

Gas Turbine Rotor Life Evaluation



- Gas turbine and compressor rotors are reaching OEM-stated service life.
- An objective technical approach is needed for evaluating accumulated rotor damage.
- Developing material degradation data and life prediction tools can safely extend rotor in-service life.

Gas turbine (GT) rotors typically are inspected during hot gas path and major maintenance intervals when casing covers are removed. The OEM typically will assist in these inspections and will judge whether the rotor is suitable for continued service. Sections of the rotor may be deemed non-serviceable after 100,000–200,000 hours or between 2500 and 5000 starts. The impacts of an extended outage for a rotor rebuild may be mitigated by using a pooled spare rotor—if one is available.

Recently OEMs have started notifying GT owners that rotors used on D/E-class machines that have acquired the stated number of hours or cycles should be retired. Some early F-class machines in cycling service also may experience rotor concerns. Even older machines with light peaking service histories may have accumulated significant corrosion damage from extended periods of layup—a condition not directly addressed by OEM maintenance guidance.

Value

Results from this project provide GT owners with procedures and technical information to objectively evaluate the condition of their GT rotors. Rotor rebuild/replacement, along with the associated outage, is estimated to exceed \$6 million per machine.

Drivers and Trends

GTs are used in simple-cycle configuration to supply peaking service. These machines acquire many cycles but relatively few hours of service. They also are idled for extended periods and are thus subject to corrosion from condensation. GTs in combined-cycle configuration can be deployed in either daily cycling or more base-loaded service. As such, combined-cycle rotor life may be governed by hours of operation or a combination of hours and starts.

To some degree, GT rotors are following an earlier trend set by fossil steam turbines. Although rotor construction generally is different, both gas and steam rotor materials use a similar class of Cr-Mo-V materials. Cyclic operation also tends to inflict the greatest wear and tear and poses the greatest technical challenge for both these turbo-machines. This project will leverage the extensive EPRI steam turbine background that has been developed for material degradation, inspection, and damage/defect tolerance evaluation.

Project Summary

The overall work scope is structured around two major tasks. The initial Phase 1 funding will focus on Tasks 1 and 2. Phase 2, not funded as part of this immediate project, is envisioned to address the development of additional rotor

subcomponent life models and related validation.

Task 1 – Rotor Life Inspection and Evaluation Guidelines.

A logical and cost-effective life assessment procedure can be modeled after EPRI's industry standard for evaluating steam turbine rotors, which consists of three distinct levels of evaluation. This three-level approach will be modified for GT rotors beginning with a simplified Level 1 evaluation using plant records, design conditions, and minimum material values. Level 2 involves actual inspection, measurements, and simplified thermal and stress analysis. Level 3 is the most exhaustive, requiring in-depth inspection, material sampling and testing, and full stress/fracture mechanics component-level analysis.

Task 2 – Model-Specific Component Evaluation

The multi-level evaluation approach requires that material degradation property data be collected and accurate finite element method (FEM) stress components be developed. Material properties including fracture toughness, Charpy impact, creep, and crack growth rates will be gathered from the literature and supplemented by testing. Accurate dimensional measurements need to be acquired to develop the three-dimensional FEM component-level stress models. The specific model/component priorities will be determined by the project participants and available funds.

Deliverables

The principal deliverables of the project include:

1. GT rotor life evaluation guidelines

2. Component damage evaluation and life prediction tools

Cost of Project

To initiate this project, we are seeking three collaborators per GT model type at a cost of \$65,000 each. Members who fund any Generation program may use tailored collaboration (TC) or set aside funding to support this project.

Project Status and Schedule

Several GT owners with high hours/starts machines are guiding the project launch. Phase 1 is nominally 12 months, dependent on component access arrangements.

Who Should Join

This project is recommended to owners of gas turbines with significant operating hours/starts histories, especially older D/E-class models in power or process applications.

Contact Information

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