Technical Quarterly Progress Report

**Quarterly Report
April 1 - June 30, 1998**

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

April 1, 1998 – June 30, 1998

SUMMARY

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

Administrative

- AGTSR submitted several success viewgraphs to DOE-FETC on university research highlights
- AGTSR released Combustion Workshop V proceedings (two volumes) to DOE and workshop participants in June 1998
- AGTSR and Stevens Institute contributors to a summary white paper being prepared by ORNL for the Metallic Coatings Specialty Workshop (release expected late summer)
- AGTSR scheduled an IRB meeting at SCERDC for September 15-16, 1998
- AGTSR distributed the 98RFP proposals on June 25, 1998 to the IRB experts for review and evaluation
- AGTSR distributed combustion R&D position paper prepared by DOE-FETC for review and comment by the combustion workshop participants
- AGTSR prepared new letter of appointment policy to expedite the payment process to AGTSR summer interns

- AGTSR distributed conference papers to the IRB from Northwestern (TBC's) and Georgia Tech (Combustion) for review
- AGTSR distributed final report notices for completed projects to Purdue, UCIrvine, Georgia Tech, Maryland, Syracuse, and Central Florida
- AGTSR received new combustion R&D contact at GE-CRD, Rob Campbell, who replaced Jeff Lovett who left to work for P&W
- AGTSR distributed notices to 95-01 PI's on add-on research mechanism and continuation proposals for re-competition within the 98RFP
- AGTSR distributed assessment form feedback from the IRB to DOE-FETC in the areas of aero-heat transfer, combustion, and materials
- In May 98, Solar Turbines visited the University of Minnesota and Carnegie Mellon University to inspect their AGTSR heat transfer projects
- AGTSR initiated contract amendments into Year 2 for the 96-01 awards

Research

- AGTSR received 57 Intent to Propose forms for the 98RFP: 31 in combustion, 18 in heat transfer, and 8 in materials
- AGTSR received 50 proposals by June 5, 1998 for the 98RFP: 25 in combustion, 17 in heat transfer, and 8 in materials
- AGTSR reviewed and evaluated research extension white paper from U-Conn with the IRB which supported the requested \$50K six-month add-on for related TBC research
- AGTSR reviewed and evaluated research extension white paper from Arizona State University with the IRB and supported \$50K twelve-month add-on for their disk-cavity heat transfer research
- AGTSR distributed FY95 research progress reports to DOE and the IRB

- AGTSR released three final reports to the IRB and DOE for review and evaluation: Syracuse University (Inverse Design/Aero), University of Minnesota (Film-Cooling/ Heat Transfer), and Clemson University (Film-Cooling/ Heat Transfer)
- AGTSR reviewed SBIR Phase I proposal in combustion for DOE-FETC
- AGTSR's UCBerkeley fiber-optic probe used to support UC Irvine research activity on catalytic combustion
- University of Pittsburgh visited Solar Turbines to discuss TBC research project and results
- VPI visited UTRC to discuss their new AGTSR research project pertaining to active combustion control and reduced-order modeling
- Westinghouse expresses interest in Syracuse's final report on inverse aero design and requested seminar from PI on research accomplishments
- AGTSR's ATS Catalytic Combustion Overview paper was accepted for the AGARD Gas Turbine Engine Conference, October 12-16, 1998, Lisbon, Portugal

Workshops/Education

- AGTSR selected 11 new industrial interns for the summer of 1998
- AGTSR co-hosted the Metallic Coatings Specialty Workshop with Stevens Institute of Technology, April 16-17, 1998
- AGTSR participated in the Advanced Small Gas Turbines/ Emerging Horizons Workshop with Concepts, ETI in May 1998
- AGTSR received and awarded five Faculty Fellowships. Professors from CalTech, Michigan State, Purdue, Arizona State, and Carnegie Mellon
- AGTSR participated in the Georgia Tech Gas Turbine Workshop, June 15-16, 1998

- AGTSR attended the June 8, 1998 ASEAN Forum at Furman University on Energy-Environmental Issues
- AGTSR accepted an invitation to co-organize a special forum on aeroderivative gas turbines for the International Society on Air Breathing Engines (ISABE), September 1999, Florence, Italy

Membership

- One new university became an AGTSR performing member: Washington State University in Pullman, WA
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MEMBERSHIP

During this reporting period, Washington State University became an AGTSR Performing Member. The point of contact at Washington State University (WSU) is Dr. B. R. Ramaprian. WSU's gas turbine research interest is in the areas of aerodynamics, materials, and combustion. AGTSR membership is currently at 95 schools, representing 37 states.

