Technical Quarterly Progress Report

Quarterly Report
October 1 - December 31, 1997

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U.S. Department of Energy
Office of Fossil Energy
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P.O. Box 880
Morgantown, West Virginia 26507-0880

By
Clemson University
South Carolina Energy Research & Development Center
386-2 College Avenue
Clemson, South Carolina 29634-5180

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Technical Quarterly Progress Report
Advanced Gas Turbine Systems Research
Cooperative Agreement DE-FC21-92MC29061

October 1, 1997 - December 31, 1997

SUMMARY

Major Accomplishments by AGTSR during this reporting period are highlighted below and amplified in later sections of this report:

Administrative

- AGTSR received their FY98 program continuation from DOE-FETC for \$4M, covering the period January 1, 1998 through December 31, 1998
- AGTSR participated in ATS Annual Review Meeting on October 28-29, 1997 in Morgantown, WV
- AGTSR devised an assessment form to be used in evaluating research progress for semi-annual, annual, and final reports
- SCERDC/ AGTSR participated in the October 7, 1997 board meeting for the Council of Consortia (COC)
- AGTSR collaborated with the Idaho National Engineering and Environmental Laboratory (INEEL) on a unique heat transfer research facility
- AGTSR coordinated the IRB review of 4 heat transfer research papers (Minnesota), 2 materials papers (Lehigh, U-Conn), 1 combustion paper (BYU), and 1 aerodynamics paper (Syracuse)

- SCERDC/ AGTSR provided the Gas Turbine Association (GTA) with a list of current R&D projects and future goals for both SCERDC and AGTSR
- AGTSR distributed 5 university success viewgraphs to DOE-FETC from Clemson, Georgia Tech, U-Conn, Syracuse, UC-Berkeley
- AGTSR released 10 winner letters to new PI's from the 97 RFP and 42 non-winner letters
- AGTSR provided consortium description and research picture for DOE-FETC's ATS brochure
- AGTSR debriefed 97 RFP non-winning PI's by telephone
- AGTSR participated in reviewing draft RFP for Clemson's new central energy facility
- AGTSR provided summary of 10 new research projects to DOE-FETC from the 97 RFP
- AGTSR began preparation and negotiation of 10 new research subcontracts from the 97 RFP
- AGTSR assisted DOE-FETC in electronic submission of research poster charts for the ATS Annual Review Proceedings

Research

- AGTSR announced 10 new research awards selected by the IRB from the 97 RFP: 3 in combustion, 4 in heat transfer, and 3 in materials
- AGTSR FY94 and FY95 progress reports distributed to the IRB and DOE-FETC
- U-Conn's heat pipe final report distributed to the IRB for review and evaluation

- AGTSR distributed a white paper to the IRB on a low NO_x gas turbine mixer concept from Houston Consulting in Hendersonville, NC
- Via Solar Turbines, AGTSR coordinated research planning meetings for new heat transfer projects with Minnesota and CMU
- AGTSR reviewed an ABB film-cooling paper for an Air Force advanced film-cooling session at IGTI 98
- AGTSR distributed material to the IRB on a unique honeycomb swirler concept from ELDIM that may be used in advanced combustion R&D
- LSU final report on enhanced internal heat transfer distributed to the IRB for review and evaluation
- AGTSR distributed white paper to DOE from the University of North Dakota on characterizing catalytic combustor exit-turbulence and its impact on turbine vane heat transfer
- AGTSR coordinated with the IRB the termination of an aerodynamics research project with UC-Davis due to the resignation of the main PI
- Via Solar Turbines and GE, AGTSR coordinated research planning meeting for new endwall heat transfer project with Penn State and Minnesota
- AGTSR distributed two white papers to the IRB from the University of Maryland on potential add-on combustion research efforts
- AGTSR distributed white paper to the IRB from Penn State University on an improved nickel-based superalloy
- AGTSR solicited research topics from the IRB for the 1998 RFP announcement

