

# POWER TURBINE LIFE ASSESSMENT

Dresser-Rand

## Introduction

The design life of a Dresser-Rand power turbine has traditionally been 100,000 hours or 5,000 starts, when operating at 100% of the design speed and temperature. Actual operating conditions vary from site to site. They are often less severe than the initial assumption and justify a life extension program. In order for our customers to continue to operate their power turbines in a safe and reliable manner, Dresser-Rand has developed a **Power Turbine Life Assessment** program with the objective of extending the service life of expensive components.

This program consists of three major activities: Inspection & NDT examination, Remaining Life Assessment study, and Component Repair & Rejuvenation.

## Process Description

There are many interdependent tasks that must be completed as part of a **Power Turbine Life Assessment study**. Experienced engineers and metallurgists will evaluate the information gained in each of these tasks to predict the remaining life of critical power turbine components. The accuracy of this prediction will vary with the quality of the data.

## Operating History

The first step is to thoroughly understand the environment that the turbine is operating in. Key variables that affect the power turbine life will be evaluated. These include:

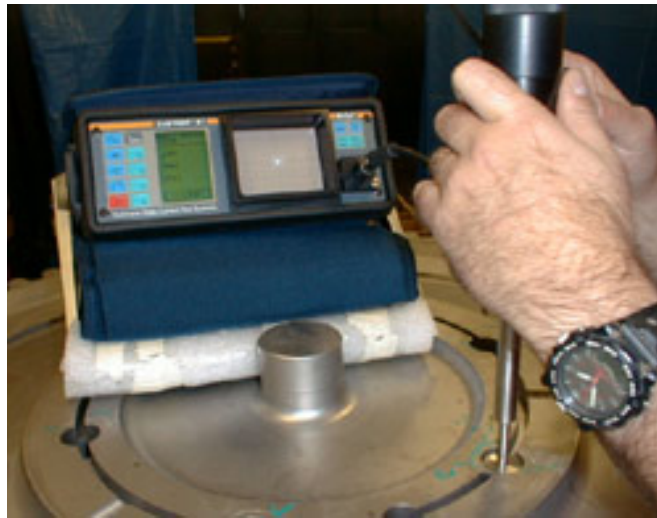
- Operating time and cycles
- Varying operating conditions
- Site conditions
- Maintenance history

This data will be used as input to thermal and stress analyses when evaluating potential failure modes such as low cycle fatigue and high temperature creep-rupture.

## Dimensional and NDT Examinations

Dimensional and NDT examinations will provide the following information for the life assessment process:

- Assurance that components are dimensionally suitable for reuse
- Detection of any surface cracks, if present
- Documentation on any fretting, corrosion, pitting, galling, or foreign object damage
- Identification of any residue deposits