The AGTSR Industry Review Board (IRB) currently consists of 8 companies, with latest two additions occurring during the last quarter, Southern Company Services and AlliedSignal Engine Company.

In 1993 through 1997, AGTSR received cost-sharing contributions of \$25,000 from each of the IRB voting members. The eight IRB companies are complemented by EPRI and GRI who continue to act as utility and industrial gas turbine advisors for AGTSR. Invoices for the IRB 1998 contribution to AGTSR were released in January 1998 to be paid by March 31, 1998. As of this date all the IRB companies, with the exception of Allison Engine Company, have paid their annual membership fee for 1998. Parker Hannifin is still an associate member of AGTSR and have paid their non-voting dues in advance through 1999.

1993-through-1997 SUBCONTRACT PROGRESS

All ten of the FY93 projects have been completed and final reports have been received and processed by AGTSR.

Nine of the thirteen FY94 AGTSR research projects have finished and completed their final report commitment. Four FY94 projects had final reports due the end of June 1998: Purdue (aero-heat transfer), Maryland and UC Irvine (combustion), and Georgia Tech (materials). These four final reports have not yet been received, and AGTSR will follow-up with the respective PI's during the next reporting period.

The FY95 Semi-Annual Progress Reports have all been received by AGTSR and were distributed to both the IRB and DOE. These progress reports were all accompanied by assessment forms for our industry contacts to complete. The FY96 Semi-Annual Progress Reports are due by the end of July 1998. The FY97 Progress Reports are due on August 31, 1998. New awards from the 98RFP are expected to get started in February 1999.

Assessment forms completed by the IRB over the last two quarters were consolidated by AGTSR and distributed to DOE-FETC on April 21,

1998. These forms covered research evaluations in the areas of aero-heat transfer, materials, and combustion.

Final reports currently being reviewed by the IRB include Clemson University (heat transfer), University of Minnesota (heat transfer), and Syracuse University (aerodynamics).

AGTSR's COMBUSTION WORKSHOP V and VI

The two volume proceedings for the AGTSR Combustion Workshop V was released near the end of June, 1998. The proceedings include summary abstracts with figures, results and charts associated with each presentation. The two volumes contain a wealth of information on lean premixed combustion systems, current state-of-the-art in industrial gas turbine combustion engineering, and related technology and R&D offered by AGTSR's university, industrial, and government partners. If interested in obtaining additional copies of the proceedings, please contact Ms. Donna Kelly at 864-656-2267/ donnak@clemson.edu.

Plans for AGTSR Combustion Workshop VI have already begun, and the co-host will be VPI in Blacksburg, VA. The meeting date is set for April 18-21, 1999, and in addition to the university and industry talks, the workshop will include a laboratory tour of the gas turbine related research at VPI and possibly a golf tournament on Sunday afternoon to kick-off the start of the meeting. The co-hosts are Professors Uri Vandsburger and Will Saunders. The first announcement for this meeting should be released by AGTSR in August-September 1998.

METALLIC COATINGS SPECIALTY WORKSHOP

This specialty workshop was co-hosted with Professor Lee of Stevens Institute of Technology and took place on April 16-17, 1998 at Stevens in Hoboken, New Jersey. In addition to Stevens, other organizers were from Oak-Ridge National Laboratory, NASA-Lewis, and AGTSR. The Workshop focused 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. These coatings are used as both bond coats for TBC systems and as overlayers for oxidation resistance. Three main sessions were held: OEM usage and experience, coating manufacturer and repair/overhaul issues, and research issues presented by select university, NASA, and ORNL investigators. During the evening of April 16, 1998, a special dinner presentation was given by the

AGTSR SETS THE DATE FOR THE NEXT IRB MEETING

The next IRB meeting is scheduled for September 15-16, 1998 at SCERDC. This will be a 1 ½ day review meeting and the agenda is given in Atch 2. The technical R&D representatives from each company may attend on the first day to discuss the merits of the top proposals. The second day of the review meeting will focus on short-listing the top proposals and discussing several programmatic issues pertaining to AGTSR. Both Abbie Layne and Norm Holcombe of DOE-FETC are planning to attend. If you have any questions on the next IRB meeting or are interested in attending, please contact Dan Fant or Donna Kelly at 864-656-2267.