Workshops/Education

- AGTSR coordinated a gas turbine university research session for the ASME Energy Technology Conference in Houston, TX, February 2-4, 1998
- AGTSR participated in the October 7, 1997 Energy Forum at Clemson University for their new central energy facility program
- AGTSR participated in the November 12, 1997 Active Combustion Control workshop at NASA-Lewis
- Via the Council of Consortia (COC), AGTSR volunteered to help in planning a DOE ATS presentation for their Aerospace Materials S&T Workshop in Washington, DC
- AGTSR was invited to give a combustion R&D talk at the Western States Section Combustion Institute meeting in March 1998
- AGTSR distributed workshop announcements for Combustion V workshop in Berkeley, CA and a Specialty Materials Workshop in Hoboken, NJ
- AGTSR distributed internship brochures to the IRB and performing member universities to advertise the 1998 summer industrial internship program

Membership

- Two new universities expressed interest in becoming AGTSR performing members: U.S. Naval Academy and the University of Miami
- University of North Dakota became a new performing member institution in AGTSR
- Southern Company Services, AlliedSignal, and Williams International expressed interest in becoming an industrial member of AGTSR in 1998

- AGTSR renewed their affiliate membership with the Gas Turbine Association (GTA) in 1998

MEMBERSHIP

During this reporting period, the University of North Dakota became an AGTSR Performing Member. AGTSR membership is currently at 93 schools, representing 37 states.

Fluent, Inc. is still interested in possibly becoming an associate member of the AGTSR Consortium in 1998. The point-of-contact for Fluent is Dr. Tom Norton, who indicated to AGTSR that they should make a final decision shortly.

On a trial basis until the end of December 1997, Southern Company Services (SCS) in Birmingham, AL became an associate member of AGTSR from July 1, 1997 through December 31, 1997 for a pro-rated fee of \$3K. The point-of-contact there is Charles Boohaker of the Power Technology Division. Charles indicated to AGTSR that we should mail SCS an invoice for 1998 since they anticipate remaining members in 1998.

AlliedSignal Engine Company is still considering membership in 1998. The points-of-contact are Vinod Nangia of Advanced Technology and Len Meyer of Marine and Industrial Engines. AGTSR anticipates a decision from AlliedSignal by the end of January 1998.

During this reporting period, Williams International in Walled Lake, MI was invited to become an associate member of AGTSR. Williams is very interested in leveraging gas turbine R&D, especially for the smaller size machines and they have a keen interest in microturbine technology in the 25 to 75kw range. Our contact at Williams is Carl Schiller, who indicated to AGTSR that they will probably make a decision by the end of January 1998.

In 1993 through 1997, AGTSR received cost-sharing contributions of \$25,000 from each of the IRB voting members. The IRB now consists of seven U.S. turbine engine/component manufacturers with EPRI and GRI continuing to act as utility and industrial gas turbine advisors for AGTSR. As of this date, all the IRB members have paid their annual contributions for 1997. Invoices for their 1998 contribution to AGTSR should be released by January 31, 1998.

1993-through-1997 SUBCONTRACT PROGRESS

With the exception of Brigham Young University (BYU), all the FY93 final reports have been received by AGTSR. BYU's combustion project ended on December 31, 1997 and their final report is due on February 28, 1998. During this reporting period, AGTSR received the final report from Louisiana State University (LSU), an FY93 heat transfer project. The IRB approved UC-Berkeley for a \$32K add-on until December 31, 1997 to

continue the testing of their optical probe for measuring air/fuel mixing in collaboration with GE. Their final report is due to AGTSR by February 28, 1998.

Out of the thirteen FY94 AGTSR research projects, four are still active. The four active FY94 projects are: Purdue (aero-heat transfer), Maryland and UC Irvine (combustion), and Georgia Tech (materials). For the other FY94 projects, final reports have now been received from MIT (heat transfer), Cornell (combustion), Central Florida (materials), and Wyoming and Michigan State (both in heat transfer). In December 1997, AGTSR received their final report from Carnegie Mellon University (heat transfer - Chyu). Final reports are still delinquent from Clemson University (heat transfer - Leylek) and Oklahoma (aerodynamics - Agrawal).

