

Duke Energy Increases Life and Reduces O&M Costs of F-Class Gas Turbine Hot-Section Components

Duke Energy has worked with EPRI over several years to conduct durability analysis studies of the hot-section components within the company's advanced high-temperature F-class gas turbine fleet. These studies included advanced computer simulation using aerothermal and structural analysis to better understand temperature and stresses within the hot-section components for different operating profiles. Extensive material testing of service-aged components was then performed to further validate life consumption estimates and establish criteria for safely extending operating intervals. The results of this research are assisting the utility in maximizing the useful life of F-class components, reducing operating and maintenance (O&M) costs, and managing risks.

Reducing Life-Cycle Costs

Gas turbine hot-section components are complex designs, incorporating superalloys, advanced forced-air cooling schemes, and protective coating systems. Each model type has design-specific features that require specialized knowledge to effectively manage machine O&M. For instance, each turbine model has unique blade designs made of superalloy thin-walled castings requiring complex internal cooling, and oxidation and thermal barrier coatings to survive in a high-temperature environment.

Gas turbine owners routinely inspect, refurbish, and replace combustion parts and the downstream hot-section vanes and blades. The cost of extensive maintenance associated with the gas turbine life-cycle can exceed the initial equipment cost by as much as a factor of three.

Faced with such specialized hardware, gas turbine owners seek to reduce O&M expenses without increasing risk by optimizing all the activities and costs related to the inspect/repair/replace life cycle. Model-specific, objective knowledge is needed of component design, repair, and degradation mechanisms experienced in the company's own units.

To meet this basic need, EPRI has developed core competencies in hot-section design analysis and repair procedures and applied them to different combustion turbine models. EPRI collaborative projects, supported by the owner/operators of 50- and 60-Hz models, have created an extensive knowledge-base, addressing widely used conventional and advanced engines.

The EPRI model-specific projects aim to optimize the hot-section economic life-cycle at the plant or fleet level according to how the parts inventory is managed. Tools are developed to manage critical aspects of the life cycle, including repair procedures, accumulated damage tracking, and replacement/upgrade procurement guidelines.



The project involved units 1–4 and 7–8 at Duke Energy's 1,904-MW Sherwood H. Smith, Jr. Energy Complex in Hamlet, NC.

“Improving GT hot section component utilization is an integral element to Duke’s gas generation strategy.”

*~ Rajeev Aluru, Lead Engineer,
Combustion Turbines,
Duke Energy*

Targeted Studies for Duke Energy's Gas Turbine Fleet

Duke Energy maintains an extensive hot-section inventory with annual maintenance costs alone typically reaching several million dollars for its gas turbine fleet. (This does include the cost of new replacement parts, which is a significant part of the savings.) The utility teamed with EPRI to conduct targeted studies aimed developing criteria to maximize the useful life of critical hot-section components and thereby reduce maintenance costs.

Starting in 2009, the EPRI research initially focused on the rotating blades and then expanded to the stationary vanes. The research included analytical modeling of critical component designs, development of quantitative life predictions, and testing of service-aged components to better understand governing damage mechanisms and distress. This knowledge was applied to develop engineering-based life-cycle criteria based on specific machine operational profiles and component design features for the Duke fleet.

Benefits Realized by Duke Energy

Results that directly benefit Duke Energy include:

- Financial savings of tens of millions of dollars over the next 10-15 years
- Increased overall useful life for these components by as much as 50% (basis defined by original equipment manufacturer hot-section useable life criteria)
- Determination of optimal maintenance intervals for hours-based or starts-based engines
- Savings without sacrificing safety, future repairability, or operational reliability
- Path created towards other component extensions in the future (first-stage buckets are being refurbished for extended third interval of operation; second-stage buckets and first-stage nozzles to follow).

Related EPRI Work

F-Class Life Management: General Electric MS7001 Model FA. EPRI. Palo Alto, CA. December 2008. 1022086.

Damage Tracking Module for General Electric 7FA Gas Turbines, Version 1.0. EPRI. Palo Alto, CA. November 2010. 1021525.

F-Class Combustion Turbine Life Management: General Electric MS9001 Model FA. EPRI. Palo Alto, CA. March 2009. 1015785.

Damage Tracking Module for General Electric 9FA Gas Turbines, Version 1.01. EPRI. Palo Alto, CA. October 2008. 1014743.

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