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3-D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS (BASE PROGRAM)

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The objective of this program is to produce a series of new computer codes that permit more accurate and efficient three-dimensional inelastic analysis of selected hot section components - combustor liners, turbine blades and turbine vanes. The computer codes embody a progression of mathematical models and are streamlined to take advantage of geometrical features, loading conditions, and forms of material response that distinguish each group of selected components.

Software in the form of stand-alone codes and modules for use in General Purpose Structural Analysis (GPSA) programs will be provided by Pratt & Whitney Aircraft (P&WA) with assistance from three uniquely well qualified subcontractors: MARC Analysis Research Corporation (MARC), State University of New York at Buffalo (SUNY-B), and United Technologies Research Center (UTRC). Primary development of special finite element models will be accomplished by MARC, while mechanics of materials models and constitutive formulations will be assembled by UTRC. Development of advanced formulation (boundary element) models will be shared by P&WA and SUNY-B. Verification of the various analysis packages will be done by P&WA.

The technical effort of this program will be conducted over a period of twenty-four (24) months and will involve three (3) distinct tasks:

Task I - Linear Theory

Under this task a linear theory will be developed consisting of three linear formulation models: 1) mechanics of materials, 2) special finite elements, and 3) advanced formulation (boundary element) models. The linear theory is defined to mean that: 1) the stresses or strains and temperatures in the generic modeling region are linear functions of the spatial coordinates, and 2) the solution increments for load, temperature and/or time are extrapolated linearly from previous information. The emphasis in the linear theory for three-dimensional inelastic analysis will be on a methodology using a large number of generic modeling regions and a large number of increments, but simple calculations per increment.

Task II - Polynomial Theory

This task will involve the development of a polynomial theory consisting of three polynomial formulation models: 1) mechanics of materials, 2) special finite elements, and 3) advanced formulation (boundary element) models. The polynomial theory is defined to mean that: 1) the stresses or strains and temperatures in the generic modeling region are at least quadratic functions of the spatial coordinates, and 2) the solution increments for load, temperature and/or time are extrapolated at least quadratically from previous information. The emphasis in the polynomial theory for three-dimensional inelastic analysis will be on a methodology using a smaller number of generic modeling regions with two intersecting, embedded discontinuities and a smaller number of increments, but more complex calculations per increment than for the linear theory (Task I).

Task III - Reporting Requirements

This task includes periodic technical, financial and schedular reporting and, at the conclusion of the technical effort, the submittal of a final Contractor Report.

Optional Program

An optional program, to be exercised at the discretion of the Government, will extend the base computer codes to include higher order representations of strain in space and time and to deal effectively with more complex collections of discontinuities such as cooling holes and coating cracks.