The FY95 Annual Progress Reports have all been received by AGTSR and were distributed to both the IRB and DOE. The nine FY96 projects that were started by AGTSR in June 1997 have their first semi-annual progress report due on January 31, 1998. Ten FY97 research projects were short-listed by the IRB from the proposals submitted in response to the FY97 RFP. The distribution for the short-listed proposals is: 3 in combustion (UC Irvine, CalTech, VPI), 4 in heat transfer (2 from Purdue, UMinnesota, Carnegie Mellon University), and 3 in TBC's (Georgia Tech, Central Florida, UCSantaBarbara). Since AGTSR has now secured FY98 funding from DOE-FETC, all ten projects will be supported with a start-date of February 1, 1998, with the exception of UC-Irvine and Central Florida who have requested a January 1, 1998 start-date.

At the request of the IRB, AGTSR has devised an assessment form to evaluate their progress reports. The purpose of the form is to better assess the value added to industry from the AGTSR university research results, and to improve R&D interactions between the PI's in funded AGTSR projects and the industry subarea contacts in the various technical disciplines. Starting with this reporting period, all the progress reports were distributed to the IRB with the assessment form attached - to be completed by the appropriate subarea R&D expert.

AGTSR's FY98 CONTINUATION REQUEST

The AGTSR FY98 continuation request for \$4M was submitted to DOE-FETC during the last reporting period. The 1998 request included sections on FY97 accomplishments, financial status of the consortium, and an outline of FY98 goals for AGTSR. On December 11, 1997, DOE-FETC approved the request and awarded AGTSR \$4M covering the period January 1, 1998 to December 31, 1998. This early

approval of FY98 funds will enable the ten new awards from the 97RFP to be started smoothly and as planned.

IRB SELECT TEN NEW RESEARCH PROJECTS

The AGTSR Industry Review Board (IRB) proposal review meeting for the 1997 RFP was held at SCERDC on September 4-5, 1997. As a result of these deliberations, the IRB short-listed ten new research projects from the 1997 RFP. Since full support for FY98 was secured from DOE-FETC in December 1997, all ten awards will be supported with a projected start date of February 1, 1998. A total of fifty-two proposals were received under this RFP; representing 32 institutions and 23 states. The technology distribution for the 97RFP is shown below:

Technology	No. submitted	No. selected
Combustion	22	3
Heat Transfer	20	4
Materials	10	3

COMBUSTION V WORKSHOP CO-HOSTED WITH UC-BERKELEY

AGTSR's fifth combustion workshop will be co-hosted with Dr. Robert Dibble and is scheduled for March 25-27, 1998 in the Berkeley Marina Marriott, Berkeley, California. The Workshop will bring together experts actively working in advanced combustion R&D from industry, universities, and government laboratories – including DOE, DOD, and NASA. The Combustion V Workshop will focus on combustion instability research and field results, active control and diagnostics, catalytic combustion, and possibly a session on combustion research activity at Sandia National Laboratory located in Berkeley, CA. DOE-FETC will also be presenting an invited talk on the status of ATS and future R&D initiatives that they are considering in the post-ATS era. Registration material for this workshop should be forthcoming by the end of January 1998. If you are interested in participating in the Combustion V Workshop, please contact AGTSR at 864-656-2267.

METALLIC COATINGS SPECIALTY WORKSHOP

This specialty workshop will be co-hosted with Professor Woo Lee of Stevens Institute of Technology and is scheduled for April 16-17, 1998 at Stevens in Hoboken, New Jersey. The Workshop will be limited to approximately 40-50 people and will focus on the development, processing, and science issues pertaining to aluminide and platinum aluminide coatings for gas turbine components used in the aircraft propulsion and power generation industries. Three main sessions are being planned: OEM usage and experience, coating manufacturer issues, and research issues presented by select university, NASA, and ORNL investigators. Registration material for this specialty workshop should be available next month. For further information, please contact Dr. Lee or Dr. Fant, wlee@stevens-tech.edu or dfant@clemson.edu.

EB-PVD WORKSHOP AT PENN STATE

The Electron Beam-Physical Vapor Deposition (EB-PVD) Workshop will be held at Penn State University on June 10-11, 1998 in State College, PA. The theme of the Workshop is "Current Developments in EB-PVD Technology." In addition to industry and academia presentations, Penn State's colleagues from the Ukraine International Center for Electron Beam Technologies will present their joint research program activities. Also, Penn State's Applied Research Laboratory (ARL) pilot production general purpose EB-PVD coater has been installed, and a tour and demonstration will be given along with a review of the coating work conducted by the new machine will be presented. For questions regarding the Workshop contact Barbra Klinefelter, Conference Coordinator, 814-865-3940 (blk3@psu.edu) or Chuck Brickell, EB-PVD Manager, 814-863-9900 (chb1@psu.edu).

