HIGH-SPEED CRUISE ENVIRONMENTAL CONCERNS

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As the Federal Aviation Administration's (FAA) Associate Administrator for Policy and International Aviation, my responsibilities encompass the formulation and implementation of the FAA's environmental policies in all areas of the air transportation system. The subject of my present discussion, "High-Speed Cruise Environmental Concerns," would not be complete if we did not review a few of the primary concerns which form the basis of the FAA's environmental policy.

FAA's Promotional Responsibilities

A fundamental responsibility of the FAA is to foster and promote air commerce at home and abroad to ensure the efficient and safe use of the airspace. The subject of safety is obviously all pervasive and includes the certification standards for the construction and development of aircraft, as well as standards for their operation. The efficient use of the airspace is reflected in actions necessary to maximize airport capacity and to meet the ever increasing demand for air travel, which will result from an expected increase in passenger enplanements of approximately 100 percent within the next 15 years. Currently we are finding that the problems of airport and system capacity are increasingly related to environmental concerns. The reason for this is simply that the increase of community pressures on airports for relief from airport noise has resulted in an increase in airport use restrictions at several major hub airports around the country, as well as at smaller community airports. This increase in airport use restrictions is leading to a saturation situation, since it is also becoming increasingly difficult to develop new airports or expand existing airports. As a result of these environmental concerns, I am continually surprised at the amount of the FAA's effort, as well as my own, which is spent in addressing environmental issues.

A secondary promotional responsibility of the FAA is to encourage the entry of new carriers into the system to ensure that an appropriate competitive situation exists such that all carriers can be expected to develop a reasonable return on their investment. Relevant to recent deregulation of the air transportation industry much has been done to promote the competitive growth of the system. This growth continues to be dynamic and, to a degree, reflects the appropriateness of our environmental policies to date. The potential for the development of commercial supersonic and hypersonic transport aircraft could reflect the next frontiers for growth of the air transport system and will only be realized if we develop and adhere to an appropriate environmental policy.

Noise Factors

Airport Noise. While I am aware that the subject of airport community noise will be discussed in a subsequent paper, its extreme importance relative to airport capacity merits several comments prior to concentration on the subject of high-speed cruise concerns. The Federal Aviation Regulations (FAR) Part 36 established noise regulations for all subsonic aircraft. The legislative requirements of Section 611 of the Federal Aviation Act dealing with

the control and abatement of aircraft noise and sonic boom stipulates that the FAA cannot issue an original type certificate under this Act for any aircraft for which substantial noise abatement can be achieved by prescribing standards and regulations. This means that manufacturers of both subsonic and supersonic aircraft cannot assume that barely meeting the current Part 36 Stage 3 standards will continue to be acceptable into the next century. Even if the federal government does not act to tighten these standards, competitive pressures between manufacturers to meet the public's demands for quieter aircraft will effect much the same result. Success of the British BA-146 in penetrating the United States market shows the value of quieter aircraft in a competitive situation. Further, FAR Part 36 noise standards would necessarily be expanded to include both supersonic and hypersonic transport aircraft prior to their eventual airworthiness certification.

As an initial step towards this objective, an Advance Notice of Proposed Rulemaking (No. 86-16) entitled "Noise Standards; Civil Supersonic Aircraft Noise Type Certification Standards and Operating Rules," has recently been issued by the FAA. Since there is currently a technology trend to the evolution of an all FAR 36, Stage 3 fleet of subsonic aircraft, one of the subjects raised in the ANPRM is "...the extent to which the current Stage 3 noise standards now applicable to subsonic turbojet-powered aircraft could be applied to future-generation SSTs." This subject was studied in depth by the International Civil Aviation Organization (ICAO) in 1983, and while the technology did not appear to be available at that time, the goal could be reasonably considered within reach. Since that time, techniques including the use of variable cycle engines, inlet choking, use of advanced noise attenuation material, and modified operational procedures all would tend to enhance the prospects of a Stage 3 airport noise environment for future supersonic transports.

