done, Cohen said, "the same powerful equipment can be brought to bear on other important chemicals such as hydrochloric acid and ozone. This is becoming increasingly important chemicals such as hydrochloric acid and ozone. This is becoming increasingly important, because launches put ozone-destroying chlorine compounds directly into the stratosphere."

The flow tube effort was funded by Space Systems Division's Bioastronautical Engineering, the Air Force Engineering Services Center and Aerospace Corporation. Besides looking for ways to meet increasingly stringent air pollution lays, the program seeks ways to produce less toxic wastes than are generated using current pollution control techniques.

Clean Air Act Amendments passed in 1991 require EPA to provide much more control of all air pollutants. For the first time, hydrazine and hydrochloric acid, both used by the Air Force, are listed hazardous air pollutants.

This work will help Space Systems Division obtain pollution control devices that can meet the new standards and continue to operate under the new regulations.

Potential 'pollution credits'

"It should also enable SSD to reduce nitrogen oxide pollution from existing power plants to provide 'pollution credits' for future Air Force programs," Cohen noted. "This function is important too, because air emissions are the limiting factor on launch rates from Vandenberg AFB."