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NASA HSR PHASE I LOW NOISE NOZZLE TECHNOLOGY PROGRAM OVERVIEW

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[redacted]

SUPERSONIC CRUISE

Significant advances in propulsion performance are required if supersonic transport vehicles are to become an important part of the 21st century international air transportation system. The objective of the NASA Supersonic Cruise propulsion research is to provide the critical propulsion technologies to the industry in a timely fashion to contribute to the design of economically viable and environmentally acceptable high-speed civil transport (HSCT).

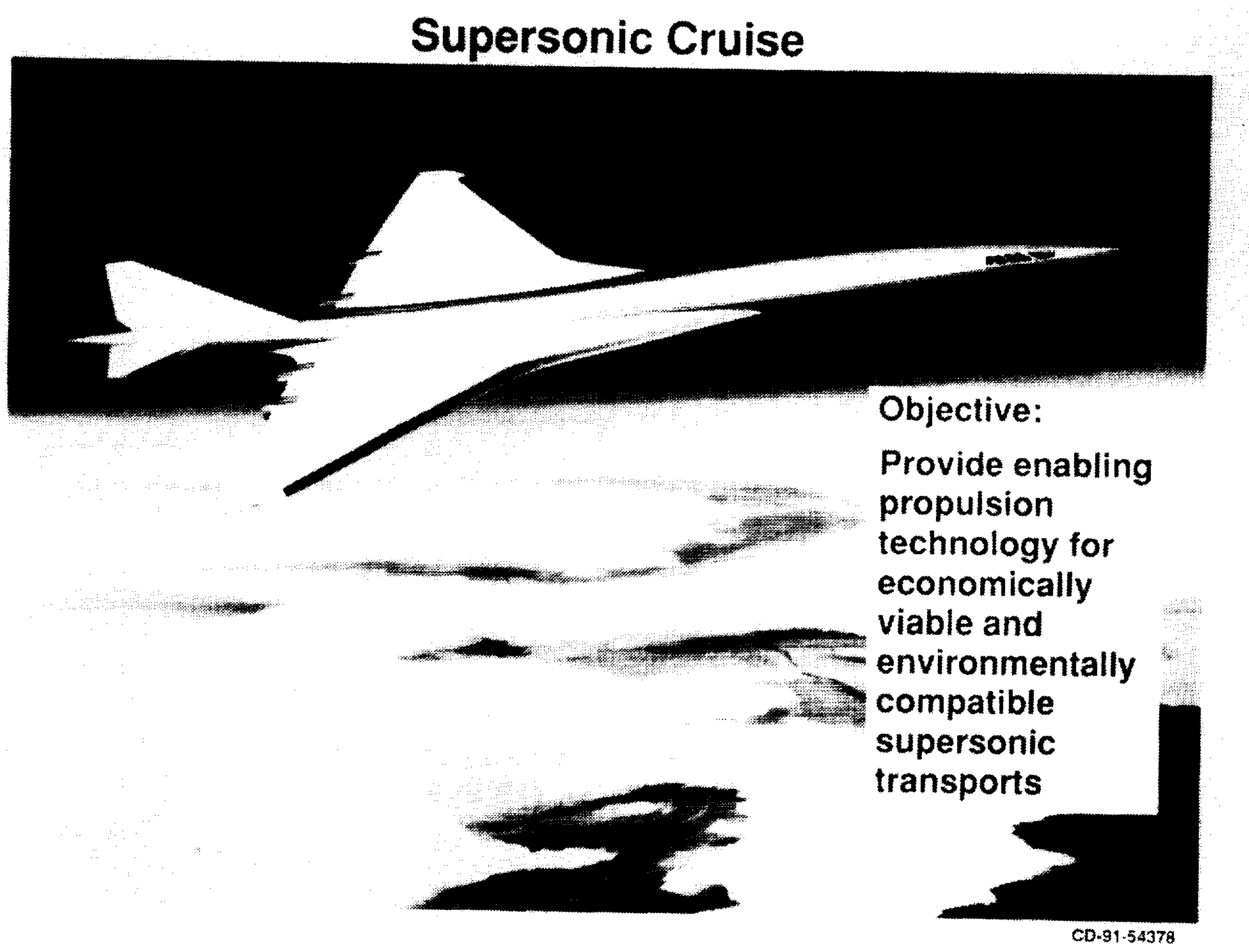

Figure 1

HIGH-SPEED RESEARCH PROGRAM

The NASA Phase I High-Speed Research Program (HSRP) emphasizes solutions to the critical environmental barrier issues associated with any future HSCT aircraft. Two of these barrier issues - atmospheric ozone depletion and community noise - are primarily propulsion issues and are addressed in the Lewis portion of HSRP. The critical economical viability issues will be the emphasis of a proposed Phase II HSRP, which could be initiated as early as FY 1992.

