
PROPULSION DIRECTORATE

Monthly Accomplishment Report July 2003



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SCRAMJET ENGINE GROUND TESTING SUCCESSFULLY COMPLETED: In June 2003, the Propulsion Directorate successfully completed freejet testing of the first generation Ground Demonstration Engine (GDE-1). This testing was conducted as part of the Aerospace Propulsion Division's (AFRL/PRA) Hypersonic Technology (HyTech) Program. GDE-1 is a flight-weight, fuel-cooled, hydrocarbon scramjet (supersonic combustion ramjet) ground test engine that was designed and built by Pratt & Whitney and tested at GASL's facilities in Ronkonkoma, New York. Government researchers teamed with these industrial partners to successfully demonstrate the operability and durability of the GDE-1 at two representative flight Mach numbers ($M = 4.5$ and $M = 6.5$). Notably, this was the world's first fuel-cooled scramjet engine to operate on conventional jet fuel. Having successfully completed GDE-1 testing, the next step in the development process is to design, fabricate, and test the second generation Ground Demonstration Engine known as GDE-2. The ambitious goal of GDE-2 testing is to



The GDE-1 in the test cell

demonstrate closed-loop operation of the engine in a ground test environment. Some major differences between GDE-1 and GDE-2 include: GDE-2 will be slightly larger; GDE-2 will include a variable geometry inlet; and GDE-2 will be regeneratively fuel cooled during testing, meaning that the fuel used to cool the engine will also be burned in the combustor. Testing of GDE-2 is currently scheduled to commence in the summer of 2004 at NASA Langley Research Center's 8-foot High Temperature Tunnel. (A. Boudreau, AFRL/PRAT, (937) 255-1237)

NEW ENVIRONMENTAL CONTROL UNIT AIDS THE WARFIGHTER: A new Environmental Control Unit (ECU) has been developed that will provide comfort for US troops and keep vital equipment running smoothly. The new ECU is a field-deployable tent cooler designed to heat or cool military tents under the most extreme conditions. During Operation Iraqi Freedom, tent coolers were used to relieve troops from the 125°F heat of the Iraqi desert, and they were also used in tents where military equipment is stored to protect it from harsh weather conditions that could degrade performance. The new ECU design came to fruition through a Cooperative Research and Development Agreement (CRADA) between the Propulsion Directorate and Mainstream Engineering Corp, Rockledge, Florida. The unit was successfully tested at Fort Drum, New York, during the Patriot Exercise in June 2003. This ECU is a second-generation prototype and was designed to operate in Nuclear, Biological, or Chemical (NBC) mode or non-NBC mode. The ECU can act as either a heater or an air conditioner and can be operated by a remote control. Compared to previous models that took up to 10% of the airbase deployment weight, the current ECU weighs only 600 lbs. The current design features improved maintainability, performance, and cost, and the training required to maintain and operate the unit



AF Program Manager Joe Gottschlich is pictured with the new ECU installed at Fort Drum

has been simplified. The unit also uses standard commercial parts, and simplicity was emphasized during the design to enhance maintainability and reliability. Moreover, there are no exotic components or materials in the new ECU, and since the unit uses Puron (R-410A) refrigerant, the tent cooler has been deemed environmentally-friendly with no ozone-depletion potential. A third prototype for the ECU is currently being built, and there are plans to test this unit at various DoD sites. (J. Gottschlich, AFRL/PRPS, (937) 255-5734)

ROQUEMORE WINS PRESTIGIOUS AIAA AWARD: Dr. W. Melvyn “Mel” Roquemore of the Propulsion Directorate was recently named the 2003 recipient of the American Institute for Aeronautics and Astronautics (AIAA) Propellants & Combustion Award. First presented in 1990, this award honors outstanding technical contributions to aeronautical or astronautical combustion engineering. Dr. Roquemore was recognized for his many groundbreaking achievements over a distinguished 38-year Air Force career. These achievements include: devising novel concepts such as the Trapped Vortex Combustor and the Quasi Constant Temperature Engine Cycle; pioneering the development and application of advanced laser diagnostics to the study of combustion processes; guiding the technical effort that resulted in the fielding of JP-8+100 fuel; and fostering the development and use of CFD design models. Furthermore, over the course of his career, Dr. Roquemore has authored more than 150 papers and has been invited to speak at universities and symposiums all over the world. His nomination for this prestigious award was supported by recommendations from many luminaries in the field of combustion, all previous winners of the AIAA Propellants & Combustion Award. Dr. Roquemore



