PROPULSION DIRECTORATE

Monthly Accomplishment Report
May 2002

Contents ***Page***

PR-WEST LMCA BEST IN AFMC…AGAIN: The Logistics Material Control Activity (LMCA) at the Propulsion Directorate's Edwards AFB site has once again been recognized for its outstanding work. PR-West's LMCA team was presented with the Richard L. Hennes Outstanding LMCA Award given annually to the top LMCA unit in the Air Force Materiel Command (AFMC). This unit also won the Hennes Award in 1999. Armstrong Data Services, Inc (ADS) demonstrated a high level of performance in the execution of the LMCA function, which is to provide acquisition support to PR's research, development, and test functions for non-standard supply items and one-of-a-kind items. ADS provides exemplary service with a strong emphasis on the customer. They specialize in resolving problems, maintaining detailed work processes, and providing education and training aids to their customers. They took the initiative to provide delivery services for customers unable to get to the LMCA facility and instituted training classes in response to customer surveys. They also made a concerted effort to help customers avoid the 50-mile round trip to the main base. The PR-West LMCA has passed 12 consecutive Quality Assurance Evaluation (QAE) Surveillance Inspections with no discrepancies and "Satisfactory" ratings. They have been praised for aggressive follow-up actions that have reduced overall processing times by an average of 8 days and increased the rate of meeting Required Delivery Dates for direct procurements by 4%. They also passed two DoD Industrial Security Reviews with no write-ups and received "Excellent" ratings from the AFFTC Industrial Security Office. In addition, the PR-West LMCA operates the AFRL Gas Station, which has consistently passed inspections by local authorities and independent contractors. (P. Raneri, AFRL/PROF, (661) 275-5287)

The award winning PR-West LMCA Team. Pictured (from L to R) are Fred Patao, Wesley Frierson, Trudy Johnson, Angela Alcoset, Sheila Hugges (Contract LMCA Chief), Veronica Norman (Government Buyer), Pamela Raneri (Government QAE), and Herb Boyd. Ms. Raneri and Ms. Norman are government employees; all others are contractors with ADS.

PR CAPTURES BEST PAPER AWARDS FROM LOCAL SYMPOSIUM: The Best Paper Awards from the 27th AIAA Dayton-Cincinnati Aerospace Science Symposium held on 5 March 2002 were just announced, and Propulsion Directorate personnel fared well. Best Paper Awards were given in 15 technical categories, and five of the 15 awards were given for papers that included PR government or on-site contractor personnel in the authorship. PR's award winning papers are listed below along with the technical area in which each award was given (the paper presenter is listed first):

in "Combustion"
August J. Rolling, P. King (AFIT), Fred Schauer (AFRL/PRTS), "Effects of Tube Geometry on Detonation Splitting"

in "Computational Tools & Design Optimization"
Jason T. Parker (Innovative Scientific Solutions, Inc) and Fred Schauer (AFRL/PRTS), "Analysis and Compression Algorithms for Megabyte Range PDE Data Sets"

in "Fuels"
Karin Straley, J. Klosterman, and Rich Striebich (University of Dayton Research Institute), "Multidimensional Gas Chromatography of Aviation Turbine Fuels and Related Materials"

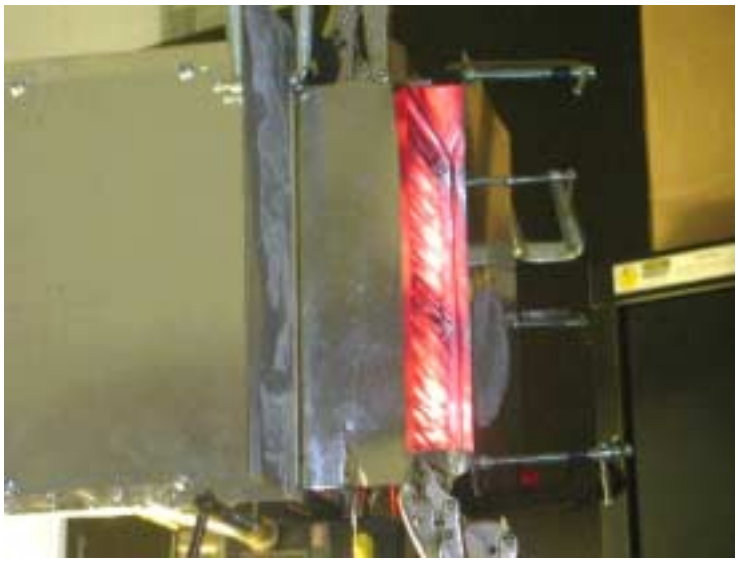
in "Biotechnology, Microtechnology, & Nanotechnology"
Barbara A. Harruff (Universal Technology Corp) and Chris Bunker (AFRL/PRTG), "Luminescence Study of CDS Nanoparticles: Observation of a Photolytic Passivation Effect"

