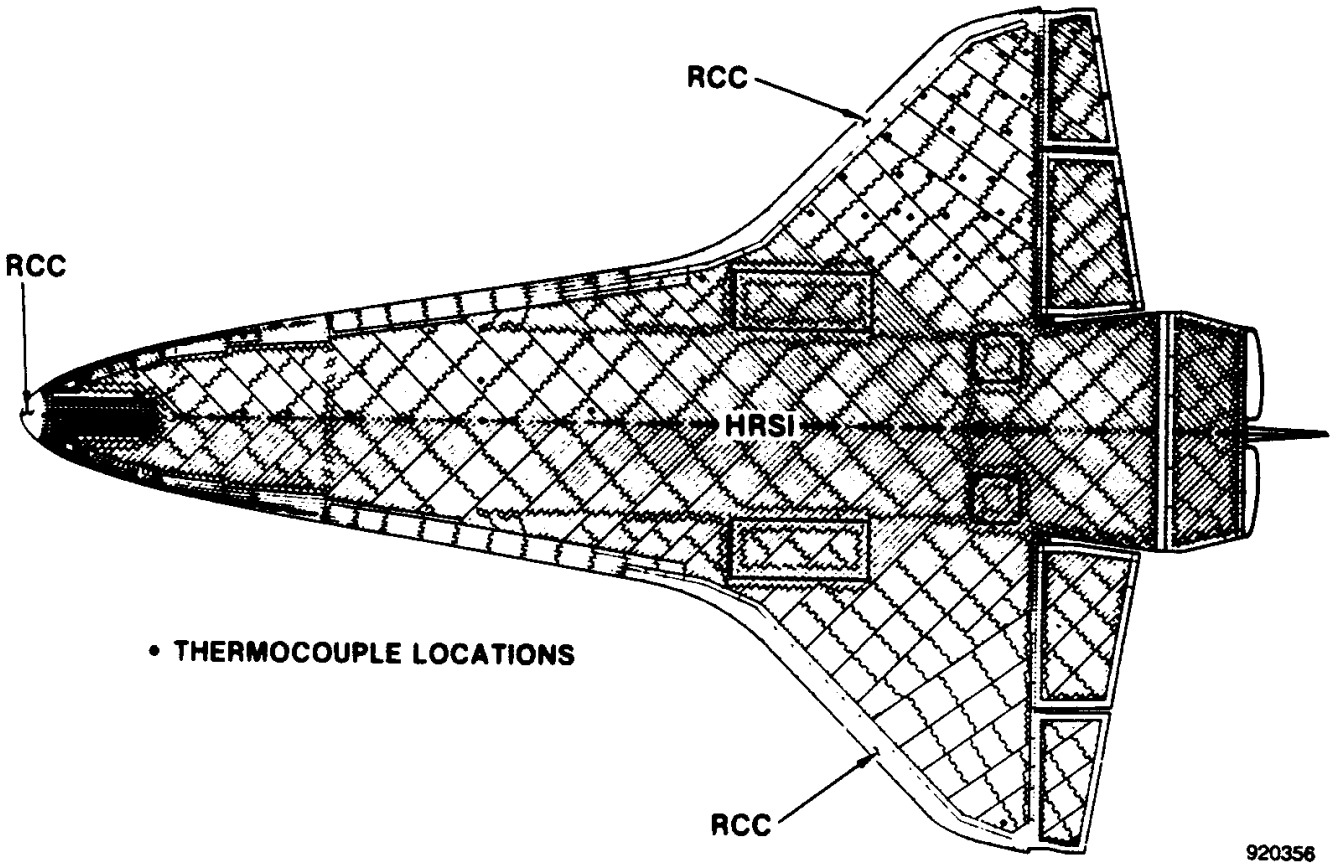

Fig. 18 Orbiter lower surface tile pattern and surface thermocouple layout (from Ref. 33). [Not to scale.]

From Iliff and Shafer, "Space shuttle hypersonic aerodynamic and aerothermodynamic flight research and the comparison to ground test results, NASA TM-4499, June 1993.

From Iliff and Shafer, "Space shuttle hypersonic aerodynamic and aerothermodynamic flight research and the comparison to ground test results, NASA TM-4499, June 1993.