Dr. Mel Roquemore was named the winner of AIAA's prestigious Propellants & Combustion Award

received this award at the 39th AIAA/ASME/SAE/ASEE* Joint Propulsion Conference and Exhibit held in July 2003 in Huntsville, Alabama. (R. Hancock, AFRL/PRTS, (937) 255-6814)

HIGH PERFORMANCE BATTERIES BOUND FOR MARS: Lithium-ion battery technology developed in part by the Propulsion Directorate is now speeding its way towards Mars. Lithium-ion batteries will power the Mars exploration rovers named “Spirit ” and “Opportunity,” which



Artist's rendering of the Mars rover in operation on the surface of Mars

were successfully launched from Cape Canaveral, Florida, on 10 June 2003 and 7 July 2003, respectively. The two rovers are expected to touchdown on opposite sides of Mars in early 2004, and when they do, they will rely on lithium-ion battery technology to complete their mission to search for and characterize a wide range of rocks and soils that hold clues to past water activity on Mars. Lithium-ion batteries will keep the rovers “alive” at night and provide additional power during intensive daytime operations. In 1997, the Propulsion Directorate, NASA Glenn Research Center, and NASA’s Jet Propulsion Laboratory (JPL) joined forces to plan and execute a rechargeable lithium-ion battery development program that addressed the

many energy storage requirements facing future space missions. PR developed the technology for the battery, and JPL and Lithion, a division of Yardney Technical Products, designed the battery. The product of this research was a battery that is lightweight, rechargeable, and much more powerful than its predecessors. Lithium-ion technology offers a three to fourfold increase in gravimetric and volumetric energy densities and produces voltages in excess of three times the value of typical nickel based battery systems. These advantages make lithium ion an attractive choice for energy storage systems where weight, volume, power, and mission duration are critical issues. (S. Vukson, AFRL/PRPS, (937) 255-5461)

PR CAPTURES TWO AFRL CORPORATE AWARDS: The Propulsion Directorate’s new Aerospace Propulsion Division (AFRL/PRA) made a splash by taking two awards at the 4th Annual AFRL Corporate Awards Luncheon held on 31 July 2003. Mr. Parker Buckley, Chief of AFRL/PRA, was presented with the AFRL Senior Leadership Award, and Dr. Mark Gruber was presented with the AFRL Commander’s Cup (Individual). PR also had placed finalists in four other categories: Ms. Debra L. Fuller for the Mission Support Award (Individual); Dr. Lawrence G. Scanlon for the Scientific/Technical Achievement Award (Individual); Dr. Tommy Hawkins for the Scientific/Technical Management Award (Individual); and both the Government Symposium Committee[†] and the National Aerospace Initiative (NAI) Teams[‡] for the Commander’s Cup

* ASME = American Society of Mechanical Engineers; SAE = Society of Automotive Engineers; ASEE = American Society for Engineering Education

† The Government Symposium Committee Team consists of Mr. John Datko, Mr. S. Michael Gahn, Mr. Martin Huffman, Mr. David Jay, Mr. Barry Kiel, Mr. William Koop, Mr. Robert Morris Jr., Dr. Christopher Murawski,

(Team). PR's nominees in the five remaining award categories were SSgt Randy D. Sarmiento, Ms. Karen C. Zawada, Capt Jeffrey Thornburg, the PR Financial Specialist Team,[§] and the Blue Velvet Team.** All of the winners and nominees are to be congratulated, as simply being nominated for one of these awards is a significant achievement due to the highly competitive nature of these awards. (Col M. Heil, AFRL/PR, (937) 255-2520)



Mr. Parker Buckley was presented with the AFRL Senior Leadership Award



Dr. Mark Gruber was presented with the AFRL Commander's Cup (Individual)

NEW BIPROPELLANT SUCCESSFULLY TESTED: The Propulsion Directorate recently completed the first test of an advanced, storable bipropellant system with a fuel based on an ionic liquid. The bipropellant system, which was developed by researchers in PR's Space and Missile Propulsion Division (AFRL/PRS), was successfully tested in a 500-lb_f thrust class engine at Purdue University in W Lafayette, Indiana. This novel bipropellant, which consists of a hydrogen peroxide oxidizer and an ionic liquid fuel, represents a greater than 10% improvement in density impulse over NTO/MMH (nitrogen tetroxide/ monomethylhydrazine), the current state-of-the-art storable bipropellant. Furthermore, the matching high densities of both the environmentally benign hydrogen peroxide oxidizer and the ionic fuel allow for greater system design flexibility. Initial reduction of the test data indicates that 96% combustion efficiency was obtained on the first test, and it is believed that an optimized system has the potential to attain even higher combustion

