TECHNICAL PROGRESS REPORT

Quarterly

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Technical Quarterly Progress Report

Advanced Gas Turbine Systems Research
Cooperative Agreement DE-FC21-MC29061

April 1, 2002 to June 30, 2002

ABSTRACT:

The quarterly activities of the Advanced Gas Turbine Systems Research (AGTSR) program are described in this quarterly report. As this program administers research, we have included all program activity herein within the past quarter as dated. More specific research progress reports are provided weekly at the request of the AGTSR COR and are being sent to NETL. As for the administration of this program, items worthy of note are presented in extended bullet format following the appropriate heading.

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EXECUTIVE SUMMARY:

ADMINISTRATION

The DOE sponsored Advanced Gas Turbine Systems Research (AGTSR) program supported under cooperative agreement DE-FC21-92MC29061 is now drawing toward completion. However, due to the fact that SCIES has multiple universities involved in continuing research subcontracts, NETL/DOE granted SCIES request for a no increase in cost time extension for AGTSR/ATS till June 30, 2003. This time extension was granted so that the SCIES subcontracts could complete their research work. During the time extension, no new activities will be added to AGTSR/ATS. SCIES will monitor the subcontracts performance and report to NETL as required. New activities such as Summer Internships, Workshops, additional research awards and development of an outreach program to increase public benefits and program awareness will be conducted under assistance number DE-FG26-02NT41431. This new award to SCIES is focused on the DOE High Efficiency Engines and Turbines (HEET) program. New initiatives by SCIES under this award will be referenced as AGTSR/HEET. During the transition period from AGTSR/ATS to AGTSR/HEET, SCIES will continue to release AGTSR/ATS Quarterly Technical Reports as required. However, the major program documentation will occur in the monthly progress reports under HEET as requested by the NETL COR. The new HEET reports requested by DOE are called—Exceptions Report. (See Attachment I for Exception Reports for April, May and June 2002). For a complete synopsis of SCIES activities under AGTSR/ATS and AGTSR/HEET, this quarterly report and HEET Exceptions Reports should be combined.

- The AGTSR/ATS Quarterly Technical Report for the reporting period of January to March 2002 was submitted to NETL on April 30, 2002. The report was submitted via hard copy and disk.
- SCIES successfully completed the search for an individual to fill the position of Manager of Outreach Development for AGTSR/HEET. Dr. William Day accepted the offer to fill this position. Dr. Day was formerly chair of the AGTSR/ATS IRB, Chair of the GTA and manager of research at P&W.
- The annual Industrial Review Board (IRB) meeting has been set for September 24-25, 2002, at SCIES.
- Normal administrative function continued throughout the reporting period.

MEMBERSHIP

- The 101 university Performing Members for AGTSR/ATS were transferred to Performing Member status under AGTSR/HEET.
- During this reporting period, the University of Massachusetts at Amherst and the University of Alaska at Fairbanks became performing member institutions. This brings the university membership base to 103 universities in 39 states.

- Industrial membership dues for AGTSR/HEET have been slow in coming, as is typical. At the end of this reporting period, Rolls Royce, Siemens Westinghouse, Parker Hannifin, Ramgen, Southern Company, Woodward and Pratt & Whitney have paid their dues. Follow-up with Solar, GE and EPRI is continuing.
- No other membership activities occurred during this reporting period.

TECHNOLOGY TRANSFER (Workshops and Education)

- A total of 17 AGTSR/ATS progress reports have been released. Eight reports were semi annuals, while 5 were annuals and 4 were final project reports.
- The AGTSR Technology Workshops for CY2002 have been established as: Combustion Workshop IX, August 26-28, 2002, at Penn State; Materials Workshop IV at University of Connecticut, October 14-16, 2002; and Aero-Heat Transfer Workshop V at LSU, November 11-13, 2002.
- Eight summer interns were placed under AGTSR/HEET. No problems or difficulties have been reported with this year intern placement.
- The first of a series of AGTSR/HEET Outreach meetings was held at Georgia Tech on April 30 – May 1, 2002. The Workshop was hosted in cooperation with the Advanced Regional DOE Office and the Southern States Energy Board. The second outreach meeting will be held following the Penn State Combustion meeting in cooperation with the DOE Philadelphia Regional Office. Other regional meetings are being planned with the cooperation of NASEO.
- The NASEO meeting dates, location and states covered are: Portland, Oregon July 22, Washington, Oregon, Montana, Idaho, Alaska, Denver, Colorado August 15, Colorado, Wyoming, Utah, South Dakota, Nebraska, Texas, San Francisco, CA September 5, Arizona, California, Nevada, New Mexico, and Hawaii
- No other AGTSR/ATS activities occurred during this reporting period.