AGTSR CONTINUES IN GTA

AGTSR has continued their membership in the Gas Turbine Association (GTA) for 1998. AGTSR endorses GTA's activities and recognizes their many contributions over the past two and one-half years. AGTSR also anticipates working closely with GTA on some of their new initiatives for 1998 which include: new gas turbine R&D programs, energy efficient and ultra-low emissions technologies, new emissions trading programs, midsize gas turbine and microturbine activities for distributed generation, and new challenges in a competitive electric industry. For more

information on GTA, please contact Jeff Abboud, the Executive Director of GTA, at 202-298-1806.

MIT VISITS SOLAR TURBINES

The AGTSR principal investigator at MIT, Dr. Choon Tan, visited Solar Turbines on November 24, 1997, to discuss his new research project on aerodynamic computations of unsteady blade-row interactions in multistage compressors. At Solar, Dr. Tan met with Dr. Razinsky and Mr. Stringham and also gave a presentation to their engineers where he provided an overview of the MIT Gas Turbine Laboratory research activities, discussed the effect of upstream rotor vortical disturbances on the time-average performance of axial stators, and presented a computational model for multistage axial compressor design. Solar engineers from the turbine group also attended Dr. Tan's presentation as Dr. Razinsky wanted them to be aware of the MIT work and its potential relevance to advanced turbine design. For questions on this research project, please contact Dr. Choon Tan at MIT, choon@MIT.edu.

SANTORO VISITS PRATT & WHITNEY

On October 27, 1997, Professor Bob Santoro of Penn State University visited the Combustion Technology Group at Pratt & Whitney (P&W), West Palm Beach, FL. The point-of-contact at P&W was Dr. Jeff Lovett. Professor Santoro briefed P&W on his AGTSR research project dealing with the experimental investigations of high-pressure gas turbine combustion instabilities. The co-investigators on this project are Professors Dom Santavicca and Vigor Yang, also of Penn State. At P&W, Dr. Santoro discussed the motivation and objectives of the research, and presented their experimental approach along with some of their most recent results. His main conclusions were that Penn State is now able to study combustion instability (CI) mechanisms at chamber pressures up to 20-25 atmospheres, they have produced CI's in a repeatable fashion, they have clearly identified the modes of instability for their lab-scale combustor, and the correlation of pressure fluctuations with heat release has been started using CH chemiluminescence images of unstable flames. Future work includes focusing on higher pressure effects between 10 and 20 atmospheres, and examining the effects of varying exit nozzle size, premixing with changes in the fuel injection location, and the effect of various swirl angles. The computational modeling complement to this research is being conducted by Dr. Yang. If you would like to discuss

the experimental research program with Dr. Santoro, please call him at Princeton University, 609-258-5041, as he is currently on sabbatical there as a visiting fellow.

INEEL's MATCHED-INDEX-OF-REFRACTION FLOW SYSTEM

Dr. Donald McEligot is the technical leader of the Experimental Thermal Sciences Group at the Idaho National Engineering and Environmental Laboratory (INEEL). His group there has developed a unique Matched-Index-of-Refractive (MIR) flow system; the design was led by Dr. Carl Stoots while Keith Condie, its present program manager, directed the fabrication and initial operation. The system provides an excellent facility for careful, precise measurements to assess the validity and guide the improvement of Direct Numerical Simulation (DNS) of turbulent and transitional boundary layer flows and of other numerical predictive methods. The MIR technique consists of using materials of construction for the test section, the model and the fluid such that their refractive indices are effectively identical or matched. Hence, techniques such as laser Doppler anemometry (LDA) and particle image velocimetry (PIV) can be used to see through objects immersed in the fluid, without disturbing the flow, and to measure velocities in and around the model. The system is primarily useful for steady and unsteady experiments in low Reynolds number viscous flows with complex geometries, and flow through and/or around complex blunt body configurations dominated by inviscid behavior. The current test section of 60 cm by 60 cm cross section and 2 1/2 meter length yields a range of Reynolds numbers from about 30,000 to 170,000 per meter, allowing large models to be employed for the desired range and, thereby, giving excellent spatial and temporal resolution. As the technique and INEEL facilities may be of interest to the ATS heat transfer R&D community, please contact Dr. McEligot with any questions or comments, 208-526-2881/ dm6@inel.gov.

