**Advanced Turbine Systems Program
Conceptual Design and Product Development**

**Quarterly Report
November 1, 1996 - January 31, 1997**

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**For
U.S. Department of Energy
Office of Fossil Energy
Federal Energy Technology Center
Morgantown Site
P.O. Box 880
Morgantown, West Virginia 26507-0880**

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**By
ABB Power Generation, Inc.
5309 Commonwealth Centre Parkway
Commonwealth Centre
Midlothian, Virginia 23112**

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**Advanced Turbine System
Conceptual Design and Product Development**

**7 th Quarterly Technical Progress Report
for
November 1, 1996 through January 31, 1997**

Revised Contract April 24, 1995
Signed by DOE June 14, 1996

I. Introduction

II. WBS 1 - Project Plan

The Project Plan for the subject program was submitted (mailed) to the Department of Energy (DOE) on May 18, 1995. This task is complete.

III. WBS 2 - NEPA Report

The information required for the NEPA Report was submitted (mailed) to the DOE on June 22, 1995. This task is complete.

IV. WBS 3 - GFATS Selection

The technical work on this task has been completed and presented to the DOE. Final report is in preparation for this task and was also be presented to the DOE.

V. WBS 4 - Conversion to Coal

Surveys of potential Task 4 CFATS cycles were completed by ABB Power Plant Laboratories (PPL). A brief overview of the results of this work to date were also presented at the September 27, 1995, briefing with the DOE. No further efforts will be expended on this task as indicated in the 5th quarterly report.

VI. WBS 5 through WBS 8 Replanned Tasks

The following tasks are included in the revised contract:

- Turbine Aerodynamics& Aero-Thermal Integration
- Advanced Steam Cooled Vanes
- Advanced Air Cooled Blading
- Thermal Barrier Coating and Steam Oxidation

The following tasks were referenced in the contract and the completion status was part of the monthly reports since July 1996. The references correlate with the contract and the task numbers with the monthly reports.

Ref. 3.4.1 - Turbine Aerodynamics and Aero-Thermal Integration (Task 8.5)

- Hardware Design and Manufacturing:
 - * Front and Rear disc were completed, delivered and ready for balancing.
 - * the uncooled airfoils were pre-manufactured. An on site review at MarTool in December revealed good quality. Finishing of the airfoils is projected for March.
 - * POs for all remaining rotating hardware have been issued.
 - * Drawings for the cooling air supply system were progressing
- Calibration / run software for total temperature probes were completed.
- Eddy brake torque meter calibration and testing has started.

Ref. 3.4.2 - Advanced Steam-Cooled Vanes (Task 8.6)

- overall cooling flow circuit is defined as a two-pass airfoil cooling scheme reflecting the concurrent requirements for inner and outer platform cooling as well as steam delivery and sealing features.
- The proposed cooling concept is based on rectangular spanwise cooling channels with variable aspect ratios and spacing.
- experimental models were designed to generate a general data base for steam cooled components
- ABB has previously designed an upgrade turbine for ABB's GT11N called GT11NM using advanced air cooling schemes. This turbine is planned to be installed at Midland Cogeneration Venture (MCV) as a complete retrofit package that can be used as a test vehicle for a steam cooled vane design that is currently ongoing (ABB contribution to ATS).
- Planning is under discussion with MCV for installation and testing of a steam cooled component in FY 1998. Together with the baseline measurements of the advanced air-cooled turbine the efficiency benefit of steam cooled components can be demonstrated.

Ref. 3.4.3 Advanced Air Cooled Blading (Task 8.3)

- preliminary configuration schemes of coolant passages were developed

- selection of schemes to be tested will be made in February.

Ref. 3.4.4 Thermal Barrier Coating and Steam Oxidation

- **Evaluation of TBC-Coating Systems in High Temperature Gradients**
 - * Initial test runs showed that the required temperature could not be reached. Decision was made to design a new manifold for less test bars per run (8 instead of 12) and to increase burner nozzle size. This new configuration was able to meet the requirements.
 - * Test bars coated with SV 20 with and without TBC were received from PWA Talon.
 - * Further test bars are in coating process at Walbar and Chromalloy.
- **Monitoring of Degradation of TBC Coating Systems**
 - * "As received" test specimen have been assessed to establish a baseline for the degradation of the TBC / bond coat
 - * Test specimen have been run for 300 hours at 1100 C
 - * A second group of specimen is in process for 1500 hours
 - * preliminary metallographic assessment of oxidized test pieces has been done
- **Thermomechanical Fatigue (TMF) of TBC Systems.**
 - * Test rig was modified to simulate internal cooling
 - * Testing of specimen under strain controlled conditions were started.
 - * Tests with 0.85% and 1.0% strain rate have been completed.
- **Kinetics of Oxidation in Steam.**
 - * Test were done in steam atmosphere at 800 C and 950 C in steam oxidation furnace
 - * in January 100 hours exposure time was reached and test specimen have been removed to evaluate oxidation amount (weight change method)

VII. WBS 9 - Program Management/Reports

Work accomplished under this task during the subject period includes the following:

- Participation and presentation of ABB's work on the annual ATS meeting in Washington D.C.

- ABB Monthly Status Reports including Summary Report, Milestone/Schedule Status, Labor Management Report, and Cost Management Report for the following months:
 1. November 1996 delivered (mailed) to the DOE February 28, 1997
 2. December 1996 delivered (mailed) to the DOE February 28, 1997
 3. January 1996 delivered (mailed) to the DOE March 14, 1997
- ABB's sixth Quarterly Technical Progress Report (Final) was submitted (mailed) to the DOE on January 28, 1997.
- Cost plan for FY 97 was finalized and mailed to the DOE February 28, 1997

VIII. General Discussion

The confirmation for the contract modification was received on February 19, 1997. All reports reflect this modification at present.

Technical highlights for the reporting period are:

- First results on steam oxidation behavior of super alloys in steam environment have been achieved.
- The tests on TBC evaluation in high thermal gradients could be started.
- The turbine test rig hardware is well progressing

IX. Program Redirection

Key Dates:

ABB Proposal mailed to DOE: January 26, 1996

DOE Concurrence received: April 29, 1996

The revised program has been implemented in all ABB's development plans and the monthly reports since May 1996 report on the progress and actual status.

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