Solar Mars Gas Turbine

Solar Turbines Incorporated (Solar), under cooperative agreement number DE-FC26-0CH11049, has conducted development activities to improve the durability of the Mercury 50 combustion system to 30,000 hours life and reduced life cycle costs. This project is part of Advanced Materials in the Advanced Industrial Gas Turbines program in DOE's Office of Distributed Energy. The targeted development engine was the Mercury{trademark} 50 gas turbine, which was developed by Solar under the DOE Advanced Turbine Systems program (DOE contract number DE-FC21-95MC31173). As a generator set, the Mercury 50 is used for distributed power and combined heat and power generation and is designed to achieve 38.5% electrical efficiency, reduced cost of electricity, and single digit emissions. The original program goal was 20,000 hours life, however, this goal was increased to be consistent with Solar's standard 30,000 hour time before overhaul for production engines. Through changes to the combustor design to incorporate effusion cooling in the Generation 3 Mercury 50 engine, which resulted in a drop in the combustor wall temperature, the current standard thermal barrier coated liner was predicted to have 18,000 hours life. With the addition of the advanced materials technology being evaluated under this program, the combustor life is predicted to be over 30,000 hours. The ultimate goal of the program was to demonstrate a fully integrated Mercury 50 combustion system, modified with advanced

materials technologies, at a host site for a minimum of 4,000 hours. Solar was the Prime Contractor on the program team, which includes participation of other gas turbine manufacturers, various advanced material and coating suppliers, nationally recognized test laboratories, and multiple industrial end-user field demonstration sites. The program focused on a dual path development route to define an optimum mix of technologies for the Mercury 50 and future gas turbine products. For liner and injector development, multiple concepts including high thermal resistance thermal barrier coatings (TBC), oxide dispersion strengthened (ODS) alloys, continuous fiber ceramic composites (CFCC), and monolithic ceramics were evaluated before down-selection to the most promising candidate materials for field evaluation. Preliminary, component and sub-scale testing was conducted to determine material properties and demonstrate proof-of-concept. Full-scale rig and engine testing was used to validated engine performance prior to field evaluation at a Qualcomm Inc. cogeneration site located in San Diego, California. To ensure that the CFCC liners with the EBC proposed under this program would meet the target life, field evaluations of ceramic matrix composite liners in Centaur{reg_sign} 50 gas turbine engines, which had previously been conducted under the DOE sponsored Ceramic Stationary Gas Turbine program (DE-AC02-92CE40960), was continued under this program at commercial end-user sites under Program Subtask 1A - Extended CFCC Materials Durability Testing. The goal of these field demonstrations was to demonstrate significant component life, with

milestones of 20,000 and 30,000 hours. Solar personnel monitor the condition of the liners at the field demonstration sites through periodic borescope inspections and emissions measurements. This program was highly successful at evaluating advanced materials and down-selecting promising solutions for use in gas turbine combustions systems. The addition of the advanced materials technology has enabled the predicted life of the Mercury 50 combustion system to reach 30,000 hours, which is Solar's typical time before overhaul for production engines. In particular, a 40 mil thick advanced Thermal Barrier Coating (TBC) system was selected over various other TBC systems, ODS liners and CFCC liners for the 4,000-hour field evaluation under the program. This advanced TBC is now production bill-of-material at various thicknesses up to 40 mils for all of Solar's advanced backside-cooled combustor liners (Centaur 50, Taurus 60, Mars 100, Taurus 70, Taurus 65, Titan 130, Titan 250 and Mercury 50). This TBC coating system significantly outperformed all other TBC systems evaluated under the program. The initial field unit, with the 40 mil advanced TBC developed under this program, has far exceeded the 4,000-hour requirement of the program, accumulating over 20,000 hours of commercial operation at Qualcomm Inc. in San Diego, CA. The 40 mil advanced TBC remains in excellent condition, with no evidence of chipping or spalling. The engine will continue operation until the unit is due for overhaul at approximately 30,000 hours. The Oxide Dispersion Strengthened (ODS) alloy injector tip testing and evaluation was also successful, however, the ODS injector tip development on this

program was terminated, primarily due to the fact that the Mercury 50 injector tip was redesigned (Generation 3) by Combustion Engineering.

Forsthoffer summarizes, expands, and updates the content from previous books in a convenient all-in-one volume. This titles offers comprehensive technical coverage and insider information on best practices derived from lessons learned in the engineering, operation, and maintenance of a wide array of rotating equipment.

Many of the economic road blocks which have previously served to discourage the implementation of alternative power generation technologies can now be readily overcome through effective energy resource optimization. It is now a fact that solid financial returns can be achieved from combined heating, cooling and power generation projects by integrating energy and cost efficiency goals, and seeking a match between power production and heating/cooling requirements. This book is intended to serve as a road map to those seeking to realize optimum economic returns on such projects. The first section provides an introduction to basic heat and power thermodynamics, with an overview of heat and power generation technologies and equipment. The second section explores the infrastructure in which the project must be implemented, including environmental considerations, as well as utility rate structures. The third section provides detailed coverage of a broad range of technology types, and discusses how opportunities for their application can be identified and successfully exploited. The final section takes you through each step of project development, implementation and

operation. Numerous examples are provided of actual field applications, with supporting documentation of system layouts and performance. The text is supplemented with more than one thousand graphics, including photos, cutaway drawings, layout schematics, performance curves, and data tables.

Vol. for 1955 includes an issue with title Product design handbook issue; 1956, Product design digest issue; 1957, Design digest issue.