AGTSR ATTENDS ACC SEMINAR AT NASA

The JANNAF (Joint Army-Navy-NASA-Air Force) Interagency Propulsion Committee organized a technology awareness seminar on Active Combustion Control (ACC) on November 12, 1997 at NASA-Lewis. The POC for this JANNAF meeting was Dr. Klaus Schadow of the Navy in China Lake, CA. The purpose of the meeting was to discuss recent successes in suppressing combustion instabilities and reducing emissions, identify R&D barriers in ACC, and explore ways of improving coordination of future

combustion R&D activities funded by the government. DOE representation was requested by Dr. Schadow and both AGTSR and Dr. Geo Richards of DOE-FETC participated in the meeting as this research focus is of extreme interest to the ATS program. Over 40 people attended the seminar from industry, academia, and government. ACC definitely has potential to impact land-based gas turbines in the post-ATS time frame, and as a result, JANNAF will likely include DOE as part of their R&D planning effort on Active Combustion Control.

AGTSR PARTICIPATES IN THE ATS ANNUAL REVIEW

The ATS Annual Review Meeting was held at DOE-FETC in Morgantown, WV this year, October 28-29, 1997. The AGTSR program was reviewed during the morning of October 29, 1997. AGTSR had a three-part review: part 1 being the AGTSR poster session displaying 27 university research projects and their major accomplishments during FY97; part 2 was an overview presentation on the AGTSR consortium summarizing its research and educational impact over the past five years; and part 3 was an industry panel consisting of the 5 IRB voting members who discussed specific research successes with AGTSR and highlighted novel AGTSR research results that had potential application to post-ATS concepts and advanced gas turbine product development. AGTSR also submitted a paper on the consortium to be published in the ATS Annual Review proceedings. To request a copy of the proceedings, please call Ms. Betty Robey or Ms. Carolyn Moore at DOE-FETC's Conference Services, 304-285-4594.

AGTSR ORGANIZES GAS TURBINE SESSION FOR DOE

At the request of DOE-FETC, AGTSR has organized a gas turbine session for the ASME Energy Sources Technology Conference, February 2-4, 1998, Houston, TX. The session is entitled "Land-Based Gas Turbine Research." The session includes four university research presentations which are representative of the core technologies being pursued by the AGTSR program. The papers are: (1) Performance of Industrial Gas Turbine Materials at High Temperatures by Dr. Vimal Desai, University of Central Florida, (2) Progress with 3D Inverse Method for Turbomachine Blade Design by Dr. Thong Dang and Sachin Damle, Syracuse University, (3) Flow and Heat Transfer Measurements in Gas Turbine Film-Cooling by Dr. Terrence Simon and Rohit Oke, University of Minnesota, and (4) Fiber Optic Probe for Primary Zone Fuel Distribution Measurements in Actual Gas

Turbine Combustors by Dr. Jong Guen Lee and Dr. Dom Santavicca, Penn State University. AGTSR will also chair this session and will handle the review process for all four papers.

AGTSR INTERNS FINISH-UP AT ATS COMPANIES

During the summer of 1997, AGTSR placed 17 graduate-level interns at ATS company sites to gain hands-on, practical experience in an industrial setting.. To date, AGTSR has placed 37 interns at ATS industrial sites. Of the 17 interns placed this summer, 6 were in the combustion area, 7 in heat transfer, and 4 in CFD/ materials. Most of the 1997 interns have now finished their 10-week program with industry, and AGTSR is currently reviewing the final reports on their projects and the value of the internship experience. Two of the interns will finish-up in December 1997 – one from UCIrvine and the other from UC Berkeley. Professor Wang of Clemson's ME department summarized the intern reports with respect to the pros and cons of their internship experience and a brief description of their technical accomplishments and the projects they worked on during the summer. For next year, AGTSR is planning to extend the industrial internship program to 12 weeks and will also consider more expedient ways to pay the interns throughout the summer via the sponsoring ATS companies.

