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WHAT IS THE X-30?

In the interest of being mercifully short, given the time of day, I'd like to narrow down my comments to maybe just referring to what we anticipate in the flight test of the X-30 as opposed to describing the entire vehicle. I'm not sure if there is a consensus of opinion on that anyway. I will have to admit to feeling like I'm on thin ice up here addressing an audience, talking about what might be to a group of people that have demonstrated a very constructive and solid engineering achievement. I agreed to possible embarrassment in the hopes of showing you that not all the lessons of the experience of the X-15 have been lost on some of us who are trying to postulate what an X-30 would be like.

Recognizing the diversity of the recent backgrounds of an audience who would be interested in the X-15, I thought I would attempt an abstract definition of the X-30. Basically, the emphasis is on research (fig. 1). We envision an airplane, a machine that is capable of exploring technology that is critical to single stage to orbit and to hypersonic cruise. I am very comfortable with the comparison of the X-30 to a laboratory that will be able to investigate such things as the chemistry of supersonic combustion and the control of an integrated engine airframe, where the forebody of the airplane is the first compression surface for the propulsion system and the tail of the airplane is the expansion surface for the propulsion. The X-30 is very ambitious; it follows a path that is pretty well established by such programs as the X-15.

Not only should the X-30 share some of the sky with the X-15, which is going to be I'd say about 68 to 69,000 ft, a little over Mach 5—which you can see (fig. 2) that's pretty much in the heart of the first part of what we anticipate for the X-30. I think it should also share some of the experiences of the people who operated the X-15, and to that order we have started with a basic list of flight test assumptions (fig. 3) that are based on the experiences of those that tested the X-15 as well as other airplanes. For example, engines will fail with a new propulsion system; what Bob has just said, from damage at a high temperature; and basically being test pilots and testers whose predictions are anticipated to be sometimes wrong.

Having these kinds of assumptions has led those of us who have thought about it to suggest a preferred flight profile that might look like the one you see here (fig. 4). That profile has the advantages which we have listed very quickly here (fig. 5), and I think this echoes some of the comments you have heard earlier this afternoon. The X-15 has shown that it is certainly to our advantage to minimize time at high Mach number, reduce the heat flow, and head home after your test flight.

I included figure 6 to demonstrate the effect of velocity squared on the turn radius which is a key factor. You can see the difference here between just a Mach 10 radius of turn and a Mach 15. Other test planning considerations (fig. 7) include potential emergency landing sites, lots of them (fig. 8), ground test ranges for line-of-sight coverage of the high-flying experimental aircraft (fig. 9), and consideration of possible sonic boom impacts on the folks under our flightpath (fig. 10). So for all those reasons we end up with a profile that looked like the one I just showed you. That profile led us to a conceptual flight test program that we might break into three phases.

The first you might call the "early" flights which we anticipate to be operated here in our 2508 test area (fig. 11). Basically, I see the objective being dedicated to traditional functional check flight. This vehicle, as Bob alluded to and I am sure all of you would appreciate, is probably the most sophisticated and highly integrated machine. Operating those systems, understanding and making sure that their interactions and subsystems are working in the normal environment early on in the functional test flights, is going to be time consuming and a very worthwhile process. In addition, it is going to be a low L/D vehicle not unlike the X-15, and therefore there is much interest in the landing and takeoff characteristics of the vehicle. Finally, no matter how fast the X-30 is designed or desires to go, it is still going to have to approach the nonlinearities of the transonic region, going from subsonic to supersonic flight in terms of structural dynamics and stability derivatives in a cautious fashion, and I would see the first phase dedicated to those types of activities.

A second phase, which is kind of euphemistically labeled "slow" (fig. 12) from the X-30 point of view, I would think almost certainly is going to be driven by operating for the first time and demonstrating a very experimental propulsion system. Convincing the flight test team that we can go from ram-to-scram transpulsion, that we understand the stability characteristics and parameters of the long external inlet and that we can control supersonic combustion.

And the final phase, which is "fast" (fig. 13), again conforms to the types of profiles that were laid out in our assumptions, which allow landing sites and heat vehicles briefly on the final test point headed towards home. I think this final phase will have to be dedicated to the validation and improvement of computational fluid dynamics—this high Mach number regime is not going to be supported by a very large database in wind tunnels, and the computational fluid dynamics will most likely be our primary way of predicting aircraft performance. Clearly, it will be dedicated towards the demonstrating of the complete total performance of the aircraft, and finally it's going to have to be concerned with the control and successful management of the heating effects on the vehicle which are associated with this flight. I think when we understand those things, we will be standing on at least the beginning of a plateau of new technology which is represented by the X-30.