71km = 233 kft,
6.73 km/s = 22.1 kft/s = 15.1 kmph

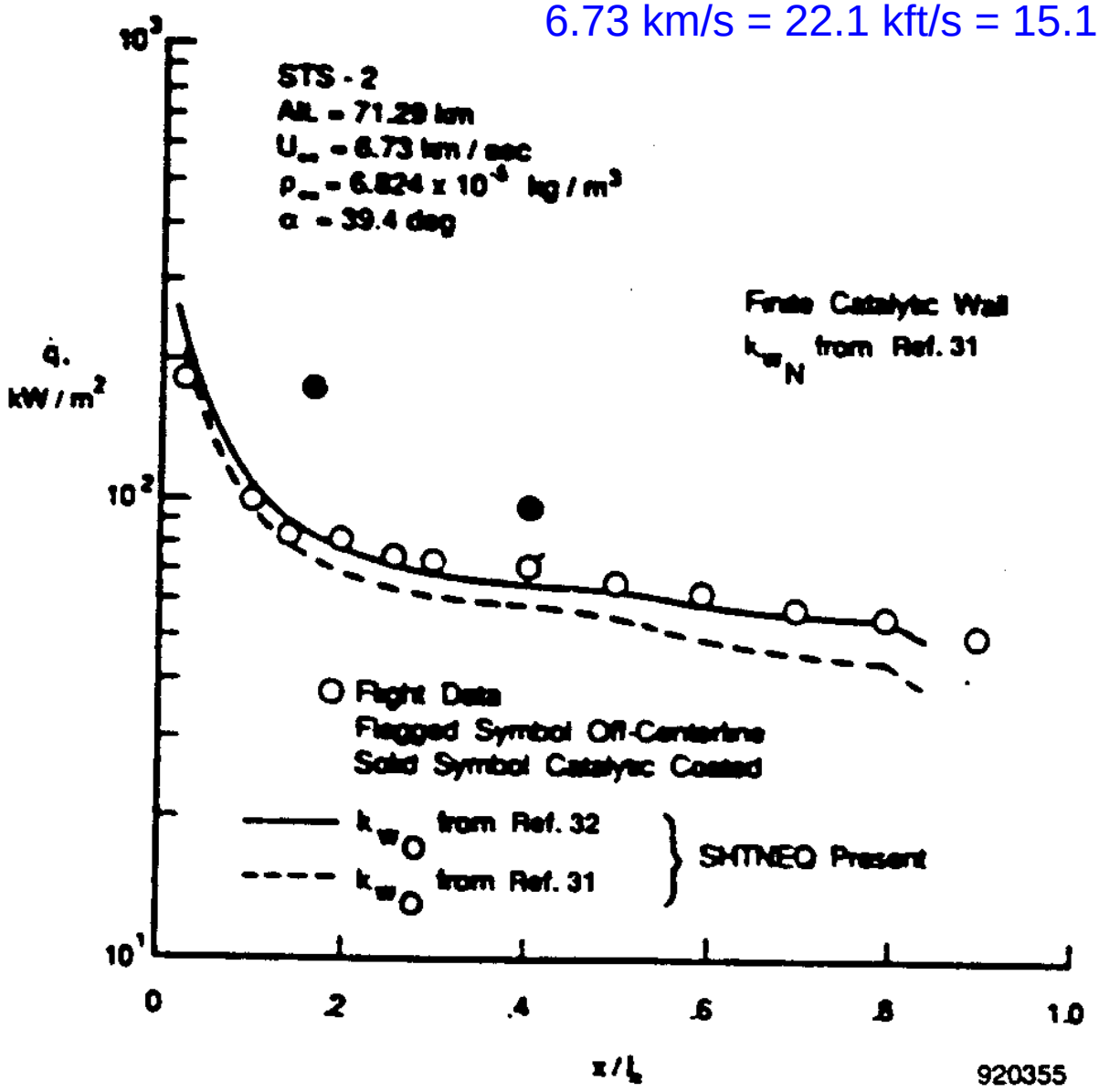

Fig. 17 Nonequilibrium heat-transfer prediction along the windward centerline at an altitude of 71 km (adapted from Ref. 30).