UCBERKELEY TO TEST PROBE AT UTRC

Professor Bob Dibble and Rajiv Mongia of UC Berkeley will be testing their unique optical probe during December 1997 at UTRC in East Hartford, CT. Their newly developed probe is used for measuring the extent of air and fuel mixing in a premixed combustion gas turbine. They have previously tested the probe during an AGTSR summer internship program at Solar Turbines under atmospheric pressure and room temperature with promising results. They have since improved the design of the probe and will test it at UTRC under separate funding. The point-of-contact at UTRC is Dr. Bill Sowa, 860-610-7958, sowawa@utrc.utc.com. For further details on the improved probe design, please contact Dr. Bob Dibble, rdibble@firebug.me.berkeley.edu.

CLEVELAND STATE GETS PROMISING RESULTS ON "DUAL LAYER" TBC'S

Dr. Lee and Dr. Tewari of Cleveland State University (CSU) are investigating advanced "dual layer" thermal barrier coatings (TBC's) by using refractory oxides as thin intermediate layers between the bond coat and the YSZ top coat to reduce oxidation and enhance bonding performance. They have obtained some very good adhesion results for the tests conducted at CSU, and they are in the process of performing cyclic oxidation tests in collaboration with NASA-Lewis. NASA is also spray coating their samples using HVOF and APS. In addition, they have recently submitted a patent disclosure to CSU based on this advanced TBC concept. For additional information on the project, please contact Dr. Kang Lee, 216-433-5634/ kang.n.lee@lerc.nasa.gov.

SYRACUSE ACHIEVES GOOD RESULTS USING THEIR 3-D INVERSE DESIGN METHOD

Professor Thong Dang and Sachin Damle of Syracuse University have demonstrated the practical utility of a 3-D inverse viscous method by carrying out a design modification of a transonic rotor of a new industrial compressor designed and built by Solar Turbines. Their results indicated that the adverse pressure gradients in the flow were reduced by controlling the blade pressure loadings. This reduction was obtained by either smoothening the original loading distributions or by using a different loading distribution when desired while keeping the same total work. The smoothened loadings also helped in weakening the passage shock. Professor Dang was also invited to give a seminar to GEPS in early 1998 on their inverse design method. They are in the process of performing some preliminary calculations on a GE compressor blade geometry using both the 3-D viscous and inviscid inverse design code. In addition, Syracuse University and Solar Turbines submitted a paper on their new results to ASME IGTI 1998 for presentation in Stockholm, Sweden during the summer of 1998. For further information on their design method, please contact Dr. Thong Dang at 315-443-4311.

UCONN/UPITT HOLD INDUSTRIAL PARTNERS MEETING IN MORGANTOWN

UConn held their fourth semi-annual industrial partners meeting on October 27, 1997 in conjunction with the ATS Annual Review in Morgantown, WV. The industrial partners include ABB, Allison Engine, GE Power Systems, Howmet Corporation, Pratt & Whitney, Solar Turbines, and Westinghouse Power Generation. Briefings were provided by Professor Eric Jordan on UConn's AGTSR research program on "Bond Strength and Stress Measurements in Thermal Barrier Coatings", and by Professors Gerry Meier (UPitt) and Jack Beuth (CMU) on the new UPitt/UConn's AGTSR program on "Chemical and Mechanical Instabilities at Thermal Barrier Coating Interfaces." Highlights of the briefing included (1) a detailed description of the mechanism of spallation in Pt-Al/EB-PVD thermal barrier coatings (TBCs), (2) the latest laser fluorescence results for stress as a function of coating type and thermal cycling produced by Professor David Clarke of UC-SB, (3) bond strength measurements as a function of coating type and (4) finite element analyses and interface fracture mechanics evaluations. The laser fluorescence technique has the potential for being developed into an TBC NDI technique for assessing initial coating quality and life remaining for service components. For additional information on these two research programs, please contact at UConn: Professors Maurice Gell (860-486-3514) and Eric Jordan (860-486-2371) and at UPitt, Professors Gerry Meier (412-624-9741) and Fred Pettit (412-624-9783).