QUESTIONS AND ANSWERS

(Audience) How fast was the speed on the chart that showed fast Mach number on it, Steve?

(Ishmael) We generated those with an aircraft in real-time simulation here at Dryden to try to help the X-30 program. Those were developed with a generic airplane, called the government baseline, which is a program that I know you are aware of. That particular profile would be associated with this airplane (which is not a real airplane) of being between maybe Mach 10 to 15. I didn't want to get into all of the details. The idea of cruising out at a low speed allowing an emergency landing if the engine fails and so forth, turning around and running back, means a lightweight airplane. That is a much different acceleration profile obviously than when taking off with a sufficient fuel fraction to go to orbit to demonstrate the program's objective, so they are surprisingly sharp turns, I do agree. But it is representative of at least a very simple performance model that is included in the government baseline simulation.

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WHAT IS THE

X - 30?

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THE X-30

- **IT IS**
  - **A RESEARCH VEHICLE**
    - **- CAPABLE OF**
      - **--SSTO**
      - **--HYPERSONIC CRUISE**
    - **- BEING BUILT TO TEST**

- **IT IS NOT**
  - **THE "ORIENT EXPRESS"**
  - **AN OPERATIONAL VEHICLE**
  - **BEING TESTED TO BUILD / PRODUCE**

Figure 1. Definition of the X-30 research vehicle.