in "Turbomachinery"
Steven Gorrell (AFRL/PRTF), T. Okiishi (Iowa State Univ), and William Copenhaver (AFRL/PRTF), "Stator-Rotor Interactions in a Transonic Compressor: Description of a Loss Producing Mechanism"

The winners were formally recognized at the AIAA Dayton-Cincinnati Section Annual Honors & Awards Program held at the University of Dayton on 22 May 2002. (J. Gord, AFRL/PRTS, (937) 255-7431)

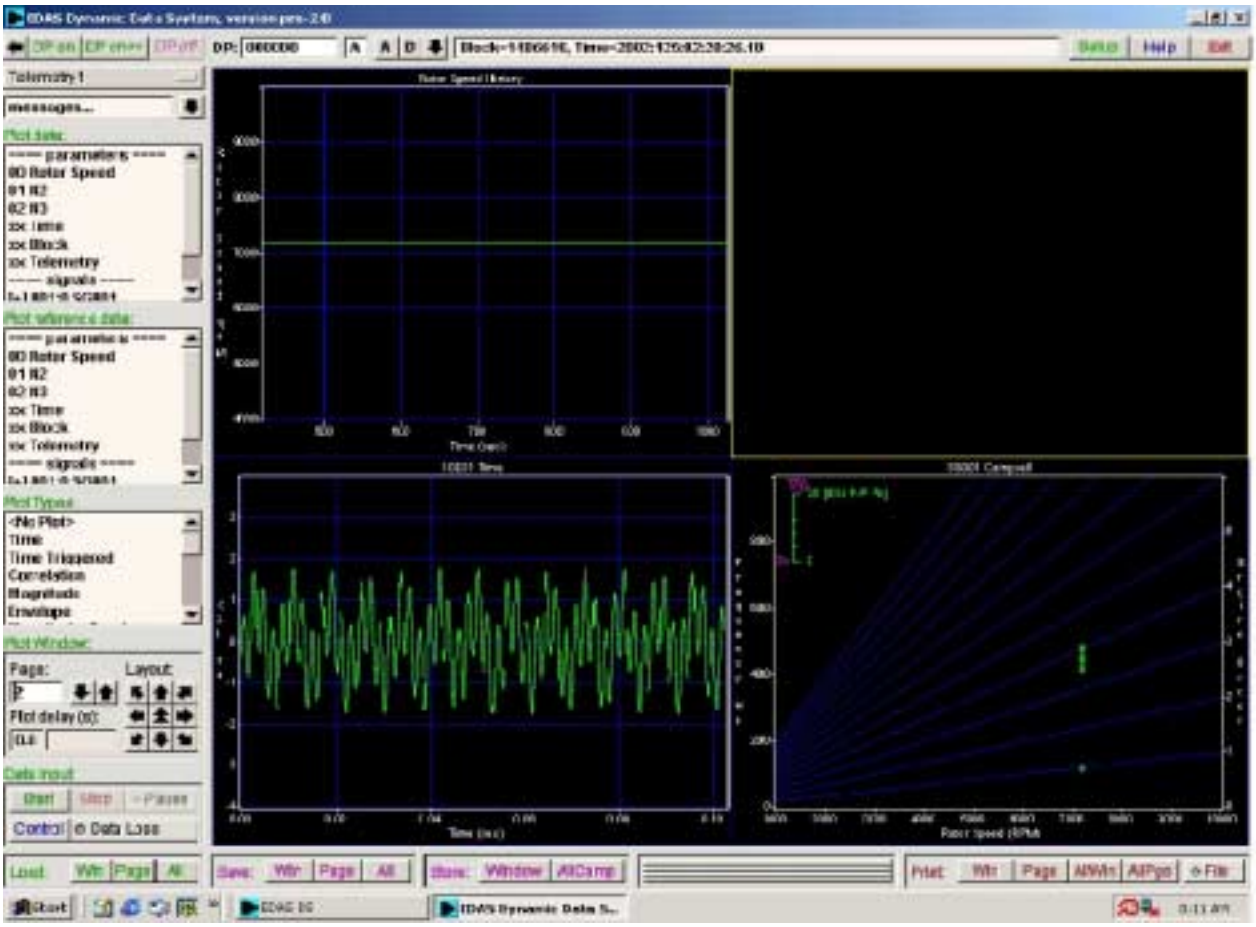
TESTS BEGIN FOR TURBOGENERATOR LOAD RESISTOR: The Propulsion Directorate's Electrical Technology and Plasma Physics Branch (AFRL/PRPE) recently performed a series of experiments for a prototype "trim-load" resistor. This testing is being performed in support of a new turbogenerator system for the F-16 fighter aircraft. This in-house project is the latest in a series of collaborative efforts with Smiths Aerospace's independent research work, focusing on high-risk enabling technologies required for the turbogenerator's implementation. The F-16 turbogenerator under development consists of a high-speed turbine coupled to a permanent magnet generator, with the shaft supported on magnetic bearings. The trim-load resistor serves as a parasitic resistive load on the generator to help regulate the generator output that is otherwise supplied to a highly cyclic power load. The prototype resistor is made up of tubular heaters

