

CREEP-FATIGUE LIFE PREDICTION FOR ENGINE HOT
SECTION MATERIALS (ISOTROPIC)

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OBJECTIVES:

The objectives of this program are the investigation of fundamental approaches to high temperature crack initiation life prediction, identification of specific modeling strategies and the development of specific models for component relevant loading conditions.

PROGRAM DESCRIPTION AND APPROACH:

The sixty month technical program is divided into two sub-programs which contain a total of thirteen tasks. The basic program (Tasks I-IV) represents a 24-month effort. Task I includes a survey of the hot section material/coating systems used throughout the gas turbine industry. Two material/coating systems will be identified for the program. The material/coating system designated as the base system shall be used throughout Tasks I-XII. The alternate material/coating system will be used only in Task XII for further evaluation of the models developed on the base material. In Task II, candidate life prediction approaches will be screened based on a set of criteria that includes experience of the approaches within the literature, correlation with isothermal data generated on the base material, and judgements relative to the applicability of the approach for the complex cycles to be considered in the option program. The two most promising approaches will be identified. Task III further evaluates the best approach using additional base material fatigue testing including verification tests. Task IV consists of technical, scheduler, financial and all other reporting requirements in accordance with the Reports of Work clause. This activity concludes the basic program.

The optional program (Tasks V-XIII) represents a 36-month effort. Specific crack initiation prediction models will be developed within the various tasks to address various aspects associated with hot section life prediction. Task V considers the development of thermal-mechanical fatigue models for uncoated and coated structures. Task VI addresses multiaxial stress state effects. Task VII considers a cumulative loading model to address sub-cycle and block loading effects. A screening of available environmental and protective coating models is conducted in Task VIII. Also, the extent of the problem for thermal-mechanical cycling will be quantified in this task. Tasks IX and X consider the development of environmental attack and protective coating models. Task XI addresses the effects of mean stress in the creep-fatigue initiation process. In Task XII final verification of the model(s) developed in the previous tasks will be conducted. In addition, baseline isothermal, TMF and biaxial testing will be conducted in the alternate material/coating system to assess the applicability of the approaches and models developed on the base material. Task XIII consists of technical, scheduler, financial and all other reporting requirements in accordance with the Reports of Work clause.

PROGRAM STATUS:

- Basic program started 5-27-82.
- Cast B1900 + Hf designated as base material.
- Wrought IN718 designated as alternate material.
- Diffusion Aluminide (NiAl) and Overlay (MCrALY) coatings selected.
- Single heat (2500 lb.) of B1900 + Hf acquired.
- 24 bars cast for initial specimen fabrication.
- Review of life prediction approaches initiated.