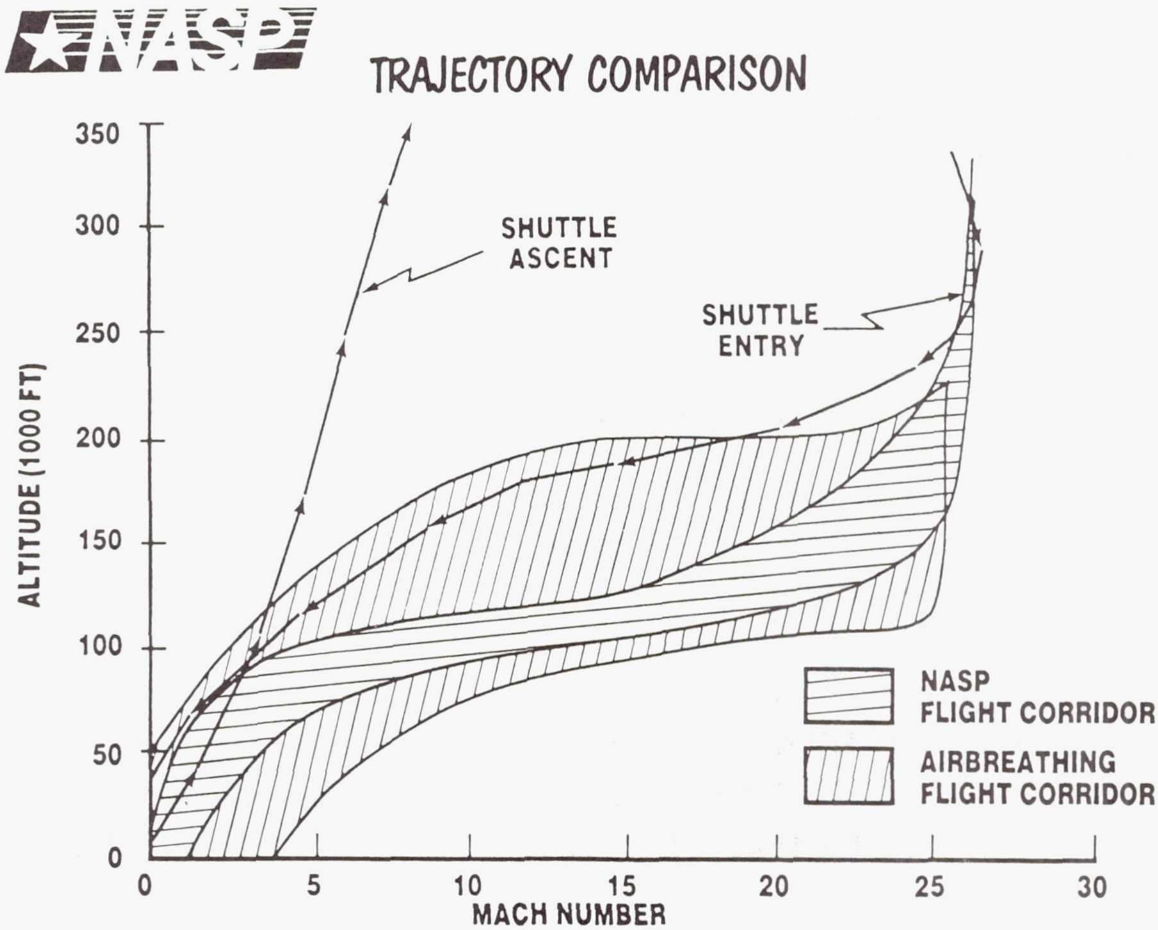

Figure 2. X-15 and X-30 trajectory comparison.

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X-30 FLIGHT TEST ASSUMPTIONS

- ENGINES WILL FAIL
- THERMAL DAMAGE WILL OCCUR
- PREDICTIONS WILL BE WRONG

Figure 3. X-30 flight test assumptions.

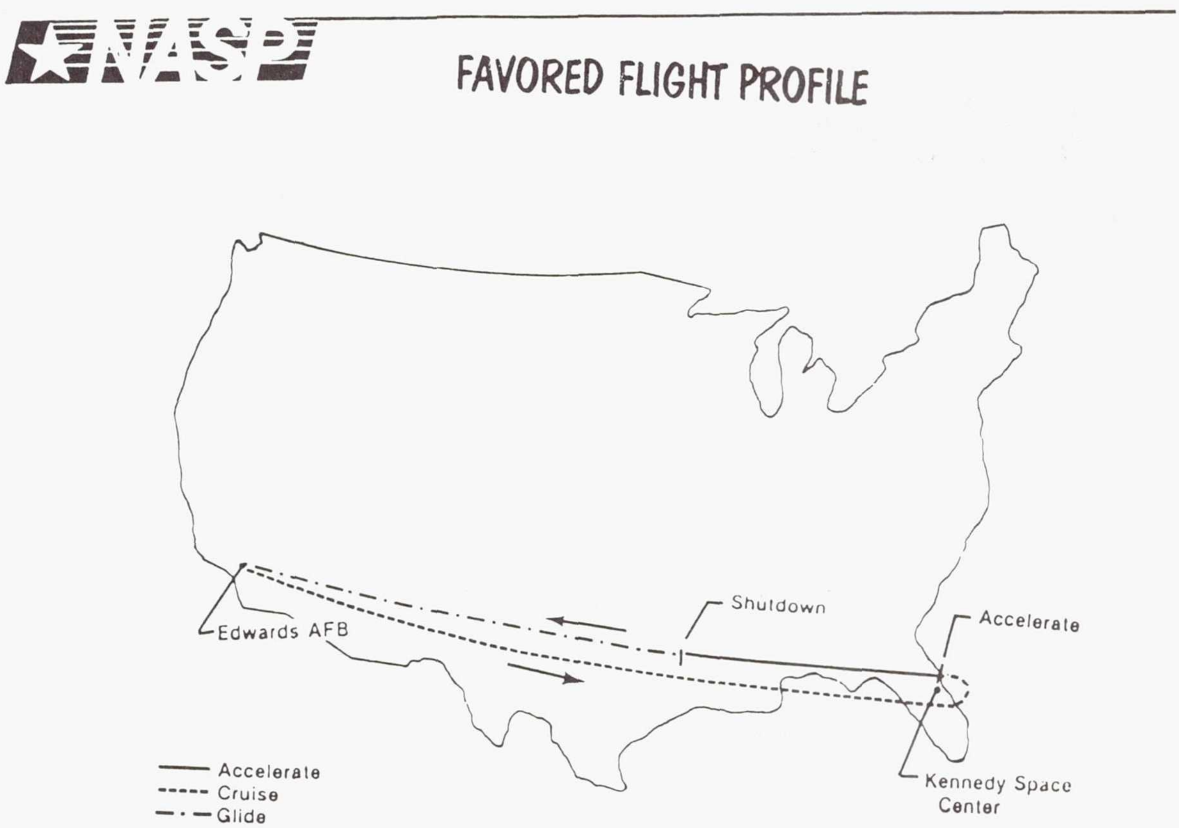

Figure 4. Favored flight profile.