Rough Estimate of Heating-Rate Effect on Aluminum if Tile Completely Missing, SP Schneider 14 Feb 03: Take 100 kw/m^2 as a nominal heating rate. Assume tile and substrate completely missing, heat is applied to aluminum. Neglect intensification of heating due to hole, neglect conduction in aluminum, do 1st and crude approx. to aluminum temperature. Guess that aluminum is 3 mm thick (also crude approx.).
Do zero-dimensional approx., q * S * t = heat added = rho c_p V deltaT, change in internal energy in time t. Simplifies to q*time = rho * c_p *thickness * deltaT, see AAE450 methods handout. Neglect radiation. Aluminum, c_p=0.90 kJ/kg-K, Reynolds, Eng. Thermo., p. 659, rho=2707 kg/m^3. If alum. starts at 0C, must rise to 660C to melt, a 660K rise, take deltaT as 660K. time to melt 3 mm alum. is about 48 sec.

From Iliff and Shafer, "Space shuttle hypersonic aerodynamic and aerothermodynamic flight research and the comparison to ground test results, NASA TM-4499, June 1993.

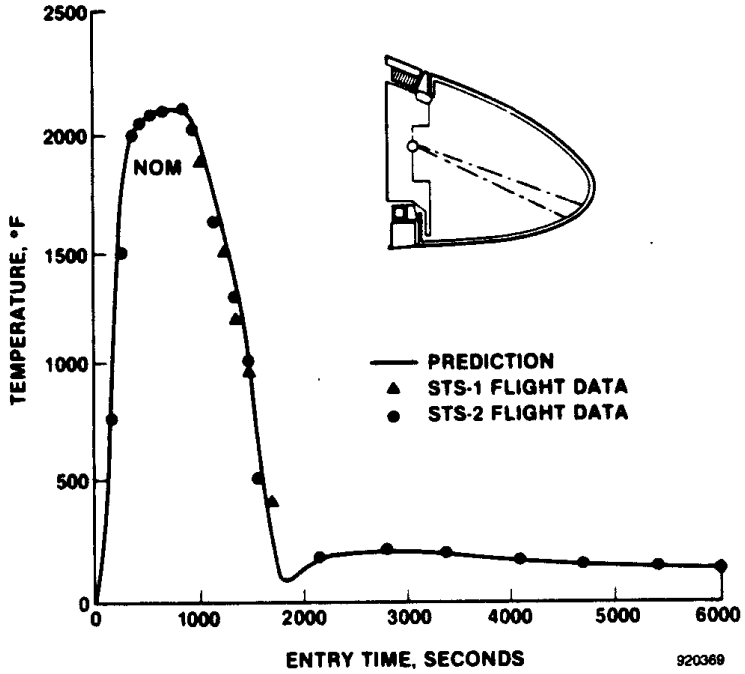

Fig. 30 The 80-percent semispan leading-edge data comparison with prediction (from Ref. 43).

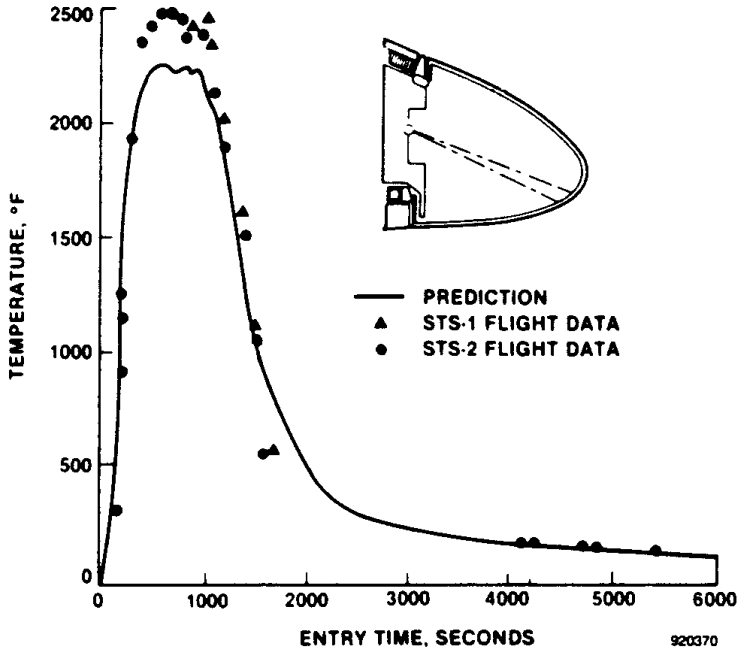

Fig. 31 The 55-percent semispan leading-edge data comparison with prediction (from Ref. 43).

