

80 New Combustion Turbine/Combined-Cycle Plant Design and Technology Selection

Program Overview

Program Description

This program provides the information and analysis needed to select combustion turbine technologies and to specify combined-cycle plant designs for today's new generation requirements while planning for future technological advances. Key attributes for new plants include flexibility to start quickly, operate efficiently at varying loads, and fire fuels of varying composition while meeting regulatory emission limits. Improved gas turbine plant profitability is achieved through an overall life-cycle approach, which includes a balanced understanding of capital and O&M costs, performance improvements, and technical risks associated with new high-efficiency turbine designs and the market context in which they operate. Up-to-date information and evaluations enable better procurement decisions and help minimize costs while optimizing plant performance, reliability, and operational flexibility for simple-cycle and combined-cycle combustion turbine plants.

Industry Needs and Issues Addressed

- Informed decisions on gas turbine selections and plant designs
- Technology selection impacts on availability, maintainability, and durability technology selections
- Appropriate environmental control technologies to meet regulatory requirements
- Firing fuels of variable composition and provision for future refueling options
- Flexible operational capabilities for optimal plant dispatch
- Future trends and potential improvements for future growth

Impact

- Optimal technology selection and design increase plant profitability, reduce overall life-cycle costs, and improve operability.
- Managing technology risk helps control operation and maintenance expenditures.
- Objective, expert assessment of technology trends and worldwide experience results in better procurement decisions.

Key Accomplishments

- Scope covers all 60- and 50-Hz gas turbine models above 20 MW used in power generation.
- Knowledge base covers life-cycle O&M costs used in model selection.
- Component durability information is based on in-depth studies of fleet-leading issues.
- Design provisions are identified for plant operational flexibility and fuel variability.

Current Year Objectives

- Address current subjects of interest in Combustion Turbine Experience and Intelligence Reports.
- Identify new models, capabilities and features in Gas Turbine Product Line Design Evolution and RAM-D Issues Reports.
- Describe equipment and system design features for improved plant operability and fuel flexibility.
- Enhance maintenance life-cycle costing capability in Combustion Turbine Combined-Cycle O&M Cost Analyzer software.
- Incorporate new equipment descriptions and emissions requirements in Environmental Control Technology and Regulatory Issues Handbook.

Industry Involvement

- Estimated 2009 funding: \$0.8M

Program Technical Lead

John Scheibel, 650-855-2850, jscheibe@epri.com

Summary of Projects

Project Number	Project Title	Value
P80.001	Experience-Intelligence Report and Project Risks	Reports provide concise analysis of subjects of topical interest, including current and emerging CTCC designs and cycles, reliability issues, maintenance strategies, industry trends, and related market conditions.
P80.002	CT Technology: Durability, Design and Performance	Reports cover OEM CT product lines, including design features, related risk concerns, and RAM-Durability experience. All 50- and 60-Hz models over 20 MW are covered, including advanced and upgraded mature engines.
P80.003	Plant Design, Repowering and Environmental Siting	Reports cover design features, risks, and operating experience of heat recovery steam generators, steam turbines, and electrical generators and integration in an operationally flexible plant design. Emissions control equipment is described, and regulatory trends are monitored. Software provides model-specific O&M cost estimates.

Project Descriptions

P80.001 Experience-Intelligence Report and Project Risks (067359)

Issue

Technical advances and issues surrounding combustion turbine (CT) and combined-cycle (CC) plants play a major role in new generation decisions, and the impact of those decisions will be felt for years to come. To optimize use of new technologies, management and technical staff need objective, concise knowledge of innovation drivers and industry experience. CTCC plant owners and developers face multiple challenges, including reduced maintenance intervals, unexpected durability shortfalls of costly components, and unplanned maintenance events. A balanced approach to risk identification and cost allocation is essential in the technical development and financial strategy of any new plant project. Because CT maintenance can cost two to three times the price of the original equipment over the project life, CT owners need to consider major maintenance during project development and recognize the technical maturity of particular turbine models. In addition, owners and developers need to understand price volatility in fuel and electricity markets and its impact on plant dispatch and profitability.