operating at temperatures up to 1500°F, in an electrical delta-connection, with a peak power dissipation of 30 kW. The experimental rig for the resistor is a 10-foot wind tunnel with a 3/4-hp variable-speed blower and is designed to help simulate the combined pressure and flow rate of cooling airflow for the resistor in a hypothetical aircraft installation. (R. Spyker, AFRL/PRPE, (937) 656-4780)



The experimental rig for the resistor (top) and the prototype resistor at operating temperature during a test (bottom)

CRF INCORPORATES NEW DATA AND ANALYSIS SYSTEMS: The Propulsion Directorate's Compressor Research Facility (CRF) recently acquired a new high speed digital data monitoring and analysis system from the Engineering Design and Analysis Solutions (EDAS) Company. PR's Propulsion Branch (AFRL/PRTP) sponsored the purchase of these new systems to assure CRF compatibility with the High Cycle Fatigue (HCF) program's test protocol for the upcoming XTE-67 test. The EDAS system has 16 channels with a 200 kHz per channel sampling rate. It will be used to monitor strain gage data online and analyze the data offline. It can generate various aeromechanical analysis plots such as strain gage stress and Campbell diagrams. The CRF also acquired four AIT-1 digital tape recorders to supplement the EDAS system. This tape system allows long-term (30 year) storage of test data. It also provides a means of loading data into the EDAS system to review and process it after a test is completed. Both the EDAS and digital tape systems are compatible with equipment used by other HCF program members, which enable the CRF to easily share data and analyses with them. The CRF is now capable of meeting HCF test requirements for complete evaluation of Air Force advanced technologies being developed under the Integrated High Performance Turbine Engine Technology (IHPTET) and Versatile Affordable Advanced Turbine Engines (VAATE) Programs. (G. Ostdiek, AFRL/PRTE, (937) 255-6802, ext 402)



This figure shows EDAS plots of rotor speed, stress, and the resulting Campbell diagram for data from one strain gage at a single rotor speed