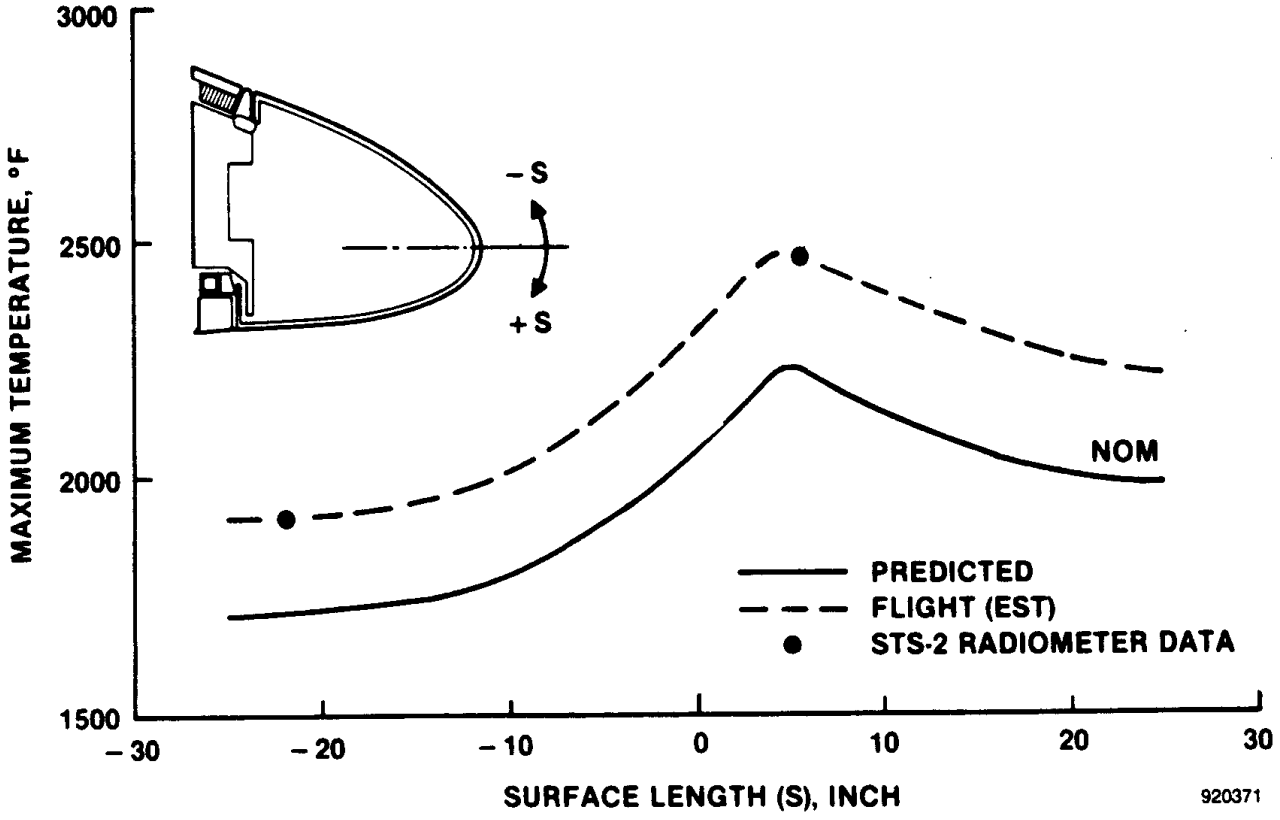

Fig. 32 The 55-percent semispan leading-edge temperature distribution (from Ref. 43).

From Iliff and Shafer, "Space shuttle hypersonic aerodynamic and aerothermodynamic flight research and the comparison to ground test results, NASA TM-4499, June 1993.