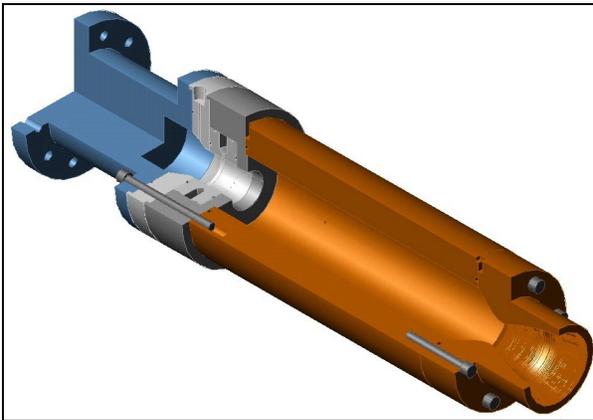
Ms. Kelly Navarra, Capt Richard Reich, Maj Steven Rose, Lt Sofya Rozenzhak, Ms. Kathleen Sargent, and Mr. Gary Terborg.

[‡] The NAI Team is joint team with members from AFRL/PR, AFRL/VA, and AFRL/VS. The AFRL/PR members of the team are Mr. Drew DeGeorge and Mr. Robert A. Mercier.

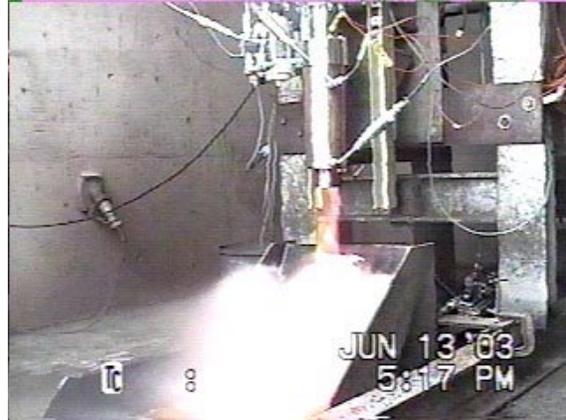
[§] The PR Financial Specialist Team consists of Ms. Temeca Jones, Ms. Cassie Spreher, and Ms. Jonna Hamrick.

** The Blue Velvet Team consists of Lt Matthew Morello, Lt Christopher Ringrose, Mr. Thomas Smith, and Dr. Marty Venner of PR as well as contractors Mr. Alan Kawasaki, Dr. Robert Lyons, Mr. Paul Markarian, Mr. William McKeon, and Dr. James Reuster.

efficiencies. The new bipropellant represents the vanguard for energy-dense, “green” bipropulsion incorporating ionic liquids. Applications are foreseen that include main propulsion for spacecraft and space booster engines. (T. Hawkins, AFRL/PRSP, (661) 275-5449)



Staged bipropellant thruster for ionic liquid fuel



Thruster during bipropellant operation

PEARCE HONORED BY ASTM INTERNATIONAL: The Propulsion Directorate’s Ms. Patricia Pearce was recently honored by the American Society for Testing and Materials (ASTM) International. Ms. Pearce was presented with the ASTM International Award of Excellence during the society’s biannual Committee D02 Meeting on Petroleum Products and Lubricants held in Norfolk, Virginia, in June 2003. She was honored for her long-standing service to ASTM International which dates back to 1989. During this 14-year period, she took on roles of increasing responsibility, becoming the secretary of Subcommittee J on Turbine Fuel Specifications in 1993, and subsequently rising to the position of chairman in 2001. This Award of Excellence honors her for her many contributions in the area of aviation turbine fuel standardization and also for her critical role as a liaison between military and commercial fuel users. Dr. W. James Bover, the ASTM International Committee D02 Chairman, presented this prestigious award to Ms. Pearce. (A. Boudreau, AFRL/PRAT, (937) 255-1237)



Ms. Patricia Pearce receives the ASTM International Award of Excellence

INTERNATIONAL HIGH CYCLE FATIGUE TESTING SUCCESSFUL: An international team consisting of the DoD, the UK’s Ministry of Defense (MOD), Rolls-Royce PLC (RRPLC), Rolls-Royce Corporation (RRC), and Allison Advanced Development Company (AADC) successfully completed a baseline distortion test on an RRC AE3007 engine. The AE3007 engine is the propulsion system for the Global Hawk. The testing was conducted as part of the High Cycle