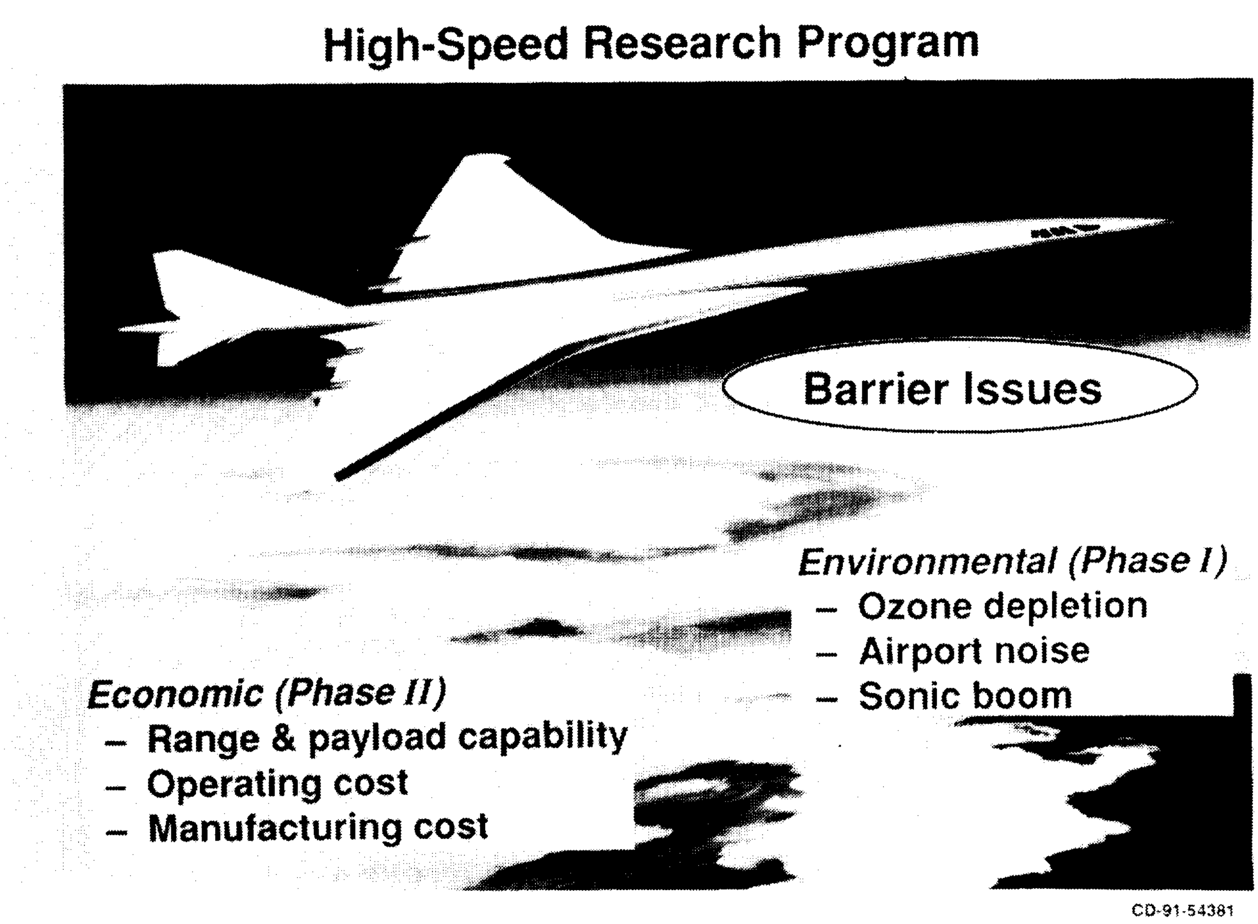

Figure 2

HSCT SOURCE NOISE CHALLENGE

The HSCT source noise challenge is illustrated in this figure. The jet exhaust noise levels at takeoff and landing conditions must be reduced by 15 to 20 db relative to reference conic nozzle levels before any future HSCT can hope to have noise levels below FAA noise regulation limits. At the same time, the nozzle aerodynamic performance levels must be kept high if vehicle overall mission performance goals are to be met. This combined acoustic-aerodynamic challenge is often expressed as a ratio of decibel noise reduction to resultant percent thrust loss. For a viable HSCT design this ratio should be in the neighborhood of 4:1. As this figure shows, current technology would yield a nozzle design with a ratio of no better than 2:1.

