DOE Fact Sheet – October 2003

Advanced Monitoring to Improve Combustion Turbine (CT)/Combined Cycle (CC) Reliability, Availability and Maintainability (RAM)

I.   Project Participants

EPRI (Prime)
Impact Technologies, LLC
Boyce Engineering International
Carolina Power & Light/Progress Energy

II.   Project Description

Objectives:
The objective is to develop a suite of intelligent software tools integrated with a diagnostic monitoring platform that will, in real time, interpret data to assess the "total health" of combustion turbines. The project team will develop advanced probabilistic and artificially intelligent performance and mechanical fault diagnostics algorithms, sensor validation and recovery modules, and prognostics for maintenance-intensive CT areas.

Background/Relevancy:
Power generators are concerned with the maintenance costs associated with the advanced turbines that they are purchasing. Since these machines do not have fully established operation and maintenance (O&M) track records, power generators face financial risk due to uncertain future maintenance costs. This risk is of particular concern as the electricity industry transitions to a competitive business environment in which unexpected O&M costs cannot be passed through to consumers.

These concerns have accelerated the need for intelligent software-based diagnostic systems that can monitor the health of a combustion turbine in real time and provide valuable information on the machine's performance to its owner/operators. Such systems would interpret sensor and instrument outputs, correlate them to the machine's condition, provide interpretative analyses, forward projections of servicing intervals, and estimate remaining component life.

Computer-based CT condition & health monitoring predictive systems offer the potential for:

- reduced nuisance shutdowns & unplanned outages
- optimum engine operation
- continuous real-time maintenance scheduling
- extended time between overhauls based upon determination of remaining component life
- protection against catastrophic failure via real-time fault assessment

A number of generic and CT-specific monitoring systems are commercially offered today, ranging from time-history database/display systems to model-specific operation/performance monitoring systems. In general, these products have limited diagnostic capability and often require the assistance of expert interpretation, which devalues their effectiveness as mainstay production tools.

Period of Performance: 10/01/2001 – 09/30/2004

Project Summary:
The Combustion Turbine Health Management System (CTHM) will consist of a series of dynamic link library (DLL) programs residing on the plant's existing time-history database/display system that accepts turbine health data from on hand monitoring instrumentation. The CTHM would leverage the data acquisition and display capability of the existing system and augment the system using CTHM application algorithms. The real-time CTHM application algorithms are intended to produce a comprehensive array of intelligent tools for assessing the "total health" of a combustion turbine, both mechanically and thermodynamically. CTHM includes the integration of real-time anomaly detection and diagnostics of performance and mechanical faults in addition to the prediction of critical component remaining useful life and turbine degradation.

CTHM software modules will be developed and customized for the selected CT applications in the following areas:

- Sensor validation and recovery (virtual sensors).
- CT performance anomaly detection, fault diagnosis and prognosis.
- CT stat-up, fuel nozzle and combustion system condition monitoring,.
- CT rotor dynamics anomaly detection and diagnosis.
- Real-time critical component prognostics.

III. Project Costs

DOE Costs are $1,233,000 with $411,000 being cost shared by EPRI.

IV. Major Accomplishments Since the Beginning of the Project

1. Completed Sensor Validation Module - Work was completed on development of a dedicated sensor analysis module for the GE Frame 7FA that may be directly tied into an integrated CT monitoring platform. This module validates the integrity of important gas path sensor signals that are used performance assessment. March 2003.

2. Completed Sensor Validation and Recovery Module and Initiate Field Testing - Work was completed on development of a beta version of the sensor validation module that predicts important parameters that are not sensed in the CT for performance assessment. The completed module was installed on a GE Frame 7FA at host utility site via the site's PI monitoring platform. June 2003.

3. Completed Performance Degradation Module - Work was completed on development of a performance degradation software module that thermodynamic analysis to compare actual simple and combined cycle performance to expected performance of the full-range of operation including part-load. September 2003.

V. Major Activities Planned During the Next Six Months

1. Complete Performance and Fault Diagnostic Module - Work will be completed on development of performance anomaly detection and diagnostic software that statistically detects the manner in which performance parameters are shifting over time and then correlate these shifts with associated performance degradation issues for fault isolation. December 2003.

2. Complete CT/CC Life Limiting Component Prognostic Module - A software module will be developed that utilizes models of critical "hot section" components previously developed and put them in a prognostic module architecture that project probability of failure for future operation. March 2004

VI.   Major Accomplishments Planned In Out-years (6 -18 Months)

Initiate Combustion Process Health Management Module - Work will begin on development of a software module to investigate the integration of a several CT monitoring techniques that can be employed to detect the onset of combustion instability and alert the operators so that appropriate actions can be taken. June 2004

VII.   Major Milestones for Entire Project

Milestone 1: Complete CT/CCT sensor validation module

March 2003

Milestone 2: Complete CT/CCT sensor validation and recovery module

June 2003

Milestone 3: Complete CT/CC performance degradation module

September 2003

Milestone 4: Complete CT/CC performance and fault diagnosis module

December 2003

Milestone 5: Complete CT/CC life limiting component prognostic module

March 2004

Milestone 6: Complete CT/CC combustion diagnostics module

June 2004

Milestone 7: Complete CT/CC rotor dynamic/mechanical anomaly module

September 2004

VIII. Issues

None at this time.

IX.   Attachments

None at this time.