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ADVANTAGES

- LESS TIME AT HIGH MACH NUMBER
- REDUCES HEAT LOAD
- SMALLER TURN RADIUS
- HEADED HOME AFTER TEST POINT

Figure 5. Advantages of the forward flight profile.

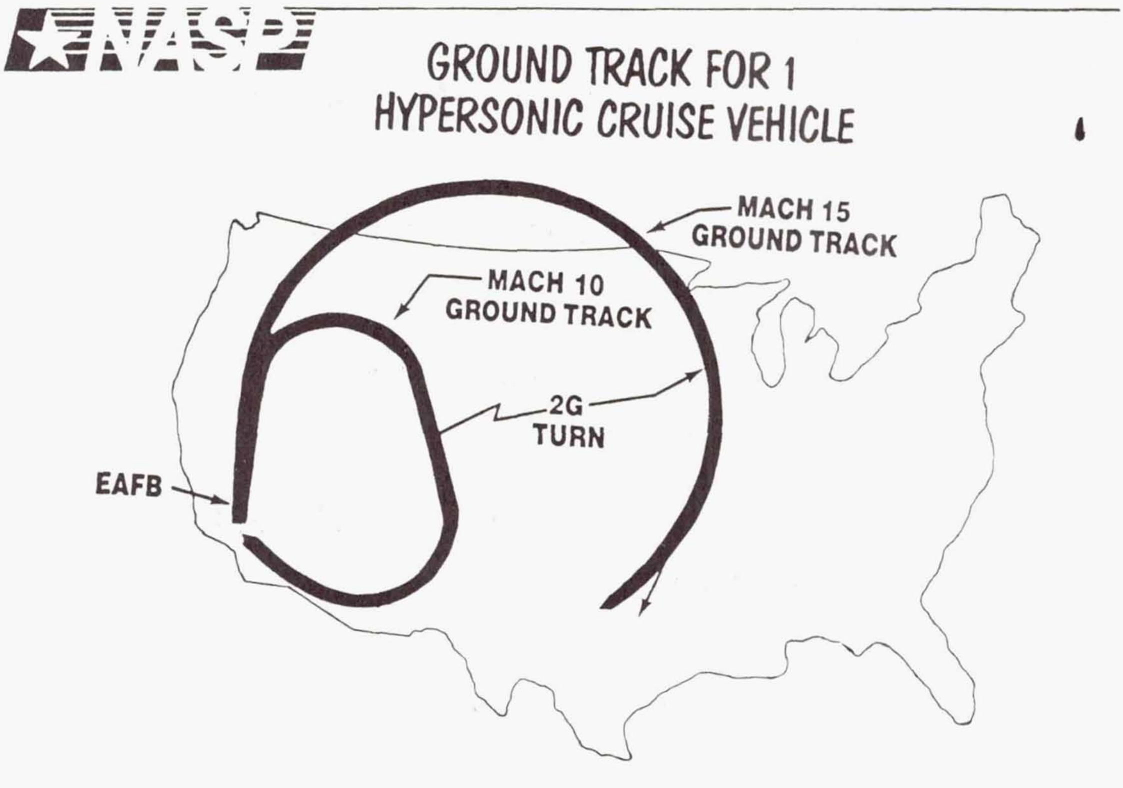

Figure 6. Ground track for representative hypersonic cruise vehicle.

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OTHER CONSIDERATIONS

- **EMERGENCY LANDING SITES**
- **GROUND TEST RANGES**
- **SONIC BOOM**

Figure 7. Other test-planning considerations.