HSCT SOURCE NOISE CHALLENGE

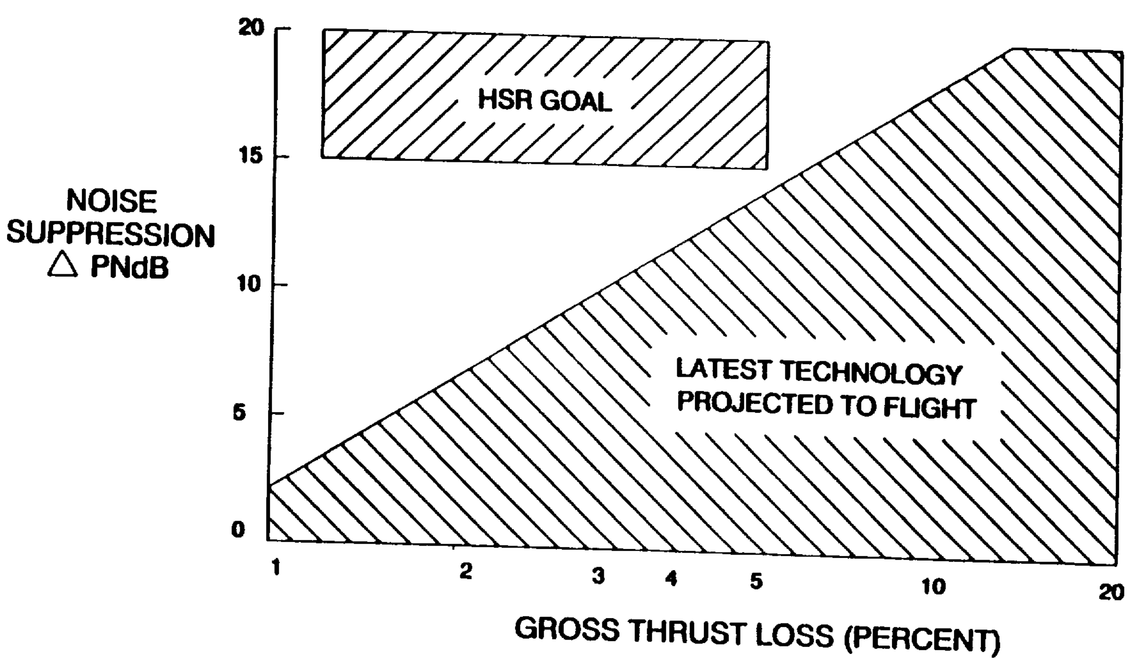

Figure 3

LOW-NOISE NOZZLE TECHNOLOGY ELEMENTS

The major elements of the source noise portion of HSRP are shown in this figure. Heavy emphases are being placed in the first years of HSRP on computer code development and validation and on subscale experiments to evaluate potentially attractive nozzle concepts. The emphases regarding the codes is again on applying available solvers for both nozzle aerodynamic flows and for the acoustic signatures of the various configurations. The laboratory experiments and computer code developments and the insights they provide as to the governing fluid physics will be key inputs to the development of advanced nozzle configurations that will meet the HSRP goals, both for aerodynamic performance and acoustic suppression.