GARSCADDEN NAMED AIAA FELLOW: The Propulsion Directorate's Chief Scientist, Dr. Alan Garscadden, was recently named a 2002 Fellow in the American Institute of Aeronautics and Astronautics (AIAA). AIAA Fellows are persons of distinction that have made notable contributions to the arts, sciences, or technology of aeronautics or astronautics. Fellows are part of a select group, as only one Fellow is elected each year for every 1,000 voting members of AIAA. In his role as PR Chief Scientist, Dr. Garscadden serves as technical adviser on a wide spectrum of aeronautical research, including many facets of propulsion, aerospace power, hypersonics, laser physics, combustion, and plasma phenomena and applications. He is known for his work in theoretical and experimental basic and applied research in nonequilibrium plasmas and energized gas flows, lasers, laser-based measurements, plasma-processing of thin films, optical and mass spectroscopic measurements, electron impact cross sections and their influence on electron transport, and the derivation of collision cross sections from transport data. He has authored more than 250 publications and presentations and served on many organizing committees for both national and international meetings and symposiums. Dr. Garscadden has served on various technical committees and several professional societies; reviewed more than 100 publications; authored several book chapters and conducted approximately 120 invited lectures and presentations to peer audiences, including plenary talks at international meetings. He

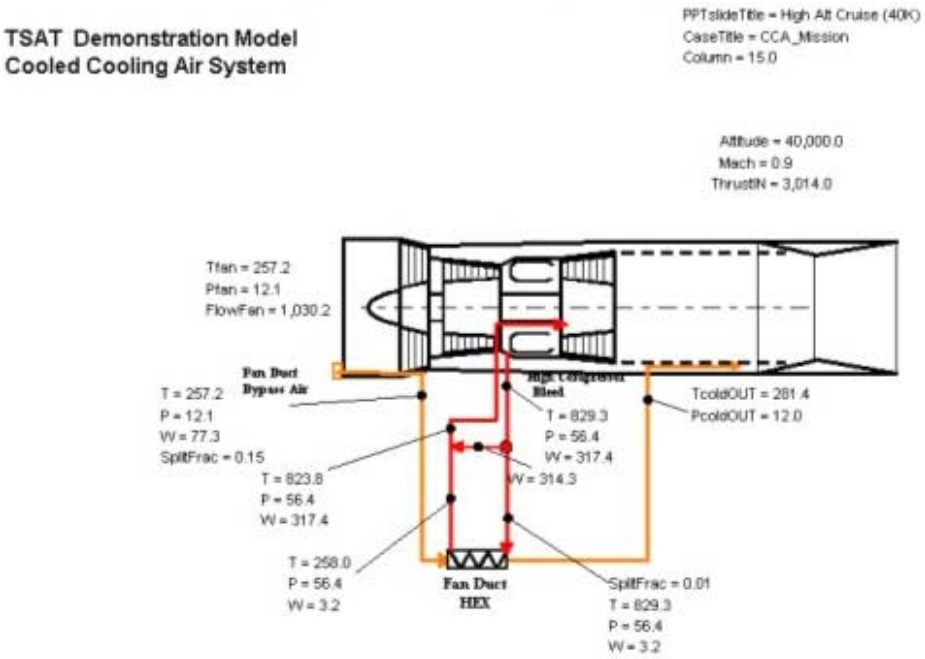
has served as thesis adviser and adjunct professor for several local and national universities. He has also been involved in various consultations and calculations on DoD activities involving different diverse areas such as lasers, hypersonics, combustors, and laser and IR sources. As a newly elected Fellow, Dr. Garscadden was honored at the AIAA Honors Night Banquet, which was held in conjunction with AIAA's Global Air & Space 2002 International Business Forum & Exhibition in Arlington, Virginia. (Col A. Janiszewski, AFRL/PR, (937) 255-2520)