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CANDIDATE EMERGENCY LANDING SITES

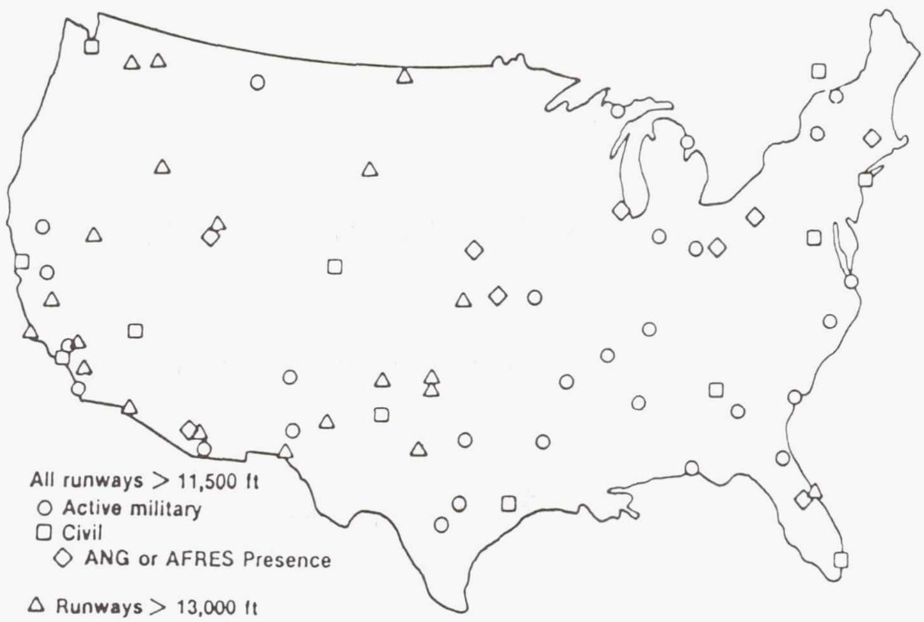

Figure 8. Candidate emergency landing sites.

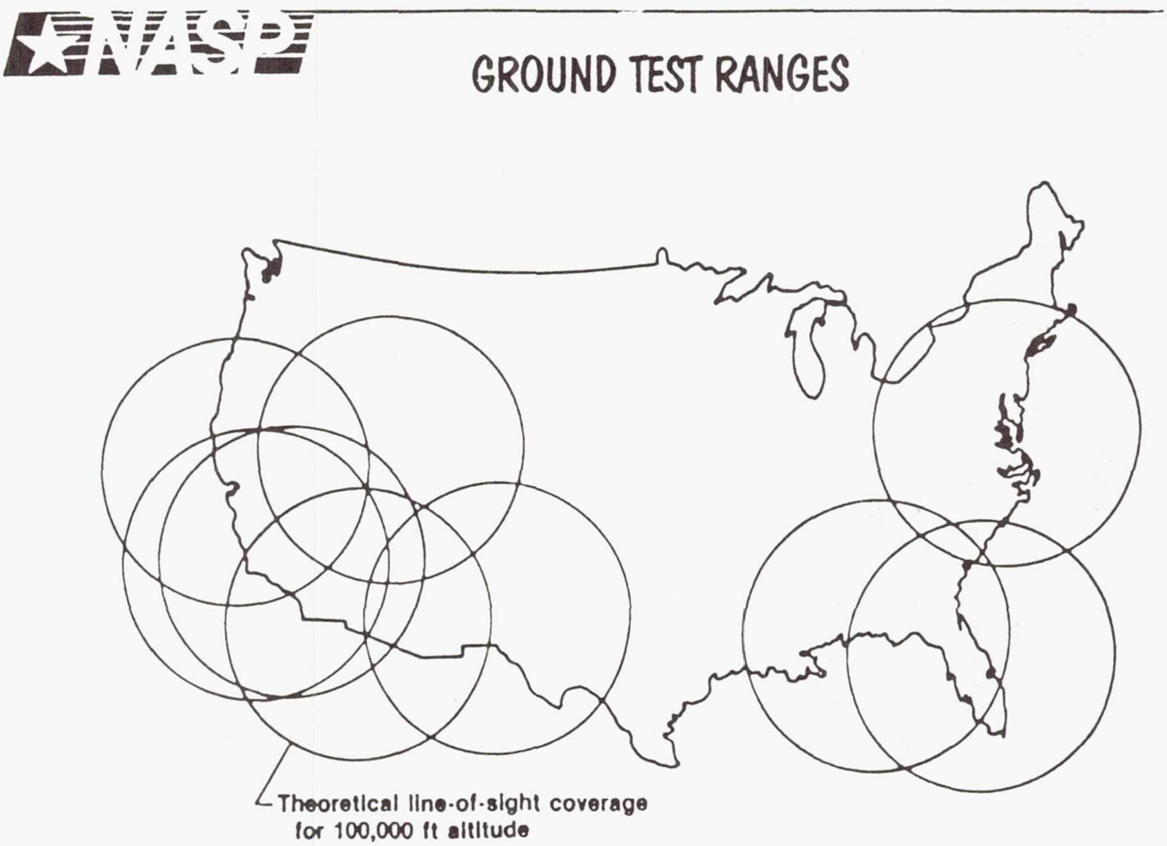

Figure 9. Ground test ranges for line-of-sight coverage of the high-flying X-30 research vehicle.