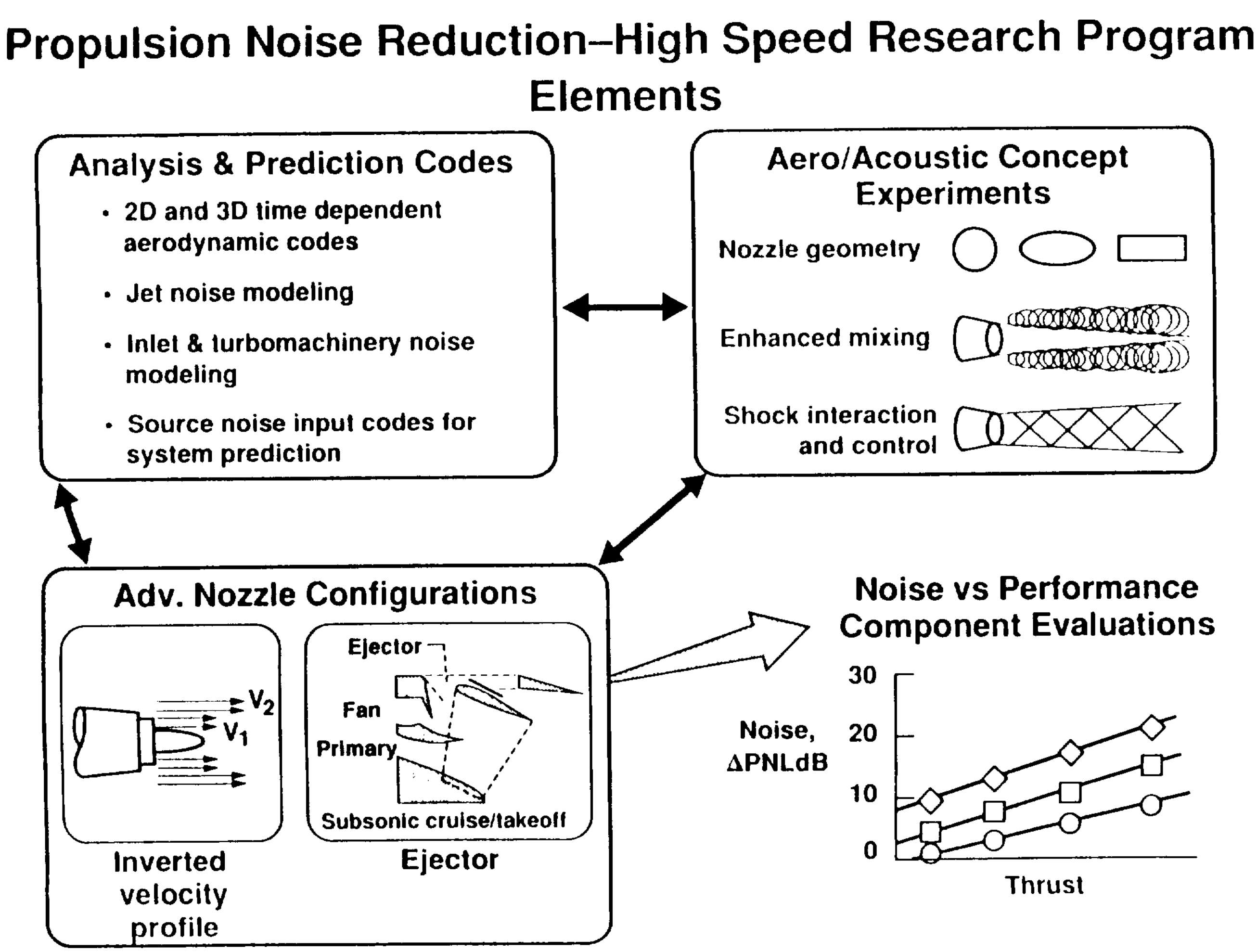

Figure 4

HSR SOURCE NOISE REDUCTION PROGRAM

This figure represents the HSR Source Noise Reduction Program in a slightly different or bar chart form. This represents basically the same information identified in the elements figure but also includes the program major milestones. The first darkened bar represents the whole program with major milestones shown at the halfway point and then at the end. The next three bars represent the previously identified activities including Aero/Acoustic Analyses, Aero/Acoustic Concept Evaluations or Experiments, and then Subscale Nozzle Performance Experiments with Advanced Configurations. Also included here is the activity relative to engine cycle analyses to determine the cycle benefits to be gained and overall aircraft system noise prediction (e.g., ANOPP). The HSR Phase I program indicated here is a six year activity with major milestones again at the halfway point at the end of FY92 and then overall at the end of FY95. The milestones shown at the halfway