AGTSR PLANS FOR HEAT TRANSFER III WORKSHOP

The AGTSR Heat Transfer III Workshop will be co-hosted with UT-Austin (UTA) and the University of Wisconsin-Madison (UW-M) and is scheduled for February 1999 with the site in Texas now being selected. The contact persons are Professor Dave Bogard of UTA and Professor Karen Thole of UW-M. The Workshop will include a review of both aerodynamic and heat transfer R&D with AGTSR/ATS university and industrial partners. An industry/ government panel is also being planned for the second day with probable presentations from DOD and NASA on related gas turbine research. Registration material for the Workshop should be released in the early fall of 1998. For additional information on the Workshop, please contact AGTSR at 864-656-2267.

AGTSR ATTENDS EMERGING HORIZONS WORKSHOP

AGTSR attended the Emerging Horizons Turbomachinery Technology conference on May 11-15, 1998 offered by Concepts ETI in Wilder, VT. As part of our gas turbine information exchange with Concepts ETI, AGTSR hosted one of the luncheons at the meeting. The conference focused on Advanced Small Gas Turbines, Emerging Design Frontiers, and Advanced Industrial Turbomachinery. AGTSR was especially interested in the Small Gas Turbine session to help learn more about microturbines and some of the emerging technology issues. Elliot Energy Systems, Inc. also displayed at Concepts ETI their 45kw turboalternator demonstration – sans recuperator. Other topics for this conference included: future computer power, directions for CFD, agile engineering, design code validation, rapid prototyping, and mini-consortium centrifugal compressor technology activities organized by

Dean of Engineering at Stevens Institute on "Re-Engineering Engineering Education." Over 60 people registered for the Workshop. Since the U.S. OEM's were against having a proceedings for this specialty meeting, the organizers have drafted a white paper summary led by Ian Wright of ORNL. This draft summary will be reviewed by the OEM's prior to release to DOE and the Workshop participants. The white paper summary should be available for distribution by the end of July 1998. For further information on the workshop and white paper summary, please contact Angie Justice or Dan Fant at 864-656-2267.

AGTSR 1998 INTERNS

For the summer of 1998, AGTSR received 16 applications for the industrial internship program. These applications were reviewed and ranked by the IRB during March 1998 and 13 interns were selected and offered an internship for this summer. 11 of the 13 accepted this offer. Most have opted for the 12-week internship period which were started in May/June 1998. The 11 interns were from the following institutions: Penn State, North Dakota, Washington, Arkansas, Berkeley, Cornell, VPI, Carnegie Mellon, Vanderbilt, and Central Florida. The interns are required to do a final written report summarizing their internship experience, which is due to AGTSR by the end of September 1998.

AGTSR SUPPORTS ADD-ON RESEARCH FOR U-CONN AND ASU

The IRB unanimously approved U-Conn's add-on, 6-month/ \$50K, proposal to AGTSR to extend their current AGTSR subcontract which is scheduled to end on August 31, 1998. U-Conn's add-on research tasks support better modeling, TBC durability improvements, and NDI techniques for determining initial coating quality and residual life remaining.

Also during this reporting period, Arizona State University (ASU) submitted a 12-month/ \$50K add-on proposal to AGTSR. This proposal was reviewed by the IRB during April-May and the majority recommended that it be supported as ASU's disk-cavity facility is unique and their proposed detailed computations and Particle Image Velocimetry (PIV) measurements are needed to better model and understand these type of flows. ASU has already received a no-cost extension until December 31, 1998 for their existing subcontract, and the add-on effort will continue the project from January 1, 1999 through December 31, 1999. In addition, the ASU PI, Professor Ram Roy, was recently selected as an AGTSR Faculty Fellow to

work with Solar Turbines for two-months on their industrial disk-cavity research rig.

