PROJECT facts

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Advanced Turbine and Engine Systems

05/2000

MATERIALS AND MANUFACTURING ELEMENT OF THE ATS PROGRAM

PRIMARY PARTNER

Oak Ridge National Laboratory
Oak Ridge, Tennessee

TOTAL ESTIMATED COST

$ 13,600,000

COST SHARING

DOE	$10,200,000
Non-DOE	$ 3,400,000

ATS WEB SITES:

www.netl.doe.gov/products/power/ats/index.html

Description

The materials and manufacturing technology task is part of the base technology portion of the Advanced Turbine Systems (ATS) Program. The objective of this element is to address the critical materials and materials manufacturing issues for both industrial and utility gas turbines. The work in this portion of the program is being performed by industry with assistance from national laboratories and universities. The projects are aimed toward hastening the incorporation of new materials and components in gas turbines. Work is currently ongoing on thermal barrier coatings (TBC's) and advanced casting techniques for single crystal turbine components. Oak Ridge National Laboratory (ORNL) is a U.S. Department of Energy multi-program lab in Oak Ridge, Tennessee. TBC activities are being carried out at Siemens Westinghouse, Pratt and Whitney, and ORNL. Casting initiatives are being conducted by PCC Airfoils, Howmet, General Electric, Siemens Westinghouse, and ORNL.

Thermal Barrier Coatings

Thermal barrier coatings are critical to the upgrading of rotor inlet temperatures while using evolutionary turbine materials (superalloys). A thermal barrier coating is actually a coatings system, consisting of a thermally-insulating ceramic bonded to an oxidation-resistant metal coating, which is applied to the superalloy substrate. The goal of these programs is the development of dependable thermal barrier coatings that enable increased turbine inlet temperatures while maintaining airfoil substrate temperatures at levels to meet ATS life goals. Pratt and Whitney will identify, test, and confirm the thermal barrier coating's ability to achieve the objectives of the ATS program. Siemens Westinghouse is directing its program at developing a state-of-the-art coating system with a minimum coating life of 25,000 hours at service temperatures required to meet increasing operating efficiency goals.

Manufacturing Technology for Scale-Up of Single Crystal Turbine Airfoils

Directionally-solidified multigrain and single crystal airfoils have been used in aircraft gas turbines for over ten years and are currently found in aircraft engine-derivative gas turbines used for land-based power generation. However, the adoption of single crystal technology for large land-based gas turbines is just underway and is not a simple scale-up. A solicitation was issued in 1994 to extend the capability of single crystal complex-cored airfoil technology to larger sizes so that higher turbine inlet temperatures could be attained in land-based turbines in a cost-effective manner. Two contracts were initiated with Howmet Corporation in Whitehall, Michigan, and PCC Airfoils in Cleveland, Ohio. Howmet's

Materials and Manufacturing Element of the ATS Program

four technology thrust areas included low-sulfur alloys, casting process development and understanding, postcase process development and improvement, and casting defect tolerance level. PCC Airfoils four major task areas included alloy melt practice, modification/improvement of single crystal casting process, core materials and design, and grain orientation control.

Advanced turbine airfoil manufacturing projects were initiated in FY 1998. The purpose of these three projects is to develop advanced manufacturing methods for producing single crystal airfoils that will be more cost effective than the present casting process. General Electric is evaluating and implementing a liquid metal cooling process, which will provide a higher yield. Siemens Westinghouse is developing a process to fabricate complex single crystal blades from small readily producible castings using transient liquid phase bonding. Howmet is evaluating novel technologies which increase yields of ATS components. The critical issues involve improving current Vacuum Induction Mett furnace capability and control, and addressing deficiencies in current shell systems.

Duration

Start Date	02/1995
Projected End Date	12/2001

Key Milestones

12/31/1999 Complete final report of Howmet SC casting project

12/31/1999 Complete final report of PCC SC casting project

03/31/2000 Siemens Westinghouse Complete TBC Project

11/30/2000 Pratt and Whitney Complete TBC Demonstration

General Electric High Gradient Casting Project

06/30/2000 Complete manufacturing process validation
10/30/2000 Product yield demonstration
12/31/2000 Final Report

Howmet Advanced Turbine Airfoil Manufacturing Project

01/31/2000 Complete VIM furnace modification
06/30/2000 Evaluate high conductivity shell systems
09/30/2000 Complete novel cooling system modeling

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