Dr. Alan Garscadden

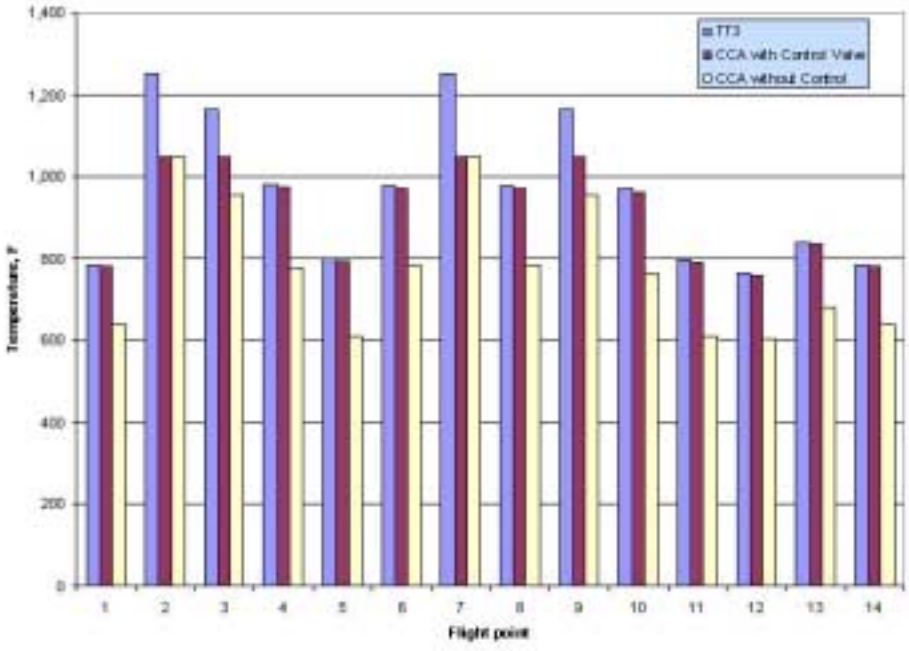
Want more information?

- Dr. Garscadden's official biography is available from the Air Force Link website by clicking here.

DUS&T THERMAL SYSTEMS ANALYSIS TOOL PROGRAM FINAL REVIEW: The final review for the Propulsion Directorate managed Dual Use Science & Technology (DUS&T) Thermal Systems Analysis Tool (TSAT) Program was held on 25 April 2002. Topics covered during the review included program objectives, TSAT/Model Engineer architecture, component descriptions, basics of building a system model, examples of system models, and a program summary. Modeling objects and utilities developed during the program included a wide range of thermal system components, engineering utilities that provide supporting property data (such as fluids, fuels, and materials), and methods (such as gas dynamic processes) and operational utilities that provide functional capabilities such as schematic tied visual outputs, control mechanisms, and data passage between the components. Discussions also included a task to link a finite element model with TSAT, an engineering code. This provided proof of concept for linking and data transfer between simulation models with different levels of complexity and dimensions. To date, TSAT/Model Engineer has been employed in a wide variety of Government and commercial applications. These include two separate High Heat Sink Fuel (HHSF) Systems programs, DARPA's Quiet Supersonic Platform, a NAVAIR electrical model, and an in-house study for United Technologies Research Center and the Modine Manufacturing Company. Example output results from the HHSF program and a preliminary look at cooled cooling air were presented (see next page). (V. Van Griethuysen, AFRL/PRTA, (937) 255-4885)



A screen capture of an output for one flight condition or segment showing temperature, pressures, and flow rates for fan duct and bleed air. The flow or split fraction at the bottom of the figure was the controlling mechanism for the calculation in order to maintain the temperature below a set temperature for T3. The flow split represents a valve setting that controls the bleed air flow into the fan duct heat exchanger.



This figure shows the resulting temperatures of T3 and the cooled cooling air for cases when the split fraction is controlled and uncontrolled. For the uncontrolled case, the split fraction was set for the worst case to see if all of the other flight conditions remained within the temperature limit. As can be seen, the temperatures for the uncontrolled case are at or below those for the controlled case.

ADVANCES IN POWER SYSTEMS MODELING & SIMULATION: The Propulsion Directorate's Power Division (AFRL/PRP) is continuing to support activities to transition technology developed under a Small Business Innovation Research (SBIR) program with PC Krause & Associates (PCKA). As part of these activities, the Automated State Model Generator (ASMG) and Dynamic Heterogeneous Simulation (DHS) technologies were showcased at the International Modeling and Simulation Forum held in France in May 2002. The US Navy, which has installed several facilities using the ASMG and DHS technologies, will present how they are using these technologies to design next-generation electric propulsion and ship-servicing electric power subsystems. AFRL and PCKA are also continuing work with Smiths Industries, Lockheed-Martin, and Allison Advanced Development/Rolls Royce to apply DHS technologies developed under this SBIR research to numerous integrated engineering design programs of direct benefit to the Air Force. (P. Lamm, AFRL/PRPE, (937) 255-6016)