AGTSR SELECTS FIVE FACULTY FELLOWS FOR 1998

The Faculty Fellowship Program is a new program for university professors and offers a unique opportunity for university faculty members to gain valuable experience/ knowledge working with gas turbine manufacturers in research, engineering, and design. The program offers an opportunity for professors to take a mini-sabbatical with industry for a duration ranging from 1-2 months up to a year. Five applications were received by AGTSR on April 30, 1998. These applications were reviewed by AGTSR in May and all five received strong endorsements from an ATS company. The five AGTSR professors supported for the first year of the fellowship program are: Jay Gore/ Purdue @ Allison – combustion, Fred Culick/ CalTech @ P&W - combustion , Abe Engeda/ Michigan State @ Allison – compressors, Ram Roy/ Arizona State @ Solar Turbines – disk cavity cooling, and Mingking Chyu/ Carnegie Mellon @ Solar Turbines – turbine heat transfer. All five fellows will be starting their programs in the summer-fall of 1998, with Ram Roy of ASU being the first fellow to start at Solar Turbines in June 1998.

AGTSR RECEIVES 50 NEW PROPOSALS

On March 31, 1998, AGTSR released their sixth RFP to the performing member universities. Proposals were due to AGTSR on June 5, 1998. AGTSR received 50 proposals for the 98RFP: 25 in combustion, 17 in aero-heat transfer, and 8 in materials (see the 98RFP spreadsheet in Atch 1). On June 29, 1998, AGTSR distributed the proposals to the IRB focal points and technical R&D contacts for review, evaluation, and rank-ordering during July and August 1998. The SCERDC IRB proposal voting meeting is set for September 15-16, 1998 at Clemson. AGTSR anticipates short-listing approximately 8-10 proposals for the 98RFP. Any new awards are expected to be announced in the late fall of 1998 with subcontracts projected to be let in February 1999.

Concepts. For more information on this conference, please call Dan Fant at 864-656-2267.

AGTSR PARTICIPATES IN GEORGIA TECH GAS TURBINE WORKSHOP

On June 15-16, 1998, AGTSR attended the Georgia Tech Gas Turbine Workshop hosted by the Army Research Office. The meeting included presentations from industry and academia on both combustion and turbomachinery R&D ongoing in DOD. The Army, Navy, and Air Force also gave brief updates on their respective research programs and new initiatives being pursued. AGTSR was invited to give a talk on their combustion research and educational programs. AGTSR summarized the status of the program and briefly highlighted the important combustion research topics being targeted by their university partners – issues in both lean premixed and catalytic combustion activity were discussed. If interested in discussing the outcome of this workshop or in obtaining a copy of the AGTSR briefing, please contact Dan Fant at 864-656-2267.

AGTSR PLANS SITE VISIT AT PURDUE

AGTSR is planning to conduct a site visit to Purdue University on August 27-28, 1998. The purpose of the site visit is to review three different AGTSR research projects on-going at the Purdue campus. The three projects are: trailing edge film-cooling with Professors Ramadhyani and Plesniak; advanced multistage turbine blade aero-heat transfer with Professors Fleeter and Lawless; and combustion diagnostics with Professors Gore and Sivathanu. AGTSR also plans to meet with Dr. Murthy at Purdue to discuss the upcoming ISABE XIV propulsion meeting in September 1999 in Florence, Italy that may include a possible aero-derivative session to be co-organized by AGTSR. If you are interested in participating in this AGTSR research review at Purdue, please contact Dan Fant at 864-656-2267.

DOE-FETC REQUESTS PROGRAM REVIEW FOR AGTSR

An AGTSR program review at DOE-FETC is set for July 24, 1998 in Morgantown, WV. This review is in addition to the ATS Annual Review where AGTSR also provides an overview of the consortium's activities. At the July 24 meeting, SCERDC and AGTSR will address the following agenda

items: status of existing AGTSR subcontracts, detailed review of select research projects, review of the 98RFP, plans for the next IRB proposal review meeting, post-ATS workshops, review of the Clemson Central Energy Facility Project, and discussion of microturbine/ hybrid gas turbine R&D activity. From SCERDC, both Dan Fant and Larry Golan will be attending the review meeting. The meeting agenda was coordinated with Norman Holcombe, the AGTSR Contracting Officer Representative (COR) at DOE-FETC in Pittsburgh, PA. For more information on this review meeting, please contact SCERDC at 864-656-2267.