EXPERIMENTAL:

No experimental data to include from the administration of this program. At the request of the AGTSR COR, weekly research progress reports are being sent to NETL

RESULTS AND DISCUSSION:

RESEARCH

- As previously stated, contains a listing of AGTSR/ATS technical progress reports released during this reporting period.
- Negotiations with the 10 short-listed AGTSR/HEET PI's/universities have been successfully completed. All HEET projects are now in force.

CONCLUSION:

This quarter ended with continued success in the administration of the Advanced Gas Turbine Systems Research Program. At the request of the AGTSR COR, weekly research progress reports are being sent to NETL. Individual conclusions on those projects are included at that time.

REFERENCES:

All references to specific projects are included at the end of each projects specific progress report. At the request of the AGTSR COR, weekly research progress reports are being sent to NETL. Individual reference listings on those projects are included at that time.

ATTACHMENT I

EXCEPTIONS REPORT

Award No. DE-FC26-02NT41431

Reporting Period

April, 2002

Completed Tasks

- The principal investigators (PIs) of the ten short-listed projects from the year 2001 RFP were notified by telephone of their impending awards. The new and additional reporting requirements for the HEET university research program were also discussed with them. The subcontracts for the new projects will be sent to the universities in early May.
- A draft of the year 2002 RFP was completed. The RFP will be sent in electronic format in May for distribution within their institutions to the points of contact of the 101 AGTSR Performing Member universities.
- SCIES responded to a DOE urgent request to provide descriptions of four university projects for a Vision 21 report to the National Research Council.
- Final arrangements were completed by SCIES for the organization of the May regional workshop on the HEET Program in Atlanta.
- A search for the new position of Manager of Outreach Development was completed. Bill Day, formerly IRB Focal Point to the AGTSR, has accepted this position.

Key Milestone Update

There are no milestone modifications this month.

Discussion Topics

There are no issues that require DOE COR attention or action this month.

Significant Accomplishments – Success Story

Under a continuing AGTSR project, the University of California at Santa Barbara is developing a scientific basis for improving thermal barrier coatings (TBCs) used in gas turbines. One effort is determining how TBCs fail under cyclic conditions and how impending failures might be detected. Determining how TBCs fail will aid in the development of better coatings. Detection before failure will enable turbine parts to be taken out of service before loss of the protective coating.

The project has shown that an early warning of TBC internal damage leading to eventual failure is wrinkling or rumpling at the surface of the TBC that increases with time and the number of thermal cycles. These surface undulations are evidence of separation of the outer ceramic coating layer from an internal thermally grown oxide layer and can be detected using low level magnification and oblique illumination. The project has also shown that use of laser techniques to monitor the change in internal stresses within the TBC combined with monitoring surface rumpling enhances the ability to detect TBC degradation before failures that limit the protection of the underlying metal surface.

Presentations and Publications

- The CDs with 13 AGTSR technical reports for January 1 to March 31, 2002 were sent to the IRB companies for review and comments.
- A presentation “Gas Turbine Research in the AGTSR Program” is being prepared for ASME Turbo Expo in Amsterdam on June 3-5, 2002.

Site Visits

No site visits occurred or were planned with high level corporate or government officials this month.

Travel

SCIES will conduct on May 1 and 2, 2002 the regional workshop in Atlanta on the HEET Program.

EXCEPTIONS REPORT

Award No. DE-FC26-02NT41431

Reporting Period

May, 2002

Completed Tasks

- Subcontracts were awarded for nine of the ten short-listed university projects from the year 2001 RFP. The final subcontract has been delayed because the Principal Investigator (PI) has moved to another university. The university from which the original proposal was issued has agreed to allow the project to be awarded to the institution to which the PI has moved. The PI has prepared an amended proposal with the only the change of university of the PI. The work statement and all facilities and subcontracts remain unchanged.
- The University of Massachusetts at Amherst was added as a new AGTSR-HEET Performing Member University. With this addition, there are now 102 Performing Member Universities in 38 states.
- The RFP for year 2002 was sent in electronic format on May 15 to the points of contact at the AGTSR Performing Member universities for distribution within their institutions. The RFP was also sent to the professors who had previously received AGTSR project awards.
- Eight students from AGTSR-HEET Performing Member Universities were placed as industrial interns for periods of 10 to 12 weeks at AGTSR-HEET Industrial Review Board organizations.
- SCIES worked with Prof. Dom Santavicca to produce a first draft agenda for Combustion Workshop IX on August 26-28, 2002 at Penn State University.
- The contract required Power Point Presentation describing the new AGTSR-HEET university program was prepared and sent to Tom George, the DOE COR.
- The contract required Program Plan for the new AGTSR-HEET university program was prepared and sent to the contract COR.
- Six proposal debriefings were given by telephone to professors who had not received awards from the year 2001 RFP.
- SCIES responded to a DOE urgent request to provide a description of the AGTSRHEET university program for a Vision 21 report.