Obviously, the definition of the hypersonic transport aircraft is not sufficiently advanced to address the question of airport noise for this category of aircraft. The stated goal that the NASP research aircraft "will take off from a runway" implies the need for serious consideration of airport noise characteristics of this class of aircraft. If the designers of future commercial hypersonic aircraft are to achieve a runway takeoff and landing capability, it is initially questioned whether or not they would be capable of taking off in a mix of conventional subsonic aircraft or whether specific isolated launch areas would be necessary.

En Route Noise. Historically, prior to the coming of the supersonic transport with its associated sonic boom, considerations of aircraft en route noise have been minimal. Generally, it had been considered possible for aircraft to fly high enough and at low enough engine thrust to minimize en route noise problems. Recently, however, concern has been expressed in this area for engine noise as well as for sonic booms.

Subsonic engine noise as a potential en route problem has surfaced as a result of two operational conditions. First, to control the takeoff operational noise at airports, procedures have been encouraged which utilize substantial power or thrust reductions during the second phase of takeoff climb. After the second phase is completed, the power is increased to maximum climb power for the remainder of the climb to cruise altitude. During this phase of the climb, it has been reported that concern has been expressed by people on the ground at

greater distances from the airport because of the environmental noise associated with the use of maximum climb power. The second form of en route engine noise may result from the use of new propulsion systems for subsonic aircraft or of the next generation of SST engines. In either case, this potential issue should be addressed in the early configurational design phases.

Sonic Boom. During the development of the Concorde and the United States' supersonic transport aircraft, the en route noise problems were only considered to be those associated with the "primary" sonic booms which were estimated to have over-pressures on the order of 2 to 3 pounds per square foot. These overpressures could in fact be amplified during acceleration by factors of 5 or more, which would result in "N wave" sonic boom signatures having a rapid pressure rise from the atmospheric level to approximately 15 pounds per square foot in the acceleration areas. This rapid pressure rise, with the associated startle effect, and the en route cruise overpressure level were sufficient to justify a Federal Aviation Regulation, Part 91.55, in March of 1973 which prevented supersonic overflight by civil aircraft.

At the time of the rule making, there was conjecture that a 1 pound per square foot or less sonic boom may be considered acceptable. Accordingly, the FAR was structured to provide proponents of supersonic overflight the opportunity of demonstrating the environmental acceptability of "tailored" sonic boom characteristics. In the interim, international concern was expressed through ICAO and cooperative procedures were worked out at the international level to avoid impact of sonic booms resulting from supersonic transport flight over or near a nation's shores. The provisions in the FAR Part 91.55 for demonstrating that "environmentally acceptable boom generating characteristics" could be developed has not been used to date and as a result nothing has been done since 1973 which has contributed to a reassessment of "acceptable" sonic boom overpressure limits.

In contrast to an acceptability demonstration, the FAA has experienced difficulties with the "secondary sonic booms" which have overpressures in the order of 0.3 pounds per square foot and less. Surprisingly the public reactions were sufficiently adverse to make routing changes in Concorde flight operations necessary.

Impact on Air Quality and the Atmosphere

Early Concerns. During the late 1960s and the early 1970s environmentalists raised questions about the potential impact of supersonic transports on air quality and the upper atmosphere. Specifically, projections were made relative to human health effects, the earth's temperature, and general ecological effects resulting from injection of water vapor and carbon monoxide into the atmosphere and the possibility of the "green house effect." These reservations were later reflected in the concern that NO_x could possibly destroy the ozone layer and subject the environment to harmful levels of ultraviolet radiation.

With the current limited fleets of supersonic aircraft, these concerns have essentially disappeared.

Additional Questions. With the reassessment of the prospects for commercial supersonic and hypersonic transport aircraft, additional questions have surfaced beyond those related to the high-speed cruise environment. If these aircraft are to operate from existing airports, their contribution to the emissions of the existing aircraft on the ground in the vicinity of airports must be considered. While the high-speed cruise effects of gaseous emissions are important, their effect during climb and descent through the tropopause and the ozone layer will also need assessment. Additionally, the effect at cruise altitude will need to be addressed.