Miscellaneous Activities

AGTSR plans to release its ninth newsletter by the end of August 1998.

AGTSR recently had a paper accepted at the AGARD Gas Turbine Engine Combustion, Emissions and Alternative Fuels conference in Lisbon, Portugal, October 12-16, 1998. The title of the paper is the "Status and Approaches of Catalytic Combustion R&D in the ATS Program."

AGTSR was also invited to co-organize a special forum for the XIV International Society for Air Breathing Engines (ISABE) Symposium in Florence, Italy, September 5-10, 1999. The focus of the forum will be on the use of Aero-Derivative Land-Based Gas Turbines for future power generation.

An International Catalytic Combustion Workshop is being planned for April 14-16, 1999 in San Diego, CA. One of the U.S. organizers is Jerry Spivey, Research Triangle Institute, 919-541-8030, jjis@rti.org.

AGTSR will assist in evaluating the gas turbine related proposals as part of the Clemson University RFP State Project for renovating their central energy facility. Proposals for this project were received by Clemson University on June 19, 1998. A meeting at SCERDC is scheduled for July 9 to distribute the proposals and review the evaluation criteria.

AGTSR RFP 98-01 BREAKOUT TECHNICAL AREA: COMBUSTION

Prop. No.	Submitted By/PI	Technical Objectives	No. Years	Total \$K	1st Year \$K	Industry Collaboration
C1	Maryland/ Gupta	Homogeneous F/A Mixtures in Swirl-Assisted Spray Flames	3	\$506.330	\$171.700	Allison, GE, P&W, Parker Hannifin
C2	Maryland/ Gupta	Stability Improvements in Swirling Fuel-Lean GT Combustors	3	\$513.370	\$178.700	Allison, GE, P&W
C3	Maryland/ Gupta	Local NO Measurements using Chemiluminescence and PLIF	3	\$542.520	\$188.300	Allison, GE, P&W, Aerodyne Research Inc.
C4	LSU/ Acharya-Gutmark	Diode-Laser Sensors for Control of LP Combustion	3	\$773.200	\$280.500	DOE-FETC, UTRC, GE, AFRL, Stanford
C5	Vanderbilt/ Mellor	Diagnostics for Unmixedness	3	\$597.370	\$191.100	University of Illinois - Urbana
C6	Purdue/ Laurendeau	Room-Temperature Lasers for Emissions Sensing....	3	\$729.580	\$257.100	Physical Sciences, Allison
C7	CMU/ Chigier	Spray Analysis for Dual-Fuel GT's	3	\$670.620	\$216.970	Parker, DOE-FETC, UTRC, AlliedSignal, UTRC, Stanford
C8	BYU/ Fletcher	Measurements and Modeling of Thermal Radiation Effects	3	\$571.230	\$197.500	ACERC Technical Advisory Committee
C9	PSU/ Yang-Santavicca	Augmentation of Lean Combustion Stability Limit	3	\$591.000	\$197.000	P&W, Solar Turbines, DOE-FETC
C10	Vanderbilt/ Mellor	NOx Control through Partial Reformation of Natural Gas	3	\$597.370	\$191.100	Combustion Science & Engineering, Inc.
C11	Georgia Tech/ Zinn	Extending the Lean Blowout Limits of Low NOx	3	\$686.300	\$217.850	DOE-FETC, ATS
C12	PSU/ Boehman	Near-IR Diode Laser Sensors for Real-Time Engine Control	2	\$364.170	\$187.980	Physical Sciences, AlliedSignal Engines
C13	Cornell/ Gouldin	Time Domain IR Absorption Tomography ...for Mixing	3	\$365.304	\$120.310	Solar Turbines, GE
C14	U-Okla/ Gollahalli	Improvement of Lean Premixed Flame Stability	3	\$420.000	\$140.000	DiversiTech, GE, Westinghouse, Parker Hannifin
C15	UMD/ Jackson	Enhancement of Lean Flame Stability By Catalytic Production ..	3	\$344.650	\$159.500	UWashington, PCI, Solar Turbines
C16	RPI/ Rusak	Instabilities in Combustion Systems with Vortex Breakdown	3	\$506.323	\$174.376	LSU, UTRC, Solar
C17	NCSU/ Gould	An Experimental Study of Passive Means to Improve Stability	3	\$206.005	\$75.630	Allison, AFRL
C18	UCSD/ Cattolica	Measurement of CO and NO Emission GT with Diode Lasers	2	\$621.050	\$320.580	Solar Turbines, Physical Sciences
C19	PSU/ Santoro, Yang	Dual Fuel Issues Related to Combustion Instability in GT's	3	\$550.850	\$187.070	P&W, GE, DOE-FETC
C20	UCB/ Dibble	Low Emission, High Efficiency, Low Acoustics Combustion	3	\$334.794	\$114.140	Solar, GE, UTRC, Westinghouse, Allison, Catalytica
C21	Purdue/ Gore	Infrared Radiation Properties and Swirling Flow Dynamics ...	3	\$623.350	\$197.340	ATS Companies, En'Urga Inc.
C22	Stanford/ Edwards...	Mixture Homogeneity in Liquid-Fueled GT Combustors...	3	\$1,018.000	\$330.000	Parker Hannifin, UTRC, GE, DOE/ASCI
C23	UCB/ Dibble	Fuel-Air Mixing Explored with Optical Probes....	3	\$291.352	\$100.090	Allison, GE, UTRC, Westinghouse, NASA-Lewis
C24	CSU/ Ibrahim	Development of a Multiple Gas Species Sensor	1	\$177.640	\$177.640	NASA-Lewis
C25	UOklahoma/Agrawal	Augmenting Stability Limits in Lean-Premixed Combustion	3	\$383.520	\$136.650	DOE-FETC, ATS Companies
<i>Proposals are listed in random order - they are not ranked.</i>						