MERCIER HONORED FOR SCRAMJET BREAKTHROUGH AT BLACK TIE AFFAIR: On 16 April 2002, the Propulsion Directorate's Mr. Robert A. Mercier received a 2001 Aerospace Laureate Award from *Aviation Week & Space Technology*. The formal ceremony to honor this year's award winners was held at the National Air and Space Museum in Washington, DC. Mr. Mercier, who serves as the Deputy for Technology of PR's Aerospace Propulsion Office (AFRL/PRA), was honored for his work on the groundbreaking demonstration of a hydrocarbon-fueled scramjet engine under the HyTech Program. For decades, the development of scramjet engines proceeded at a slow pace due to a variety of formidable technical challenges. However, in testing completed in 2001, the Air Force and Pratt & Whitney completed ground test demonstrations of a hydrocarbon fueled scramjet at hypersonic speeds and measured a net positive thrust. This breakthrough testing has been likened to the accomplishments of Sir Frank Whittle when he completed bench tests of the first fully functional gas turbine engine in 1937. Mr. Mercier was honored along with Joaquin H. Castro, Robert F. Faulkner, and Curtis W. Berger of Pratt & Whitney Space Propulsion. (J. Pearce, AFRL/PRO (UTC), (937) 255-5015)

From L to R: Robert Faulkner, Curtis Berger, Robert Mercier, Stanley Kandebo (Aviation Week Assistant Managing Editor), and Joaquin Castro

Want more information?

- The 29 April 2002 issue of *Aviation Week & Space Technology* has extensive coverage of the 2001 Laureate Awards on pp. 35-54.

PR VOLUNTEERS HONORED WITH ANGEL AWARDS: In 1988, Mrs. Eunice Welch, wife of former Air Force Chief of Staff General Larry Welch, created the Angel Awards. This worldwide award program honors volunteers for their outstanding support and dedication to the local community. The Angel Awards are presented annually at the base level across the Air Force, and three of this year's Wright-Patterson AFB winners are associated with the Propulsion Directorate. Lt Gen Richard V. Reynolds, ASC Commander, presided over the ceremony at the Air Force Museum on 1 May 2002 to honor the Wright-Patterson AFB Angel Award winners for 2002. PR's Project Helping Hands,* which was created by Ms. Linda Hartsock and is currently led by Ms. Lynne Nelson, captured a Team Angel Award. Project Helping Hands is a charitable, non-profit organization focused on offering humanitarian support to the local community. Project Helping Hands arranges a wide variety of fundraising events in PR, and also sponsored a booth at the 2001 WPAFB 4th of July celebration. Project Helping Hands made a generous contribution to the Red Cross in wake of the September 11th tragedy and helped to brighten the Christmas holidays for eight local families that were struggling financially. In addition to the team award, PR also received two individual awards. One individual award went to Dr. Jeanette Robinson of PR's Propulsion Contracting Division (AFRL/PRK). Dr. Robinson has been involved in an impressive array of volunteer activities including Wright STEPP (Science, Technology, and Engineering Preparatory Program), which provides educational opportunities for inner city children, and numerous base and community wellness programs. She is also a board member of

Members of the Project Helping Hands team accept their Angel Award. Pictured (from L to R) are Lt Gen Reynolds, Lynne Nelson, Jane Cansler, Laurie Regazzi, and Kathy Johnson.

* Project Helping Hands team members (listed alphabetically) include Robin Bartley, Jane Cansler, Capt Tony Cerminaro, Toni DeLoach, Betsy Graham, Hank Grinner, 1Lt Kim Groleau, Linda Hartsock, Kathy Johnson, Debby Kaucher, Wanda Longstreth, Sally Martin, Lynne Nelson, Angela Pickard, Melissa Prickett, Capt Michelle Rauch, Laurie Regazzi, and Sharon Steltz.

the Montgomery County Volunteer Chaplaincy Ministry and is her organization's chairperson for African American History Month. PR's other individual award went to Mrs. Grace Janiszewski, wife of PR Director Col Alan Janiszewski, for her wide ranging activities supporting the local community. Mrs. Janiszewski generously volunteers her time to Fairborn Cares, the Deployed Spouses Group, and Family Services. She also serves as a Red Cross Volunteer Coordinator and helps out regularly at the main hospital pharmacy. In addition, she is a Greene County Master Gardener, and she puts her talents to use to feed the hungry of Fairborn through a project in conjunction with Mary Help of Christians School. (J. Pearce, AFRL/PRO (UTC), (937) 255-5015)

Want more information?