Description

EPRI collects and analyzes information about current and emerging CTCC designs and cycles and publishes the results in a concise series of reports supplemented by technical presentations. Topics covered include hot-section design features, emerging alternative parts suppliers, compressor dependability, and dry low-NO_x (DLN) combustion instabilities. Also addressed are the impacts of liquefied natural gas (LNG), syngas and biofuel firing, fuel market trends, air-cooled generator issues, and other topics as determined by the members. The on-line database for CT owners and operators, INTURB, provides a worldwide directory to facilitate contact with peers to discuss model- and configuration-specific concerns affecting procurement decisions. The project risk assessment framework helps define and quantify risks associated with investment in new CT technologies. Guidance covers decisions about up-

front maintenance strategies, such as self-managed maintenance or long-term contracts by the original equipment manufacturer (OEM) or third parties. EPRI reports provide the background and analysis to evaluate various options. In addition, special studies examine other aspects of project risk such as the electricity market, natural gas supply, and the timing and impact of LNG in the fuel marketplace.

Value

- Take full advantage of existing and new CTCC plants through concise, current information on new technology developments, and issues affecting durability, reliability, and plant operating flexibility to meet dispatch demands
- Mitigate technology and market risk for new CTCC project development through evaluation of alternative maintenance approaches and insights on natural gas and electricity markets
- Gain insights on industry best practices and concerns via a peer-to-peer directory that facilitates experience sharing

How to Apply Results

Reports serve as a valuable resource for understanding major components of risk in project development and use of insurance and maintenance contracts to mitigate a portion of the technical risk. Insights on model maturity and alternative parts suppliers influence maintenance strategy planning. Other EPRI studies are employed to address project stakeholder concerns about equipment reliability risks and impacts from changing fuel and electricity market conditions. The INTURB CT owners' directory can be readily accessed on-line to identify other companies and contacts potentially able to provide valuable information and lessons learned from experience with equipment.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
CT Experience and Intelligence Reports: Concise reports in article format on selected topics issued electronically several times per year. Reports are supplemented by technical presentations from advisory meetings and are compiled annually in a single report.	12/31/2009	Technical Update
Web-based CT Owners INTURB Directory: Annual Update: Interactive, searchable database contains information on more than 6,100 sites and 3,400 contacts worldwide. Users can update information for their own company's sites and contacts.	12/31/2009	Technical Resource

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
CT Experience and Intelligence Reports	2010	Technical Update
Web-based CT Owners INTURB Directory: Annual Update	2010	Technical Resource
Natural Gas and Electricity Markets - Update	2010	Technical Update
Technical Risks and Mitigation Approaches - Update	2010	Technical Update

P80.002 CT Technology: Durability, Design and Performance (104059)

Issue

Gas turbine manufacturers continue to add new and upgraded models to their combustion turbine (CT) product lines. Understanding the design features of each model and their relationship to the overall design evolution and possible risks is a challenge. To meet this challenge, project developers and electricity generation owners and operators need an objective, in-depth perspective on technology risk and benefits, and operation and maintenance (O&M) implications of new and upgraded model offerings for all major original equipment manufacturer (OEM) suppliers.

Description

This project periodically updates a multi-volume series of reports covering the heavy-duty and aero-derivative engines over 20 MW capacity most frequently used in power generation applications. These reports summarize design characteristics of the turbine product lines manufactured by General Electric, Siemens (including Siemens-Westinghouse), Mitsubishi, ALSTOM, Pratt & Whitney, and Rolls-Royce. Each report includes a pedigree matrix detailing design attributes in a standard format. High-risk design features are identified, and relevant technical issues and experience are discussed. Reliability, availability, and maintainability (RAM) statistics are provided for selected models to further identify the overall model maturity and quantify RAM performance. Models of particular interest include more advanced F-, G-, and H-class machines, engines suited to highly cyclic duty, and those used for syngas/hydrogen firing. The project seeks information about advanced models as opportunities arise.

Value

- Receive high-quality design assessments and in-service data for high-confidence technology selection and procurement decisions
- Have access to independently obtained RAM statistics for use in plant economic modeling evaluations

How to Apply Results

Members can use these detailed reports to account for site and market conditions, and equipment capabilities, as well as identification of technical attributes and associated risks when planning generation additions. In procurement, the information is used to evaluate equipment and select appropriate technology.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
General Electric Aero-Derivative CT Product Line - Design Evolution and RAM-D Issues: This report describes the design evolution, features, and performance of the LMS100, LM6000, and LM2500 gas turbine models, including recent upgrades. Current reliability and availability data is included. Technical issues affecting maintenance, durability, reliability, and life-cycle costs are reported. Maintenance intervals and activities are described. Existing sites are listed.	12/31/2009	Technical Update

