S.L. Nayler Apr 23/59

Summary of Thermodynamic Reports of General Interest

1. Report No. 72/Thermo/12.

Title: Determination of heat transfer coefficients over a wing at supersonic speeds with reference to unequal heating rates of upper and lower surfaces.

A.H. Flint, January 1958

Summary: The method of Van Driest was used to determine the heat transfer coefficients on the upper and lower surfaces of the Arrow wing at M = 2.0, 50000 ft. in level flight. The heating rates at corresponding points on the upper and lower surfaces was found to differ by 10% or more only in a narrow spanwise strip fairly close to the leading edge. Increase in incidence was shown to enlarge this area and increase the differences. It is mentioned that a difference in transition point between the two surfaces may produce differences of 800 or 900% over small areas of the wing.

2. Report No. 70/Thermo/7.

Title: Temperature distribution through a typical engine bay structure.

R.B. Erb, October 1957.

Summary: The steady-state temperature distribution in a typical engine bay structure consisting of a shroud, evenly spaced formers and the outer skin is derived assuming a constant temperature of the engine and its cooling air.

3. Report No. 70/Thermo/8.

Title: The effects of radiation on aircraft skin temperature.

R.B. Erb, October 1957.

Summary: The simple equation for radiation from the skin to the atmosphere is stated, assuming the infinite air mass to be a black body and accounting for the effect of solar radiation. The relative merits of several pigments as surface coatings are mentioned and the net effect on the adiabatic skin temperature is calculated for Mach Nos of 2.3, 2.4 and 2.5.

4. Report No. 70/Thermo/20

Title: A simple analytical solution for temperature response in an insulated skin.

R.B. Erb, March 1958

Summary: Expressions are derived for the transient temperature distribution in the insulation protecting a thin skin from a hot gas stream and for the response of the skin temperature itself to a step function in the environmental temperature. A simplification of the general expression is derived for the case of low density type insulation.

5. Report No. 70/Thermo/22.

Title: Calculation of two-dimensional temperature and thermal stress distributions in structures.

J.Q. Calkin, Feb. 1958.

Summary: This report describes a method of obtaining two-dimensional temperature and thermal stress distributions in an aircraft structure, using finite difference technique, employing an I.B.M. 704 high speed digital computer. Development of the temperature and stress equations is given along with procedures for tabulating and preparing data for a particular program.

6. Report No. 70/Thermo/24.

Title: An exact solution for temperature response in an insulated slab.

R.B. Erb, April 1958.

Summary: The Laplace Transform method is used to derive the exact solution for the transient temperature distribution in a composite slab, assuming one-dimensional flow and a step function in environmental temperature.

7. Report No. 72/Thermo/29.

Title: Description and analysis of the Arrow 2 oil cooling system.

S.L. Nayler, June 1958.

Summary: The Arrow 2 oil cooling system is described in detail and the method of analysis is presented. The results of calculations done, using the I.B.M. 704 digital computer, for subsonic speeds are presented and discussed.

8. Report No. 72/Thermo/30.

Title: Analysis of transient fuel temperatures at engine inlet-Arrow 2.

S.L. Nayler, June 1958.

Summary: It is shown that, due to the heat input to the fuel supply from the oil cooling system, high fuel temperatures can be produced under some transient flight conditions, e.g. throttling back to idle power whilst maintaining M = 2.0 by diving. This analysis results in a pessimistically high peak fuel temperature since it is a quasi-steady-state analysis in which the heat capacities of the fluids and heat exchangers is neglected.

9. Report No. 70/Thermo/31.

Title: An analytical solution of steady state temperature distributions in joints.

A. Gunter, June 1958.

Summary: The steady-state temperature distribution in a two-element joint is derived assuming one-dimensional heat flow in each element. The results for two typical configurations are shown.

10. Report No. 70/Thermo/32.

Title: Some considerations in establishing temperature distributions as used for thermal stressing.

J.A. Boddy, July 1958.

Summary: This report presents a discussion of the accuracy of the input data available for the estimation of thermal stresses. It is concluded that in many cases due to the inherent errors in the data, the use of exact solutions is not justified as a good approximation will not give errors as large as those due to the input errors.

11. Report No. 70/Thermo/33.

Title: Equilibrium temperature of an isolated skin.

A. Gunter, July 1958.

Summary: The equation governing the equilibrium temperature is stated and the effect of varying skin emissivity, solar absorbitivity and local heat transfer coefficient is investigated. Results are presented for Mach Nos. from 1.5 to 3.25.

12. Report No. P13/Thermo/1

Title: Estimation of I.C.B.M. skin temperatures.

S.L. Nayler, March 1958.

Summary: The variation of skin temperature of a blunt nosed I.C.B.M. during climb and trajectory outside the atmosphere is investigated for several missile ranges. Due to lack of data on the climb trajectory calculations were done for the extreme cases of vertical launch and minimum energy ballistic trajectory climb angle. Some approximate calculations of re-entry heating are also included in the analysis.