point represent the completion of a series of initial screening activities of either the advanced codes or the nozzle concepts. The best of these concepts will then be researched in more detail through the rest of program. Details of the activities occurring relative to each of the program bars will be discussed in the various papers presented in this session of the workshop including inputs from NASA, Industry, and an example of support from the Academic Community.

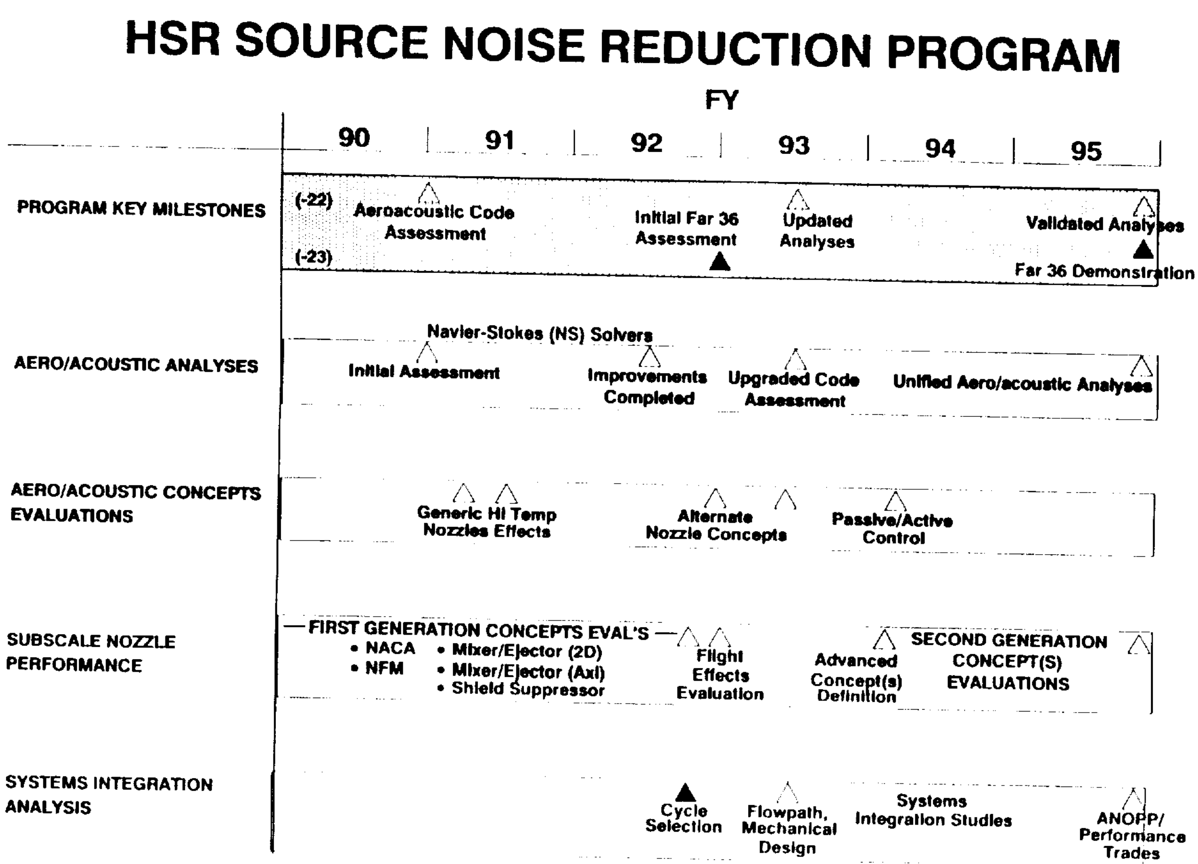

Figure 5

NASA HIGH-SPEED RESEARCH PLAN
PROPULSION ELEMENTS

The roadmap for the propulsion elements of NASA's overall High-Speed Research Program is shown in this figure. HSRP Phase I efforts will result in demonstrations of low-NO_x combustor and low-noise nozzle concepts as well as determination of preferred HSCT propulsion cycles. NASA's HITEMP engine materials program will provide the basis for the development of the advanced composite materials required for the combustor and nozzle components of any future HSCT engine.