AGTSR RFP 98-01 BREAKOUT
TECHNICAL AREA: AERO - HEAT TRANSFER

[illegible]

**AGTSR RFP 98-01 BREAKOUT
TECHNICAL AREA: COATINGS (TBC'S)**

[illegible]

AGTSR Proposal Review Meeting for '98RFP

Industry Review Board
September 15-16, 1998

Agenda

September 15 - Tuesday

7:15 – 8:00 am	Continental Breakfast
8:00 – 8:30 am	ATS Update/ Issues Abbie Layne/ Norm Holcombe
8:30 – 9:00 am	AGTSR Update & Review Dan Fant
9:00 – 9:30 am	AGTSR Finances Larry Golan
9:30 – 10:00 am	Break
10:00 – 12:00 noon	<i>Combustion</i> Proposal Deliberations
12:00 – 1:00 pm	Working Lunch at SCERDC
1:00 – 2:00 pm	Finish up <i>Combustion</i> Discussions with Industry Experts
2:00 – 3:00 pm	<i>Aero-Heat Transfer</i> Proposal Deliberations
3:00 – 3:30 pm	Break
3:30 – 4:30 pm	Finish up <i>Aero-Heat Transfer</i> Discussions with Industry Experts
4:30 – 6:00 pm	<i>Materials</i> Proposal Deliberations with Industry Experts
7:00 – 9:00 pm	Dinner (hosted by AGTSR/ Energy Center) Location to be announced

September 16 - Wednesday

7:15 – 8:00 am	Continental Breakfast
8:00 – 10:00 am	IRB Final Rank-Ordering/ Vote on Short List
<i>Combustion, Aero-Heat Transfer, Materials</i>
10:00 – 10:30 am	Break
10:30 – 12:00 noon	Programmatic Issues for AGTSR:
<i>RFP mechanism</i>
<i>ABB membership</i>
<i>ATS Annual Review</i>
<i>Upcoming Workshops/ Short Courses</i>
<i>Summer Industrial Internship/ Fellowship Program</i>
<i>Summary of Research Findings by Experts</i>
<i>Research Add-Ons/ Continuations</i>
<i>Assessment-Evaluation Reports</i>
<i>Overseas University-Industry Involvement</i>
<i>Collaboration with DOE National Laboratories</i>
12:00 – 1:00 pm	Wrap-up and Lunch at SCERDC

Note:

Continental Breakfasts, Breaks, and Lunches will all be served at the Energy Center. If you have any dietary preferences and/or restrictions, please make your request known to Ms. Donna Kelly, 864-656-2267/ donnak@clemson.edu.