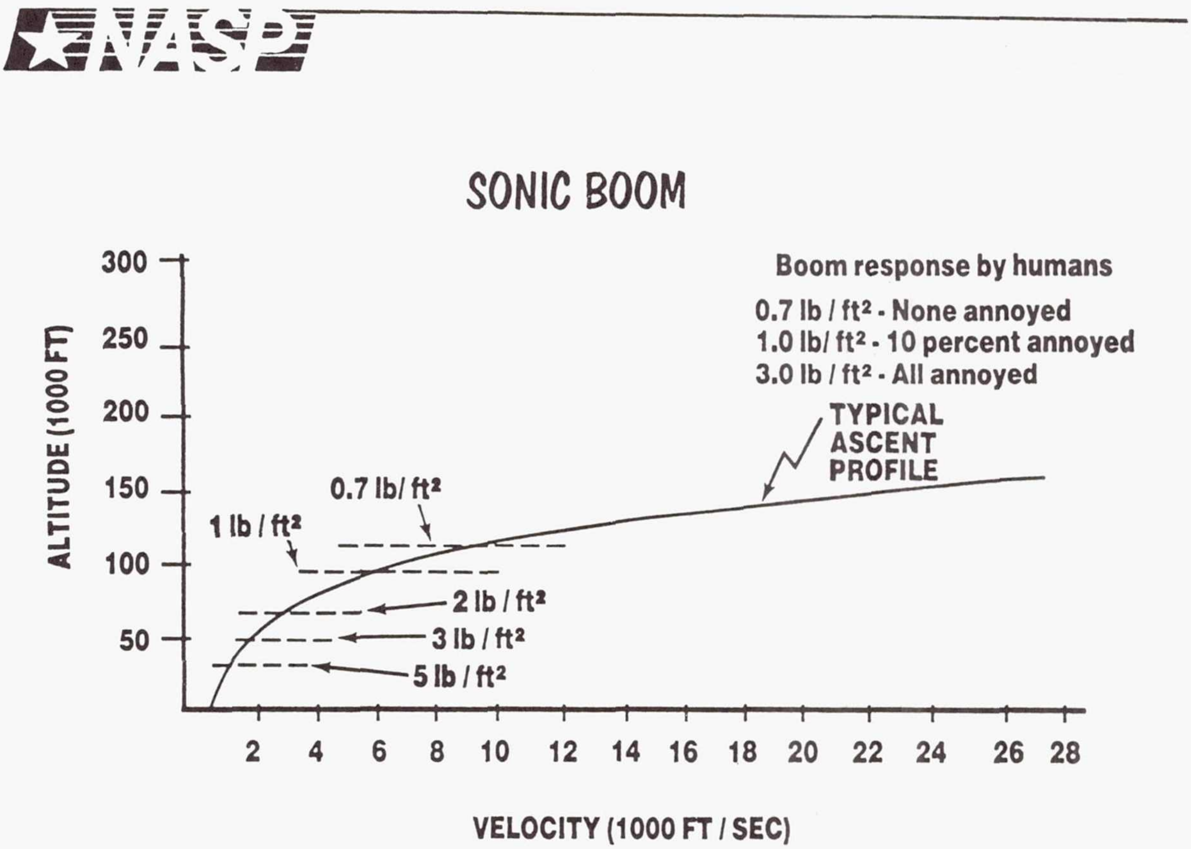

Figure 10. Possible sonic boom impacts on individuals under the flightpath.

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CONCEPTUAL

ENVELOPE

EXPANSION

SEQUENCE

Figure 11. "Early" flights anticipated in area R2508.

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SLOW

Figure 12. "Slow" test phase.

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FAST

Figure 13. "Fast" test phase.