The HSRP Phase I and HITEMP research results will be the inputs to the proposed HSRP Phase II Program currently advocated by NASA. The propulsion elements of HSRP II would demonstrate HSCT propulsion technology readiness initially through large-scale testing of the critical components (inlet, fan, combustor, and nozzle); then these components would be combined with an available core engine in propulsion systems technology demonstrations at both low-speed (takeoff) and high-speed (supersonic cruise) conditions.

The Enabling Propulsion Materials of HSRP II would demonstrate the materials technology readiness through tests of an uncooled ceramic matrix composite (CMC) combustor liner and a nozzle substructure element fabricated from an advanced intermetallic matrix composite (IMC) developed in HSRP II.

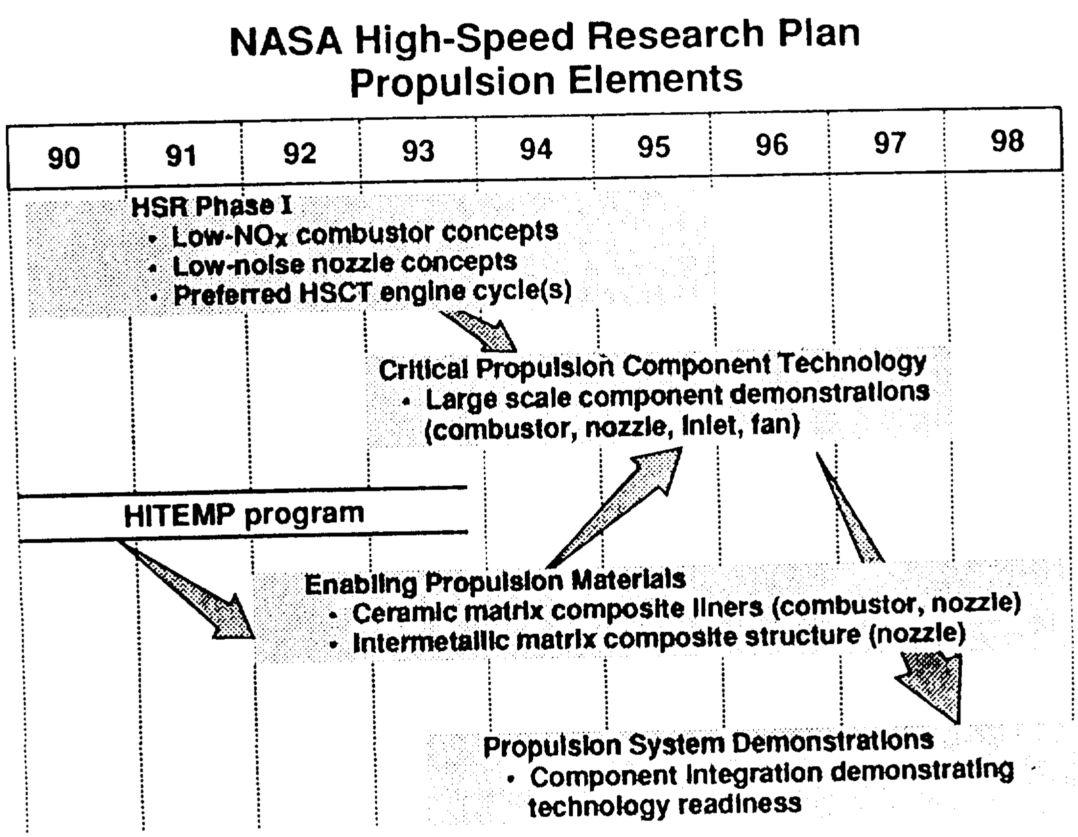

Figure 6

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