The XTL17/SE1 demonstrator engine in the test cell

Fatigue (HCF) Program under the Integrated High Performance Turbine Engine Technology (IHPTET) Program. The engine was instrumented with advanced sensors such as Tip Timing, Non-Intrusive Measurement System (NSMS), and strain gages. Testing commenced in early June at RRC and included eight different test configurations to develop and measure the target levels of distortion and fan blade stress. The removal of strain gages from the fan blades was included in the test configurations to determine the damping effect of the strain gage applications on those blades. Target fan blade stress levels and modes were achieved with good correlation between strain gages and fan blade tip displacements (both Tip Timing and NSMS). Follow-on endurance testing at target stress levels will be run in early 2004 after a damping coating has been applied to the fan blades. Data from this

testing will be compared to the baseline test to determine the effectiveness of the damping coating. This research will directly benefit the Global Hawk and will also lead to a more durable Joint Strike Fighter (JSF) lift fan, which is manufactured by RRC. (S. Sepeck, AFRL/PRTP, (937) 255-7334)

JANISZEWSKI HONORED BY NMA'S WRIGHT CHAPTER:

The Wright Chapter of the National Management Association (NMA) presented Col Alan Janiszewski with the Silver Knight of Management Award on 16 July 2003. This is the highest award that an NMA chapter can bestow upon an outstanding executive, and each chapter can only present one Silver Knight Award each year. A nominee for this award can be a civic or business executive who is well known to the members of his organization and whose example has inspired them. The nominee must also

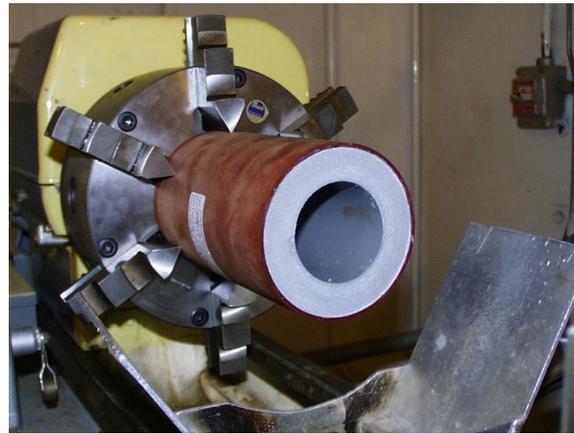


Col Janiszewski (left) receives the Silver Knight of Management Award from John Hojnacki

be a person who has demonstrated the highest qualities of leadership in business and community relationships. During his tenure as the Director of the Propulsion Directorate from January 2000 to May 2003, Col Janiszewski regularly demonstrated these requisite qualities, and this award honors his efforts during that period. The award was presented to Col Janiszewski by Mr. John Hojnacki, PR's Corporate Development Officer and an NMA National Director. (J. Hojnacki, AFRL/PRN, (937) 255-4546)



PR RESUMES PRODUCTION OF BATES MOTORS: After a hiatus of several years, the Propulsion Directorate has successfully resumed the production of Ballistic Test and Evaluation System, or BATES, motors. BATES motors were originally developed by the US Air Force and are the standard test motor series recognized by all US propulsion companies. Two 15-pound BATES motors were recently produced in-house at PR and successfully fired under a program funded by the Missile and Space Intelligence Center. The tests enable propellant performance evaluation for a customer's specific propellant formulation. Initial performance calculations have been performed and efforts are currently focused on developing the ability to perform more exhaustive analysis of the data. (A. Brand, AFRL/PRSP, (661) 275-5787)



SMITH HONORED FOR LEADERSHIP OF PLUME PHENOMENOLOGY GROUP: The Propulsion Directorate's Mr. Thomas A. Smith was recently selected to receive the Exemplary Civilian Service Award. This award recognizes Mr. Smith for his distinguished service as the Group Leader for Plume Phenomenology in the Propulsion Directorate's Aerophysics Branch (AFRL/PRSA) at Edwards AFB, California, from 1 October 2000 to 31 December 2002. Mr. Smith is an internationally recognized expert in plume phenomenology as applied to missile propulsion systems. As the Group Leader for Plume Phenomenology, he is the lead person for the major center of excellence for missile plume phenomenology in the US. In this capacity, he has continually expanded and refined the capabilities of this center to world-class status. Mr. Smith is also extremely active in the