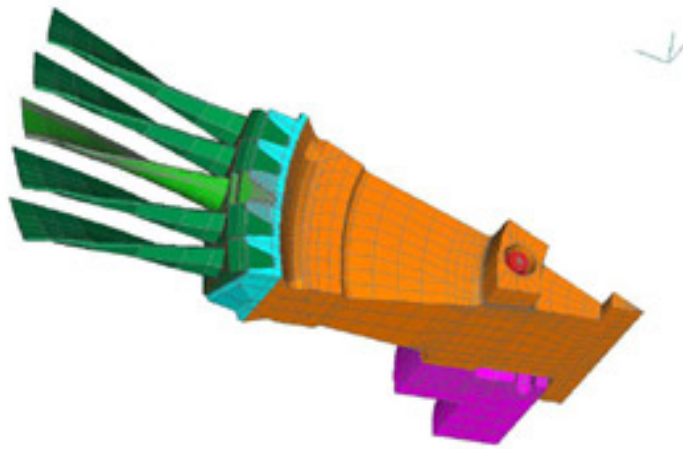


### **Eddy Current Inspection of Blade Fir Tree and of Disc Bolt Hole**

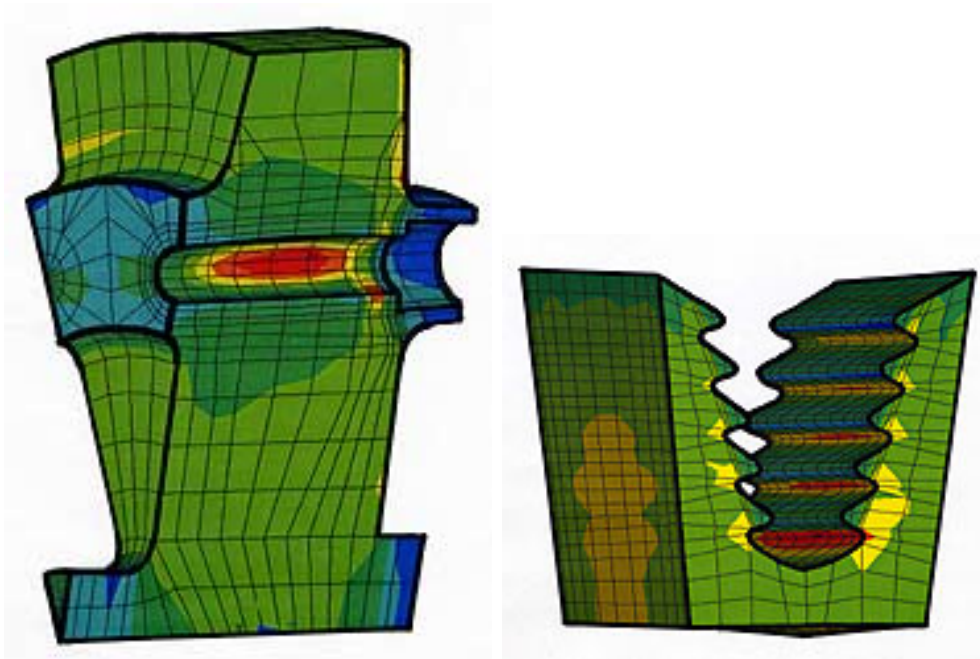
NDT examinations are performed using dye penetrant, ultrasonic, eddy current, and/or magnetic particle techniques. Certified technicians perform all inspections. The client will be appraised of all findings. At this point in the process, judgements are made regarding the continued use of the component.

### **Analytical Evaluation**

The next step in the Remaining Life Assessment is to determine the actual stress and temperature environment the components are operating in. This entails performing a finite element analysis of the appropriate components to evaluate both transient temperatures and stresses.



**Power Turbine Rotor  
Finite Element Model**



**Disc Bolt Hole**

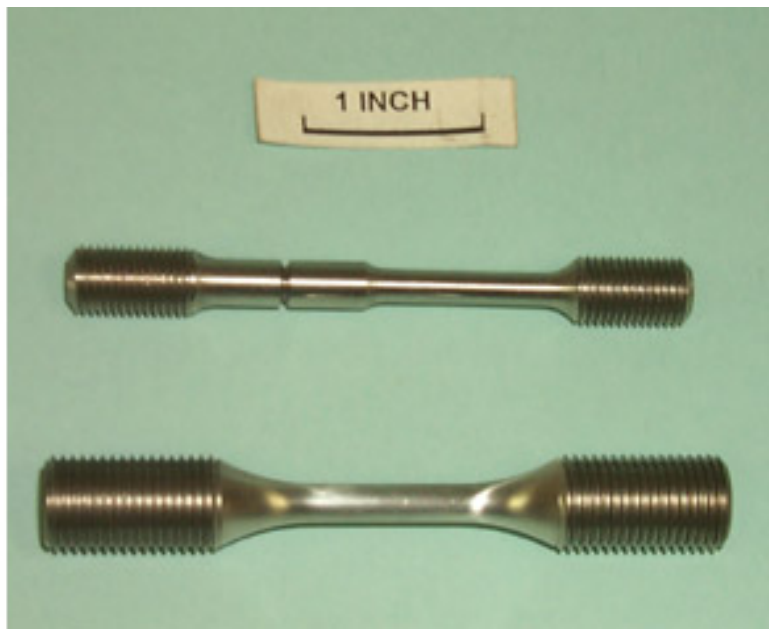
**Disc Blade Attachment**

***Typical Finite Element Stress Analysis Results***

## **Material Destructive Testing**

Textbook material data is sometimes available for use in a life analysis, but because of wide variability in the data, the results will be more conservative than if we can use data derived from the client's equipment. Generally, a few blades from a set can be sacrificed for this purpose. The disc, however, can not be destructively tested if the goal is to extend its operating life. In this case there are two options:

- Use available textbook data and accept its limitations.
- The client wants to extend the lives of several units and is willing to sacrifice one disc to maximize the service lives of the others.



## Disc Material Testing

Room temperature and elevated temperature tensile tests and elevated temperature stress-rupture tests will be performed on bore, web, and rim specimens.

Hardness testing, grain size inspection, and microstructure examination of the above mentioned three locations will also be performed.

Provided the above results indicate acceptable ductility and stress rupture characteristics, additional testing will be performed to determine:

- Stress strain curves
- Creep properties
- Low cycle fatigue
- Fracture mechanics

## Blade Material Testing

Specimens will be machined from the roots and airfoils of a sample of blades. Tensile and creep-rupture tests will be performed to compare the blades to a new material baseline. If the sample blades pass these tests, and no excessive corrosion or fretting is evident, then the set will be acceptable for reuse. If the properties of these tests vary too far from the baseline, then the blade set will be a candidate for re-heat treatment. Additional material tests and dimensional inspections will be done after heat treating to confirm the acceptability of the blades.

A Larson-Miller creep-rupture plot will be constructed using specimens machined from the airfoils of three blades. This plot will be used to estimate remaining creep life of the blade set.

## Remaining Life Analysis

With this information Dresser-Rand will assist the client with:

- Inspection and maintenance schedules
- Components replacement schedule

**Refer questions to:**  
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