Technical Comments

Comment on "Sonic Booms Attributed to Subsonic Flight"

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IN Ref. 1 the author developed relationships based on the method of geometric acoustics for atmospheric conditions which could result in the formation of sonic booms by subsonic airplanes. In checking the results it was found that the inequality (4) is in error by a factor of 2. The error stems from the failure to substitute the expression for $\cos\gamma$, which is a function of z, in the expression for $[d(\Delta x)/dz]$ before performing the integration with respect to z. The correct result is

$$-hz/a > 1 - M$$

A more general form of the conditions (4) and (8) can be obtained from Ref. 2 for arbitrary variations of atmospheric conditions with z. This relationship is

$$M > [(a + u) - u_a]/a_a$$

where M = airplane Mach number; a = sound speed at distance z from airplane; u = wind speed at distance z (positive in (+) x direction); a_a = sound speed at airplane; and u_a = wind speed in x direction at airplane.

The qualifications mentioned by the author[1] in his discussion should be re-emphasized, especially those concerning the spreading of the energy associated with the elementary subsonic disturbances and their formation into shock waves. The rapid dissipation of this energy with distance from the airplane in subsonic flow would probably preclude coalescence into a shock wave, even in the presence of high wind shear.

References

[1] Barger, R. L., "Sonic Booms Attributed to Subsonic Flight," *AIAA Journal*, Vol. 5, No. 5, 1967, pp. 1042–1043.
[2] Kane, E. J. and Palmer, T. Y., "Meteorological Aspects of Sonic Boom," Rept. RD 64-160, Sept. 1964, Federal Aviation Agency SRDS.

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Reply to Comment by E. J. Kane

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INEQUALITY (4) is in error as a result of the failure of the analysis to account for the refractive effect of the wind. However, Kane's suggested correction to the analysis would still yield an incorrect expression for the wave fronts. [It would not satisfy the partial differential equation (11) of Ref. 1.] With regard to the general inequality stated by Kane it should be noted that: 1) the equation for the wave fronts was not required in the derivation; 2) the inequality was obtained from consideration of the rays associated with the wave envelope formed at supersonic speeds; and 3) its applicability as a criterion for formation of an envelope of elementary disturbances at subsonic Mach numbers was apparently not discussed in Ref. 2. Another mechanism for generating subsonic booms (suggested by some recent experiences) is the tail wave which may extend a considerable distance below an airplane flying at a Mach number very close to one.

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References

[1] Milne, E. A., "Sound Waves in the Atmosphere," *The Philosophical Magazine*, Ser. 6, Vol. 42, 1921, pp. 96–114.
[2] Kane, E. J. and Palmer, T. Y., "Meteorological Aspects of Sonic Boom," Rept. RD 64-160, Sept. 1964, Federal Aviation Agency SRDS.

Comment on "Thermal Radiation from Solid Rocket Plumes at High Altitude"

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IN a recent paper Fontenot[1] described a method for estimating base heating rates due to radiation from aluminized solid propellant exhaust plumes for conditions where the particle temperatures are controlled by radiation rather than by convection. In this analysis gas radiation was neglected and the particles were assumed to be of a unique size with uniform distribution and temperature at each cross section of the plume. Similar to Morizumi and Carpenter,[2] Fontenot reduced the problem to that of an equivalent radiating surface. This then required determination of the local temperature of the plume and its apparent emissivity. The purpose of this note is to show that the energy balance used to calculate the plume temperature is in error and, more significantly, to point out that the data used to describe the spectral emissivity of the plume are not valid for aluminum oxide.

To determine the variation of temperature with axial distance, Fontenot assumed a conical shape of the plume and considered a control volume comprised of the conic section between two closely spaced circular cross-sectional planes located normal to the axis. The change in internal energy of particles passing through the control volume was equated to energy radiated from the lateral conic surface. This is an un-

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