This comprehensive, best-selling reference provides the fundamental information you'll need to understand both the operation and proper application of all types of gas turbines. The full spectrum of hardware, as well as typical application scenarios are fully explored, along with operating parameters, controls, inlet treatments, inspection, troubleshooting, and more. The second edition adds a new chapter on gas turbine noise control, as well as an expanded section on use of inlet cooling for power augmentation and NOx control. The author has provided many helpful tips that will enable diagnosis of problems in their early stages and analysis of failures to prevent their recurrence. Also treated are the effects of the external environment on gas turbine operation and life, as well as the impact of the gas turbine on its surrounding environment.

A significant addition to the literature on gas turbine technology, the second edition of Gas Turbine Performance is a lengthy text covering product advances and technological developments. Including extensive figures, charts, tables and formulae,

this book will interest everyone concerned with gas turbine technology, whether they are designers, marketing staff or users.

Covering basic theory, components, installation, maintenance, manufacturing, regulation and industry developments, Gas Turbines: A Handbook of Air, Sea and Land Applications is a broad-based introductory reference designed to give you the knowledge needed to succeed in the gas turbine industry, land, sea and air applications. Providing the big picture view that other detailed, data-focused resources lack, this book has a strong focus on the information needed to effectively decision-make and plan gas turbine system use for particular applications, taking into consideration not only operational requirements but long-term life-cycle costs in upkeep, repair and future use. With concise, easily digestible overviews of all important theoretical bases and a practical focus throughout, Gas Turbines is an ideal handbook for those new to the field or in the early stages of their career, as well as more experienced engineers looking for a reliable, one-stop reference that covers the breadth of the field. Covers installation, maintenance, manufacturer's specifications, performance criteria and future trends, offering a rounded view of the area that takes in technical detail as well as well as industry economics and outlook Updated with the latest industry developments, including new emission and efficiency regulations and their impact on gas turbine technology Over 300 pages of new/revised content, including new sections on microturbines, non-conventional fuel sources for microturbines, emissions, major developments in aircraft engines, use of coal gas and superheated steam, and new case histories throughout highlighting component improvements in all systems and sub-systems.

This is the first book dedicated to solar gas turbines, providing fundamental knowledge and

state-of-the-art developments in the field. A gas turbine is a heat engine in which a mixture of fuel and air is burned in a chamber that is an integral part of the flow circuit of the working fluid. The burnt gas mixture expands and turns the turbine, which can be connected to a generator for electricity production. Solar gas turbines offer an important alternative to conventional gas turbines driven by non-renewable, polluting fossil fuels such as diesel or natural gas. The book provides a comprehensive overview of the topic as well as numerous illustrations.

This landmark joint publication between the National Air and Space Museum and the American Institute of Aeronautics and Astronautics chronicles the evolution of the small gas turbine engine through its comprehensive study of a major aerospace industry. Drawing on in-depth interviews with pioneers, current project engineers, and company managers, engineering papers published by the manufacturers, and the tremendous document and artifact collections at the National Air and Space Museum, the book captures and memorializes small engine development from its earliest stage. Leyes and Fleming leap back nearly 50 years for a first look at small gas turbine engine development and the seven major corporations that dared to produce, market, and distribute the products that contributed to major improvements and uses of a wide spectrum of aircraft. In non-technical language, the book illustrates the broad-reaching influence of small turbinesfrom commercial and executive aircraft to helicopters and missiles deployed in recent military engagements. Detailed corporate histories and photographs paint a clear historical picture of turbine development up to the present. See for yourself why The History of North American Small Gas Turbine Aircraft Engines is the most definitive reference book in its field. The publication of The History of North American Small Gas Turbine Aircraft Engines represents an important milestone for the National Air and Space

Museum (NASM) and the American Institute of Aeronautics and Astronautics (AIAA). For the first time, there is an authoritative study of small gas turbine engines, arguably one of the most significant spheres of aeronautical technology in the second half o

This book is the proceedings of the International Conference on Power Engineering-2007. The fields of this book include power engineering and relevant environmental issues. The recent technological advances in power engineering and related areas are introduced. This book is valuable for researchers, engineers and students majoring in power engineering.

Advanced Materials for Mercury 50 Gas Turbine Combustion System

The comprehensive guide to engineering alternative and renewable energy systems and applications—updated for the latest trends and technologies This book was designed tohelp engineers develop new solutions for the current energy economy. To that end it provides technical discussions, along with numerous real-world examples of virtually all existing alternative energy sources, applications, systems and system components. All chapters focus on first-order engineering calculations, and consider alternative uses of existing and renewable energy resources. Just as important, the author describes how to apply these concepts to the development of new energy solutions. Since the publication of the critically acclaimed first edition of this book, the alternative, renewable and sustainable energy industries have witnessed significant evolution and growth. Hydraulic fracturing, fossil fuel reserve increases, the increasing

popularity of hybrid and all-electric vehicles, and the decreasing cost of solar power already have had a significant impact on energy usage patterns worldwide. Updated and revised to reflect those and other key developments, this new edition features expanded coverage of topics covered in the first edition, as well as entirely new chapters on hydraulic fracturing and fossil fuels, hybrid and all-electric vehicles, and more. Begins with a fascinating look at the changing face of global energy economy Features chapters devoted to virtually all sources of alternative energy and energy systems Offers technical discussions of hydropower, wind, passive solar and solar-thermal, photovoltaics, fuel cells, CHP systems, geothermal, ocean energy, biomass, and nuclear Contains updated chapter review questions, homework problems, and a thoroughly revised solutions manual, available on the companion website While Alternative Energy Systems and Applications, Second Edition is an ideal textbook/reference for advanced undergraduate and graduate level engineering courses in energy-related subjects, it is also an indispensable professional resource for engineers and technicians working in areas related to the development of alternative/renewable energy systems.