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OVERVIEW OF NASA HUMAN RESPONSE TO SONIC BOOM PROGRAM

BY

KEVIN P. SHEPHERD
NASA LANGLEY RESEARCH CENTER

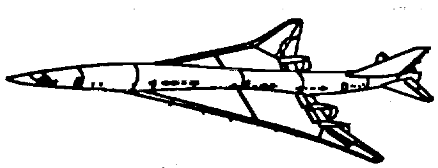
[redacted] PROGRAM OBJECTIVE

For some routes the ability to fly at supersonic speeds over land as well as over water would greatly enhance the time benefit to the passenger. It would also increase the productivity and and economic viability of the aircraft. There are no reliable guidelines which can be used to determine a sonic boom exposure which would be acceptable for over land supersonic flight. In addition to the peak pressure of the sonic boom, the detailed shape of the signature will also influence the perception, and therefore the community response, to sonic boom exposures.

Initially, the program aims to develop the capability to predict human response to individual sonic booms. This will enable a quantitative assessment of the benefit of "low boom" aircraft configurations and will also serve to guide the design of the aircraft and its operating conditions. This capability will form the foundation of studies to determine the relationship between sonic boom exposure and community response. Only then will it be possible to assess the feasibility of acceptable overland supersonic flight.

HSR SONIC BOOM ACCEPTABILITY

PROGRAM OBJECTIVE



- Establish feasibility of acceptable overland supersonic flight

OR

- Economic viability assuming subsonic overland restriction

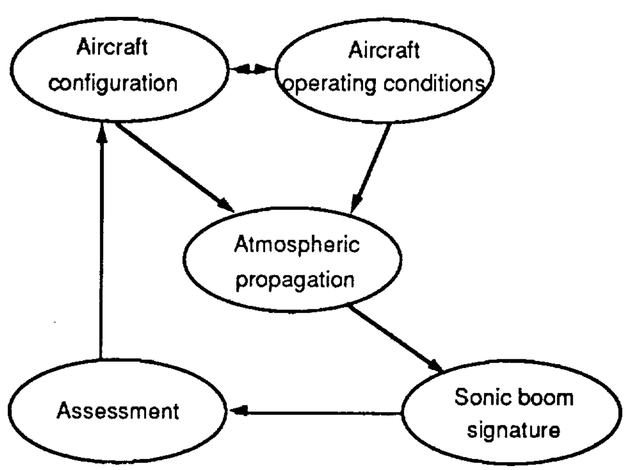
PROGRAM APPROACH

The assessment of the feasibility of acceptable overland supersonic flight requires that consideration be given to the range of sonic booms that are achievable through aircraft design. The determination of an appropriate single-event sonic boom assessment method can be used to guide the design of "low boom" configurations and their operating conditions, since these influence the sonic boom that reaches the ground. Furthermore, it is necessary to quantify the effects of the atmosphere on the sonic boom signature passing through it.

HSR SONIC BOOM ACCEPTABILITY

APPROACH

- Define acceptable sonic boom exposure
- Assess feasibility through aircraft design and operation



ELEMENTS OF THE SONIC BOOM ACCEPTABILITY PROGRAM

The determination of a sonic boom exposure which would be acceptable to the general population requires, as a first step, a method to quantify human response to individual sonic booms. Laboratory studies are being conducted to determine human response to simulated sonic booms. The sonic booms include the classical N-wave as well as those shapes which might be produced by "low-boom" configurations. These studies are aimed at identifying a noise metric which can predict, with confidence, human response to arbitrary sonic boom shapes and amplitudes. These studies also include the simulation of sonic booms as they would be heard indoors, by incorporation of the acoustic transmission properties of residential structures. Human response to sonic booms within a structure is a function of both the transmitted acoustic signal and any perceivable vibration or secondary acoustic radiation due to rattling of windows, pictures, etc. Thus, analytical and experimental studies are being performed to assess the response of typical structures to excitation by sonic booms.

The response of people who experience sonic booms on a regular basis in their homes will be influenced by many factors such as the number of booms, the time of day that they occur, the activity that the person is engaged in, etc. An in-home sonic boom generation system will be installed in volunteers' homed for an extended period of time in order to examine some of these variables. It will also be possible to compare the residents' response to sonic booms with their response to more familiar sounds such as aircraft flyover noise.

The determination of the relationship between sonic boom exposure and community response will be derived from studies of populations which are routinely exposed to sonic booms. Studies of this type provide the information to answer public policy questions regarding acceptable levels of sonic boom exposure.

HSR SONIC BOOM ACCEPTABILITY

PROGRAM ELEMENTS

- LABORATORY RESPONSE STUDIES
  - Single event sonic boom metric (outdoor listening conditions)
  - Single event sonic boom metric (indoor listening conditions)
  - Quantify benefits of sonic boom shaping
- BUILDING RESPONSE STUDIES
  - Building response and acoustic transmission
  - Contribution of vibration & rattles to human response
- IN-HOME RESPONSE STUDIES
  - Sonic boom exposure metric
  - Comparison with familiar noise sources (aircraft noise, road traffic)
- COMMUNITY RESPONSE STUDIES
  - Sonic boom exposure criteria
  - Comparison with familiar noise sources

SONIC BOOM ACCEPTABILITY CRITERIA

The determination of sonic boom acceptability criteria initially requires the determination of a method to assess individual sonic booms. The sonic boom simulators shown on the left of the figure are designed to examine human response to sonic booms. The booth, located at the NASA Langley Research Center, is equipped with loudspeakers which generate simulated sonic booms. The signal provided to the speakers is computer-generated, to allow flexibility in the range of signals and to enable compensation for some of the inadequacies of the sound reproduction system. The simulator can simulate sonic booms having overpressures as high as 4 psf, with rise times as short as 1 msec. The sketch represents a house with external acoustic sources that is being built at the Georgia Institute of Technology, and is intended for studies of both human and structural response to sonic booms. In contrast to the NASA simulator, the simulation will examine additional factors such as perceivable building vibration and secondary acoustic radiation due to the rattling of picture frames, etc.

The in-home simulation system, shown in the center of the figure, is designed for deployment in homes for relatively long periods of time. This approach adds a degree of realism that is not present in the laboratory, and enables the number of sonic booms and the time at which they occur to be examined. The system generates sonic boom sounds, measures noise levels in the home, and records the resident's reaction to the sonic boom exposure. A prototype system is to be pilot tested in the near future.

An absolute determination of human response to sonic booms requires that a population be routinely exposed to real sonic booms over an extended period. Military operations will hopefully provide this opportunity.

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