NASA TECH BRIEF

Langley Research Center

Thermal-Dynamic Modeling Study

A NASA study is now available which provides basic information for designing models and conducting thermal-dynamic structural tests. The factors considered are the development and interpretation of thermal-dynamic structural scaling laws, the identification of major related problem areas, and the presentation of viable model fabrication, instrumentation, and test procedures.

The wide range of formidable thermal-dynamic structural problems associated with Space Shuttle thermal design provided the basis for this study. The results should provide useful information towards planning meaningful thermal-dynamic experiments.

While related analysis procedures have improved significantly in the past, analytical difficulties still exist due to geometric nonlinearities, inelastic and nonlinear material behavior, complex liquid-solid interactions, and the presence of poorly defined damping mechanisms. Thus, analytical solutions must be supported by carefully controlled laboratory tests.

Large vehicles require that much of the experimental work be performed on reduced-scale models. However, before meaningful tests can be conducted, it is necessary to understand the proper thermal-dynamic similarity laws and to evaluate the feasibility of their implementation in a practical modeling program. Thermal and structural dynamic similarity laws are derived and interpreted in the study. It is shown that the major difficulty associated with application of the scaling laws is that the internal radiation, convection, and conduction modes of heat transfer do not scale uniformly on a reduced scale replica model.

Model design is also considered, and geometric distortions, consistent with practical manufacturing requirements and cost, are discussed.

Dynamic testing at elevated transient temperatures is covered and such items as experimental methods, instrumentation, excitation methods, and necessary data processing techniques are identified.

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.95)

Reference: NASA CR-2125 (N73-33921) Thermal Dynamic Modeling Study

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