Two views of the 15-pound BATES motors (top and middle) and a BATES motor being fired (bottom)

development of a wide variety of modeling, simulation, and analysis codes for plume phenomenology. Through his efforts, the Plume Phenomenology group's reputation for expertise, reliability, and timeliness was firmly established. As a result, he has attracted numerous plume phenomenology and threat characterization projects from external customers throughout DoD, NASA, NATO, the United Nations, and other friendly nations. Mr. Smith is very deserving of this special recognition. (J. Levine, AFRL/PRSA, (661) 275-6179)



Mr. Thomas Smith was honored with the Exemplary Civilian Service Award

AGILE ACQUISITION IN ACTION AT THE PROPULSION DIRECTORATE:

A team consisting of the Propulsion Directorate's Power (AFRL/PRP) and Propulsion Contracting (AFRL/PRK) Divisions has received approval for the acquisition strategy/acquisition plan for a critical new program. The open-ended Broad Agency Announcement (BAA) titled "Power and Thermal Technologies for Air and Space" was approved at a level of \$492 million for 7 years. This open-ended BAA will provide a flexible and streamlined acquisition tool for procurement of

science and technology efforts in all technical areas of interest to the Power Division. This will allow technology development awards to be made that will meet present and future Air Force needs on a "real-time" basis as ever-changing technology issues are identified. The Power Division will use this mechanism to demonstrate and improve upon key power and thermal technologies in power generation, power management and distribution, energy storage, and subsystems integration, to support various air and space applications. The technical improvements in these four areas will contribute toward meeting the Power Division's goals in the 2009 and beyond timeframe and also those goals deemed necessary to facilitate nearer-term transition and transfer. (G. Fronista, AFRL/PRPE, (937) 255-5935)

PR PERSONNEL CAPTURE LOCAL AIAA AWARDS: Propulsion Directorate personnel walked away with four of the six major awards presented at the American Institute for Aeronautics and Astronautics (AIAA) Dayton-Cincinnati Section Annual Honors & Awards Program. Dr. Robert Hancock, Chief of PR's Combustion Science Branch (AFRL/PRTS), received the Outstanding Management Contribution Award for his superior managerial and technical leadership contributions to the branch. The Special Service Award went to Dr. James Gord for his outstanding contributions to AIAA's local symposium and for his continued participation in AIAA Dayton-Cincinnati Section activities. For her outstanding leadership and planning in support of the 2003 Centennial of Flight activities, Ms. Cynthia Obringer received the Chairman's Award. Finally, Dr. Sukesh Roy and Dr. Terrence Meyer, PR contractors with Innovative Scientific Solutions, Inc (ISSI), received the Outstanding Technical Contribution Award for their efforts in the development of dual-pump, dual-broadband coherent anti-Stokes

Raman scattering. In addition to these awards, PR's Ms. Cynthia Obringer, Dr. Steven Puterbaugh, and Dr. Daniel Risha were all named Associate Fellows of AIAA. These awards were presented in a ceremony held at the University of Dayton on 21 May 2003. (J. Gord, AFRL/PRTS, (937) 255-7431)



Dr. Robert Hancock
Outstanding Management
Contribution Award



Dr. James Gord
Special Service Award



Ms. Cynthia Obringer
Chairman's Award



Dr. Steven Puterbaugh (left), Dr. Dan Risha (right), and Ms. Cynthia
Obringer (above right) were named Associate Fellows of AIAA

BARNES HONORED FOR SUPERCONDUCTIVITY RESEARCH: The Propulsion Directorate's Dr. Paul N. Barnes was recently selected to receive the Exemplary Civilian Service Award. Dr. Barnes was recognized for his outstanding accomplishments in developing high temperature superconductor technology over the period of 4 January 2000 to 30 October 2002. His tenacity and ambition led him to establish world-class research efforts in high temperature superconducting (HTS) coated conductors, the results of which drew respect from the HTS

technical community. He took responsibility for the planning, technical direction, and execution of in-house research for HTS coated conductors, and his group achieved several world-class milestones. Dr. Barnes' incredible successes, including his outstanding leadership of a multi-directorate team, earned a second AFOSR STAR team designation for the HTS research group. Furthermore, he spearheaded a comprehensive conductor development plan incorporating university and industrial research plans, as well as other government organizations. His leadership integrated government, university, and industrial research to create a path to commercialization achievable within a few short years. As a result of Dr. Barnes' vision, drive, and knowledge, PR's HTS research area has been vaulted into a position of national prominence. (J. Nairus, AFRL/PRPG, (937) 255-5948)



Dr. Paul Barnes was honored with the Exemplary Civilian Service Award