For the hypersonic aircraft, until the configurations can be more explicitly defined, assessment of the environmental impact cannot be initiated. In addition to forecasting aircraft types, fleet sizes, and engine types, it will obviously be necessary to identify the fuels that will be used (i.e., JP-4, hydrogen, or possibly liquid methane). All of these fuels will produce water vapor, and the engines will produce NO_x from the nitrogen and oxygen in the air during the combustion process.

Atmospheric Ozone

Status. In the early 1970s the prospect of supersonic flight by a large fleet of SSTs flying at high altitudes resulted in expressions of considerable concern that man-made pollutants would adversely modify the total ozone content of the earth's atmosphere. It was expected that the nitrogen oxides (NO_x) from aircraft would have a direct adverse impact on the atmospheric ozone, 90 percent of which was located in the stratosphere. As a result of research conducted since the advent of the first SSTs, studies have indicated that the distribution of ozone within the total atmospheric column is critical and of equivalent importance to the quantity of stratospheric ozone at a specific altitude. One indication of that importance is the recent evidence indicating a substantial thinning of the Antarctic total ozone during the spring. Early studies of atmospheric ozone tended to concentrate on the effect of individual pollutants. It now is clear that the effect of many pollutants, including the chlorofluorocarbons (CFC), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), and the nitrogen oxide (NO_x), all tend to interact and contribute to the processes controlling the atmospheric ozone distribution. To evaluate factors impacting this distribution process, it is no longer possible to study only the physical and chemical processes in the stratosphere (i.e., above approximately 36,000 feet to 50,000 feet), since it is agreed that it is also necessary to understand the processes controlling the chemical composition of the troposphere (i.e., below approximately 36,000 feet to 50,000 feet).

Study Areas. For a reliable understanding of the earth's atmospheric ozone distribution, it will be necessary to understand the interaction of atmospheric chemistry, radiation, and dynamic processes in the tropopause as well as in the stratosphere. Experimental evidence gathered during the last decade has shown that the atmospheric concentration of CH_4, NO_2, and the chlorofluorocarbons are currently changing at a significant rate and in the future modeling studies of the atmosphere, these constituents must be studied collectively, and not in isolation. It has also become apparent that multidimensional photochemical models are necessary to obtain realistic estimates of the atmospheric ozone variability.

Studies for Criteria Determination. Since the ozone layer modification is a global phenomena, it is fortunate that international organizations such as the United Nations Environmental Program (UNEP), the World Meteorological Organization (WMO), and other groups are all addressing the problem. During the last decade, as a result of upper atmospheric research, many world governments have come to recognize the relative destabilizing contribution of chlorofluorocarbons to the ozone layer when compared with the potential destabilizing effects of gaseous emissions by supersonic and hypersonic aircraft operating in the stratosphere. It has been alleged that ozone depletion is now viewed as a "minor barrier" to commercial HST flight since the ozone layer at 100,000 feet and above may be considered more stable and also that it has tendency which "cures" itself of damage caused by high-speed aircraft If this projection is substantiated in the total context of tropospheric as well as stratospheric chemistry, including the contributions of other source gases, with attention given to their combined effect on the total ozone column, then the prospects for establishing acceptable upper atmospheric emissions criteria for high-speed cruise of SST and HST aircraft will be substantially enhanced.

Criteria for Environmental Concerns

When reviewing the subject of high-speed cruise environmental concerns for SST and HST aircraft, as with any other existing highly complex transportation systems, these concerns cannot be isolated to a single operational mode. It is apparent that the environmental concerns will have an impact on airport capacity, en route noise levels, and international problems of protection of the earth's upper atmosphere. Aircraft design and operational criteria, must be established before investment and launch programs are considered for this category of aircraft.

The establishment of the necessary acceptability criteria will be a shared responsibility between all members of the air transport industry, the public, and the federal government. In the establishment of the acceptability criteria, we cannot afford the luxury of a mistake because the adverse economic impact of environmentally innapropriate criteria could not be economically absorbed. With respect to the outlook for commercial SST and HST aircraft, the advances in technology over the past decade must be considered highly encouraging. Long-range prospects are also encouraging and, in spite of the hard work involved, reasonable prospects of success are indicated if a comprehensive shared program is initiated.