SOLAR TURBINES INITIATES PLANNING MEETING FOR AGTSR HEAT TRANSFER RESEARCH

Dr. Boris Glezer of Solar Turbines initiated a working session meeting on November 17, 1997 at Solar Turbines in San Diego, CA. The purpose of the meeting was to initiate ATS industrial collaboration to establish a practical framework for an AGTSR heat transfer project recently selected by the Industry Review Board (IRB). The research team consists of Carnegie Mellon University (CMU) and the University of Minnesota. This project has the potential to lead to sizable improvements in current nozzle endwall design practice by addressing interdisciplinary issues in aerodesign, heat transfer, and combustion. At Solar, eighteen engineers in various design disciplines participated in the meeting. The university researchers are Professors Chyu and Shih from CMU, and Professor Simon from Minnesota. On behalf of AGTSR and ATS, Dr. Glezer also initiated a similar planning meeting at

Penn State on December 8, 1997 to discuss a new edge cooling heat transfer program with Minnesota and Penn State University. For further information on these research planning meetings, please contact Dr. Glezer at 619-544-5464.

LIST OF PROJECTS SELECTED FROM 97RFP

A total of ten research projects from the 97RFP solicitation were selected for funding by the AGTSR Industry Review Board. AGTSR will initiate these awards in February 1998. The technical categories are 3 in combustion, 4 in heat transfer, and 3 in materials:

COMBUSTION:

1. VPI, Drs. Vandsburger, Saunders and Baumann, "Development of Modular, Reduced-Order Models for Prediction of Combustion Instabilities", 3-years, \$600K.
2. CalTech, Dr. Culick, "Nonuniformities of mixture ratio as a mechanism of combustion instabilities in lean pre-mixed combustors", 3-years, \$390K.
3. UC Irvine, Dr. Samuelsen, "Mechanistic Study of Critical Technology Issues in Natural-Gas Fired Gas Turbine Combustion - Dual Fuel and Gas Composition Effects", 3-years, \$450K.

HEAT TRANSFER:

4. Purdue, Drs. Ramadhyani, Plesniak and Lawless, "Airfoil Trailing Edge Cooling", 2-years, \$160K.
5. Minnesota and Penn State, Drs. Goldstein (Minnesota) and Camci (PSU), "Edge Cooling Heat Transfer on Turbine Blades", 3-years, \$600K.
6. CMU and Minnesota, Drs. Chyu and Shih (CMU) and Dr. Simon (Minnesota), "Experimental and Computational Studies of the Nozzle Endwall Region of Advanced Gas Turbines", 3-years, \$560K.
7. Purdue, Drs. Fleeter and Lawless, "Turbine Blade Tip, Endwall and Platform Heat Transfer Including Rotation Effects", 3-years, \$430K.

MATERIALS:

8. UCSanta- Barbara, Drs. Evans, Clarke and Levi, "A Mechanism-Based Approach to Life Prediction and Non-Destructive Evaluation for Thermal Barrier Coatings", 3-years. \$600K.

9. Central Florida, Dr. Desai, "Non-Destructive Evaluation and Monitoring of TBC's by Electrochemical Impedance Spectroscopy", 2-years, \$200K.

10. Georgia Tech, Drs. Hampikian and Carter, "Improvements in TBC Durability via Combustion Chemical Vapor Deposition", 3-years, \$440K.

Miscellaneous Activities

AGTSR wrote their 8th newsletter in December 1997 and it will be released for distribution in early January 1998. This newsletter highlighted AGTSR's accomplishments during 1997 and discussed several collaborative R&D successes with its industrial and university partners.

AGTSR will begin coordinating RFP research topics in January and February of 1998 and plan to release the 98RFP in March 1998. Again, the research issues are being solicited from the IRB subarea contacts in each of the AGTSR companies.

In December 1997, AGTSR advertised their fourth summer industrial internship program. Applications are due to AGTSR by February 20, 1998, for placement starting May-June. To date, AGTSR has placed 37 interns at ATS sponsoring companies, and expects to place an additional 15-20 interns for next summer.

AGTSR had a very dynamic year in 1997. Thanks to your ideas, support, and enthusiasm for effective interactions and R&D planning, AGTSR enters 1998 with a full agenda and much optimism for continued success of its mission.