Product Title & Description	Planned Completion Date	Product Type
ALSTOM CT Product Line - Design Evolution and RAM-D Issues: This report describes the design evolution, features, and performance of the GT24/GT26, GT13E2, GT11N2, and GT8C gas turbine models, including recent upgrades. Current reliability and availability data is included. Technical issues affecting maintenance, durability, reliability, and life-cycle costs are reported. Maintenance intervals and activities are described. Existing sites are listed.	12/31/2009	Technical Update
Siemens (including Siemens-Westinghouse) CT Product Line - Design Evolution and RAM-D Issues: This report describes the design evolution, features, and performance of the V-series (V84.2/V94.2, V84.3A/V94.3A), W-series (W501D5A, W501F, W501G), and SGT5-8000H gas turbine models, including recent upgrades. Current reliability and availability data is included for selected models. Technical issues affecting maintenance, durability, reliability, and life-cycle costs are reported. Existing sites are listed.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Pratt & Whitney CT Product Line - Design Evolution and RAM-D Issues - Update	2010	Technical Update
General Electric Heavy-Duty CT Product Line – Design Evolution and RAM-D Issues - Update	2010	Technical Update
Mitsubishi CT Product Line – Design Evolution and RAM-D Issues - Update	2010	Technical Update
Rolls-Royce CT Product Line – Design Evolution and RAM-D Issues - Update	2011	Technical Update

P80.003 Plant Design, Repowering and Environmental Siting (067360)

Issue

A plant design includes several requirements, including increasingly stringent environmental regulations, minimal water use, high efficiency, capital cost recovery, and operational flexibility. The ability to include features such as rapid startup and load change, and low-load operation is highly valued in many markets. These features are best considered during the procurement process, because retrofits are costly and might not be practical. Repowering an existing site or adapting a gas-fired plant for future coal syngas capability requires additional considerations.

Description

Reports emphasize economical and flexible designs and consideration of project life-cycle costs for the selection of the heat recovery steam generator (HRSG), environmental controls, steam turbine, electrical generators, and other balance-of-plant equipment. Equipment for the control of nitrogen oxides, carbon monoxide, particulate matter, volatile organic compounds, and other air pollutants is described; U.S. and worldwide regulatory trends are monitored. The CTCC O&M Cost Analyzer software estimates costs on a

model-specific basis for different operating missions, quantifying the likelihood and cost impacts of scheduled maintenance and unplanned events. O&M costs based on alternative parts replacement, and repair costs can be compared.

Value

- Develop more competitive designs and equipment procurement decisions by using detailed information on combined-cycle design features, performance, and reliability trade-offs
- Enhance operational flexibility by identifying and evaluating new plant design features
- Assess environmental control options on an objective and credible basis
- Quantify and compare life-cycle maintenance costs based on user-defined scenarios

How to Apply Results

Reports provide information for understanding equipment designs, making procurement decisions, and determining most effective configurations to meet duty cycles and flexibility requirements. Software quantifies the impact of operating scenarios on O&M costs.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
CTCC O&M Cost Analyzer, Version Updates: Excel spreadsheet-based software estimates the O&M costs for simple-cycle and combined-cycle plants for user-specified operating scenarios. CT model-specific maintenance costs are based on component replacement and repair costs, life estimates, and maintenance intervals. (Product shared with Program 79, Project 79.004)	12/31/2009	Software
Equipment Selection and Procurement Guidelines: Report addresses and updates a topic of current interest, such as plant designs for operational flexibility, phased construction, repowering or refueling, or plant equipment such as heat recovery steam generators, steam turbines, generators, or other plant equipment. Future report topics depend on interests expressed by members.	12/31/2009	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Gas Turbine/Combined-Cycle Environmental Control Technology and Regulatory Issues Handbook - Update	2010	Technical Update
Heat Recovery Steam Generator Design and Procurement - Update	2010	Technical Update
Steam Turbine and Generator Designs for Combined-Cycle Plants - Update	2010	Technical Update
Phased Refueling of Natural Gas-Fired Combined-Cycle Plants to Firing Syngas from Coal Gasification with CO2 Capture - Update	2010	Technical Update
Lessons Learned in Startup and Commissioning of Simple-Cycle and Combined-Cycle Plants - Update	2010	Technical Update
Selective Catalytic Reduction of NOx: Reactor Designs and Procurement - Update	2010	Technical Update
Cyclic Operation of Combined-Cycle Plants: Designs, Maintenance, Reliability and Cost Impacts - Update	2010	Technical Update
Conversion to Dual Fuel Capability by Addition of Distillate Oil Firing Systems in CT Plants - Update	2010	Technical Update
Repowering Studies and Assessments - Update	2010	Technical Update
Gas Turbine/Combined-Cycle Environmental Control Technology and Regulatory Issues Handbook - Update	2011	Technical Update