Key Milestone Update

There are no milestone modifications this month.

Discussion Topics

There are no issues that require DOE COR attention or action this month.

Significant Accomplishments – Success Story

Under the Advanced Gas Turbine Systems Research (AGTSR) program, Texas A&M is evaluating methods to improve cooling for gas turbine airfoils. The project experimentally and computationally evaluates parameters and design aspects associated with airfoil internal cooling passages with rectangular cross sections and various internal

features such as dimples to enhance cooling effectiveness. Evaluations in the program have shown that dimples on interior surfaces of cooling channels can improve cooling effectiveness by as much as a factor of two compared to smooth cooling channels. The stationary and rotating experimental and computational results from this project will provide turbine engineers with new data for design of airfoil internal rectangular cooling passages and thereby potentially improve the cooling efficiency and thermal efficiency of gas turbines.

Presentations and Publications

- The CDs with 13 AGTSR technical reports for January 1 to March 31, 2002 were sent to the IRB companies for review and comments.
- A presentation "Gas Turbine Research in the AGTSR Program" was completed for ASME Turbo Expo in Amsterdam on June 3-6, 2002.

Site Visits

No site visits occurred or were planned with high level corporate or government officials this month.

Travel

On May 1 and 2, 2002 SCIES conducted a regional workshop in Atlanta on the HEET Program.

EXCEPTIONS REPORT

Award No. DE-FC26-02NT41431

Reporting Period

June, 2002

Completed Tasks

- The subcontract was awarded for the tenth and final short-listed university project from the year 2001 RFP.
- The University of Alaska at Fairbanks was added as a new AGTSR-HEET Performing Member University. With this addition, there are now 103 Performing Member Universities in 39 states.
- The RFP for year 2002 was released in electronic format in May. The recipients were notified in June of a modification of the RFP according to a modification of SCIES cooperative agreement with the DOE. This modification allows for up to 10% of the total budget of university research subcontracts for purchase of supplies and equipment.
- SCIES is proposing a change in the scope of university research to achieve linkage between different technical fields (example: coal gasification and gas cleanup in addition to turbines). A draft white paper has been written, and meetings are being set up with key FE executives.
- Proceedings were released for the first HEET Regional Workshop, held in Atlanta on May 1-2.
- The second HEET Regional Workshop will be held back to back with the Combustion Workshop IX on August 26-28, 2002 at Penn State University. This will save cost and facilitate attendance at the Regional Workshop by university people. A preliminary agenda has been prepared, and speakers are being lined up. The registration package and preliminary agenda have been sent to potential attendees specializing in combustion and a later mailing will invite a broader audience.
- For Regional Workshops in the west, arrangements have been made to combine

efforts with the National Association of State Energy Officials (NASEO), who are working under a DOE-FE contract to hold regional workshops in Portland, OR, Denver and San Francisco. The purpose is to address the issues, needs and opportunities for collaboration on advanced turbines and hybrid fuel cell systems in the western states. Combining the Regional Workshops with the NASEO meetings will save cost and avoid asking many of the same audience to attend two similar sets of workshops.

- The contract required Fact Sheet describing the new AGTSR-HEET university program was prepared and sent to Tom George, the DOE COR.
- Another proposal debriefing was given by telephone to a professor who had not received an award from the year 2001 RFP.

Key Milestone Update

There are no milestone modifications this month.

Discussion Topics

There are no issues that require DOE COR attention or action this month.

Significant Accomplishments – Success Story (AGTSR Project)

Under the Advanced Gas Turbine Systems Research (AGTSR) program, a University of Connecticut (UConn) project has the goal of identifying a new thermal barrier coating (TBC) material with improved properties over those for the conventional TBC now used in turbines. Two of those properties are lower thermal conductivity (to better insulate underlying metal surfaces) and no reactivity with the aluminum oxide scale that forms on the interface between the insulation layer and the bond coat layer on the metal turbine part. Experiments at UConn have previously shown that compositions of gadolinium zirconates (Gd-Zr) have over 30 % lower thermal conductivity than the conventional TBC material. Recently reported experiments have shown that Gd-Zr compositions do not react with aluminum oxides even at 500 F higher than turbine temperatures. Consequently, UConn has identified a material with two important superior properties over those for current TBCs used in turbines.

Presentations and Publications

A presentation “Gas Turbine Research in the AGTSR Program” was given at ASME Turbo Expo in Amsterdam on June 5, 2002.

Site Visits

The IRB Focal Point persons have been asked to confirm their availability for the Industrial Review Board (IRB) Meeting at SCIES on September 24-25. Purposes of the meeting are to short list university proposals and discuss the AGTSR-HEET program.

Travel

Bill Day, AGTSR-HEET Manager of Outreach, traveled to Washington DC to discuss the scope of activities for SCIES during a meeting at DOE Fossil Energy headquarters.