NASA Facts

National Aeronautics and
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NASA's High-Speed Research Program

Researching the Environmental Effects of a Supersonic Passenger Jet

A Supersonic Passenger Jet for the Future

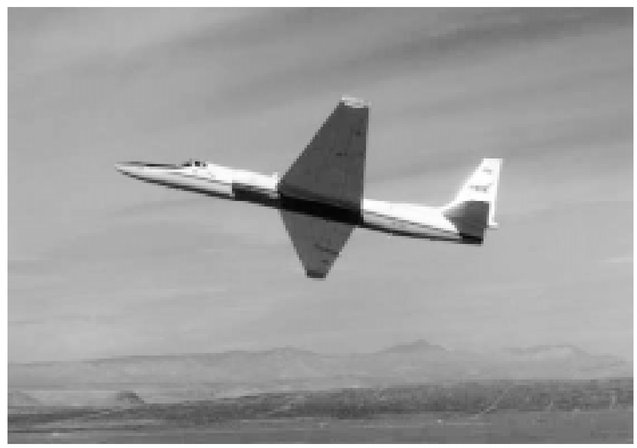
With air travel expected to double in the next five to 10 years, NASA and its industry partners have been working on a concept for an environmentally-friendly supersonic passenger jet. This jet would fly 300 passengers at more than 1,500 miles per hour (twice the speed of sound) across the Pacific or Atlantic oceans — all in less than half the time of modern jets. Ticket prices would be about 20 percent above comparable, slower flights.

Work to make this jet a reality began in 1990 with Phase 1 of the NASA High-Speed Research (HSR) program. The HSR program, now in Phase 2, is supported by a team of U.S. aerospace companies. A possible market for about 500 of these jets between the turn of the century and 2015 may mean more than $200 billion in sales, creating a positive balance of trade, and a potential of 140,000 new jobs in the United States.

Ozone Destruction in the Atmosphere

In the early 1970s, the most publicized environmental concern about a future fleet of supersonic transports was the possible destruction of ozone in the Earth's upper atmosphere due to pollutants in the jets' engine exhausts. The ozone layer protects life on Earth from the Sun's ultraviolet rays by absorbing those rays. In the process, the ozone molecules are broken apart into individual oxygen molecules. In the absence of other chemicals, the oxygen molecules soon reunite to form more ozone molecules. If certain chemicals (oxides of Nitrogen – NO_x) are present, however, this ozone rejuvenation process can be delayed or eliminated.

To address the possibility of ozone destruction, the HSR Atmospheric Effects of Stratospheric Aircraft program was formed. As part of this program, an international team of scientists developed global atmospheric computer models to predict the impact of various engine exhausts on stratospheric ozone. In addition, a converted military spy plane called the ER-2, along with ground-launched balloons, was used to make measurements in the stratosphere. The ER-2 was also used to measure engine exhausts from the Concorde supersonic transport. Current predictions using these computer models show almost no impact on stratospheric ozone by a fleet of 500 High-Speed Civil Transports (HSCTs) whose engine combustors produce ultra-low levels of NO_x. Designing these cleaner engines has also proven feasible. Laboratory tests of advanced combustion techniques have been very successful in improving fuel efficiency, along with reducing ozone-destroying emissions from the engine exhausts.



The ER-2, a converted military spy plane, made measurements in the stratosphere to predict the impact of engine exhausts on ozone, and to measure engine exhausts from the Concorde.

Minimizing Jet Noise

Any future supersonic airliner will operate from existing international airports and must, therefore, meet local airport community noise requirements, as well as any national or international noise certification regulations. The HSR program is moving forward with the assumption that a future supersonic passenger jet must be as quiet as today's commercial subsonic aircraft.

The design of an advanced propulsion system for such a fast and powerful aircraft must include noise reduction goals from the onset. The selection of the basic engine concept as well as the design of propulsion components such as the inlet, fan and nozzle will all be impacted by noise reduction requirements.

The designer's challenge is to produce a low noise propulsion system without seriously affecting engine performance. Even the shape of the airplane can be impacted by the need to reduce noise. By enlarging the outboard panel of the wing, for example, the aircraft's performance at low speeds is improved, thereby reducing the required engine thrust, and subsequent noise levels, during take off, climb and landing.

Sonic Booms

When an aircraft flies faster than the speed of sound it produces sound waves that can reach the surface of the Earth, creating an often startling and annoying noise. Although studies have found ways to redesign supersonic aircraft to create less intense sonic booms, these methods seriously compromise the aerodynamic performance. To minimize the effects of these sonic booms on humans, HSCTs will fly at supersonic speeds only over the oceans.

The National Zoo and the Hubbs-Sea World Research Institute, however, are conducting studies of wildlife responses to sonic booms at various intensities. In previous studies, biologists have shown that wildlife quickly adapt to sonic booms in their habitat, but NASA and industry engineers are working to reduce sonic boom levels to help minimize any impact on the marine environment.

High-Altitude Radiation

High-altitude atmospheric radiation is of galactic or solar origin. Galactic cosmic rays are high energy and penetrate deep into the Earth's atmosphere. Solar cosmic rays are generated by solar flares and are less penetrating, but may be very intense over short periods of time. NASA developed a program based on a recent study completed by the National Council on Radiation Protection (done at the behest of the HSR Program) which suggested that a high-altitude radiation data base be acquired to properly characterize the radiation environment in which the HSCT will operate.

Using the NASA ER-2 aircraft, based at the NASA Dryden Flight Research Center in California, researchers measured radiation at altitudes between 52,000 and 70,000 feet. This radiation data is being used to characterize and define the radiation environment for both crew members and the frequently flying public on future HSCTs. The broad aim of the ER-2 flight measurements campaign was to understand the composition, distribution and intensities of cosmic and solar radiation at commercial supersonic transport cruise altitudes. The primary concern is the level of uncertainties in the knowledge of the upper atmosphere's radiation environment and the biological response to that type of environment.

A second purpose of the ER-2 testing was to develop and validate techniques and monitoring devices for the protection of crew members who may work many hours at cruise altitudes up to 68,000 feet. Researchers believe that long-term radiation exposure can be managed by crew rotation scheduling. Though the exposure levels are higher at the HSCT cruise altitude than for current subsonic flight altitudes, the typical flying public will actually receive less radiation exposure than on today's subsonic transports because of the higher speed of the HSCT.

Future Environmental Research

The resolution of these environmental issues has been a centerpiece of the HSR Program since its inception in 1990. Great strides have been made in understanding these issues and their potential impact on the HSCT design, its propulsion components and on HSCT operational procedures. Even the routes flown by the airplane could be influenced by the desire to ensure that this airplane does not pose any hazards to the environment, or human and marine populations.

These environmental principles are now firmly rooted in the HSCT development process. As new aeronautical technologies are introduced into the evolving HSCT design, the engineering team must test each new concept for its ability to meet the environmental constraints. Research also continues to add fidelity to the environmental prediction methods used to assess noise, emissions and sonic boom impacts. Because of this research, at the conclusion of the HSR program, there will be high confidence that HSCT will be an environmentally compatible airplane.

For more information: http://hsr.larc.nasa.gov/