- A *Skywrighter* article on the WPAFB Angel Awards is available by clicking here.

Dr. Jeanette Robinson

Mrs. Grace Janiszewski

LOCKHEED MARTIN STUDIES THERMAL MANAGEMENT FOR CONCEPTUAL HIGH ENERGY LASER ON JOINT STRIKE FIGHTER**:** Lockheed Martin Aeronautics Company (Ft. Worth) has completed a study of the thermal management issues associated with integrating a conceptual solid state high energy laser (HEL) on a fighter-sized aircraft. The mission of this HEL concept is to perform air-to-air self defense against enemy aircraft and missiles and is not part of the JSF baseline program. The potential also exists for air-to-ground missions with the HEL. The study team considered thermal system solutions for a baseline laser concept of a diode pumped solid state HEL with an average radiation output power of 100 kW. Lockheed Martin has predicted that a significant technical challenge of integrating the HEL system into fighter aircraft will be the removal and dissipation of several hundred kW of waste heat generated during HEL operation. Lockheed Martin has determined that prime power generation is a lesser technical challenge as near-term engine systems could deliver over a megawatt of mechanical

power to a generator without impacting thrust performance. The study investigated three methods of removing the HEL waste heat from the aircraft. The first method was to boil off a fluid (such as ammonia) which is then discharged from the aircraft. Although this method was deemed a low technical risk, Lockheed Martin determined that the expendable fluid would likely have a negative system impact in terms of increased logistics, magazine limitations, and potential environmental concerns. A second heat removal method, rejecting heat to ambient air, was determined to be not feasible due to complexities arising from the high required temperature difference between the cooling fluid and ambient air. The third heat removal method was to reject the waste heat to fuel, which is then burned in the engine. Lockheed Martin found this method to be very attractive since the logistics of jet fuel are standard and that mid-air refueling could provide a fresh heat sink as well as a new magazine of ammunition for the HEL. By soliciting input from Honeywell, Fairchild, and Raytheon, Lockheed Martin determined that the method of HEL waste heat rejection to the fuel reservoir using a closed cycle system to transport heat from the HEL to the fuel was a viable option. An investigation was also conducted on the aircraft integration issues of such a closed cycle system. Lockheed Martin determined that a representative closed cycle system could be integrated into an HEL fighter that provided an operational capability with reasonable "laser on" and "thermal recovery" times. Lockheed Martin has shown that advanced thermal management technologies being developed by the Propulsion Directorate's Power Division (AFRL/PRP) are potentially applicable to the HEL concept. Advancements in closed cycle single and two-phase thermal transport systems with various working fluids are necessary to meet the requirements of the conceptual HEL thermal management system. (S. Adams, AFRL/PRPE, (937) 255-5179)

STUDENTS WIN REGIONAL AIAA AWARD: Two students from the University of Southern California (USC) recently won first place at the American Institute of Aeronautics and Astronautics (AIAA) Western Region Student Competition. These students, Messrs. Brian Eccles and Brian Bjelde, performed their award winning work on a project that directly supports research for the Propulsion Directorate's Aerophysics Branch (AFRL/PRSA) at Edwards AFB, California. The two USC seniors are being advised by Dr. Andrew Ketsdever (AFRL/PRSA). Their selection as winners of the Western Region was based on their work entitled, "Design and Calibration of a Torsion Microbalance with Applications to Micromechanical Actuation and Laser Propulsion." This work is being supported by AFRL/PRSA with the development of an impulse thrust stand for research in microfluid dynamics and gas-surface interactions. Eccles and Bjelde will represent the Western Region in the AIAA National Student Competition at the AIAA Aerospace Sciences Meeting in Reno, Nevada, in January 2003. (A. Ketsdever, AFRL/PRSA, (661) 275-6242)

COMPACT SOLID STATE PULSERS: The Plasma Physics Group of the Propulsion Directorate's Electrical Technology and Plasma Physics Branch (AFRL/PRPE) has recently designed, built, and tested two versions of a variable pulse-width compact solid-state pulser. Both versions are capable of delivering 500 kW peak power at 15 kV maximum voltage to a capacitive load with impedance exceeding 300 Ω. The voltage slew rate can be as high as 1 MV/microsecond. These pulsers can be operated at repetition rates up to 30 kHz. Currently, these high-voltage pulsers are used for in-house research on both shock wave mitigation and high E/N plasma-assisted ignition simulation experiments. The latter experiments could have a direct

positive impact on improving combustion efficiency of low-pressure turbines used in very high altitude unmanned aerial vehicles (UAVs). (B. Ganguly, AFRL/PRPE, (937) 255-2923)

The 15 kV, 30 Amp compact pulser. The pulser is the copper box labeled HTS 150.

TURBINE COMPONENTS SELECTED FOR PROBABILISTIC LIFE MODEL DEVELOPMENT: Pratt & Whitney has completed prioritization and selection of candidate turbine components for life model development following a detailed analysis of four C-17 engine maintenance databases. In a PRDA VII effort managed by the Propulsion Directorate's Turbine Engine Division (AFRL/PRT), real-time engine component life models are in development. Starting from mathematical theory, realistic component life prediction algorithms will be designed, coded, and bench tested as part of the Onboard Engine Component Probabilistic Life Model effort. A major accomplishment at Pratt & Whitney's modeling group is the application of orthogonal transforms (mathematical mapping techniques) to the problem of information extraction from large arrays of temperature, pressure, and strain data. Developing an efficient, highly compact model to predict the life of engine components is a high payoff activity. It addresses both the Integrated High Performance Turbine Engine Technology (IHPTET) and Versatile Affordable Advanced Turbine Engines (VAATE) goals by reducing engine maintenance cost, reducing fleet sustainment cost, and reducing the number of inspections required. The use of engine prognostic and life models is relatively limited in current military engines. Less than six models (algorithms) reside in the F119 engine diagnostic unit. However, new mathematical techniques developed in this effort employing both feature extraction and compression, make possible a tenfold expansion in the number of prognostic and life models. It is expected that the JSF engine diagnostics unit will utilize over 60 models. Significant difficulties in developing onboard engine models are their large size, computational complexity, and applicability to only single points on a component, such as a compressor disk. Pratt & Whitney's Proper Orthogonal Decomposition (POD) technique, combined with new types of sensors (such as stress wave), will enable life models to run in real-time on the computer processor technology planned for the JSF. The final milestone in this effort will be a demonstration of the life algorithms installed on an advanced engine diagnostics unit. Following selection of the engine components (such as the first stage turbine and HPC), performance data for each component will be collected. This data will support the design and development of the POD life models. Statistical regression models will also be developed as a baseline in determining the overall benefits of the new technology. Developments on this effort are coordinated with the Navy's Life Extending Control (LEC) Program. In the LEC Program, the Navy is evaluating the potential benefits of life models on the Full Authority Digital Engine Control (FADEC). (K. Semega, AFRL/PRTA, (937) 255-6741)

JACOBSON NAMED CGO OF THE QUARTER: 1Lt Andy Jacobson of the Fuels Branch (AFRL/PRTG) was recently named the Propulsion Directorate's Company Grade Officer (CGO) of the Quarter for the 1st Quarter of 2002. Lt Jacobson has made outstanding contributions to a number of Fuels Branch programs. He superbly led a joint AFRL, industry, warfighter, and academia team in the measurement of smoke and soot levels produced by C-130 and B-52 aircraft. This work is of vital importance to the warfighter as smoke and soot are keys to survivability due to their high infrared and visual signatures. Lt Jacobson also shepherded the conversion of a C-130 unit to JP-8+100 fuel to reduce engine coking and fuel system damage. He was also handpicked to assist in the analysis of engine "sparking" on AC-130 gunships in New Mexico. Detailed emissions analysis that he spearheaded quickly determined the cause of the sparking and consequently minimized aircraft down time. Lt Jacobsen has also made great strides towards self improvement as evidenced by his recent completion of a Master's Degree Program in Business Administration from Wright State University. He also obtained Level I Certification in three important areas of the Acquisition Professional Development Program (APDP): Acquisition Logistics, Program Management, and Test and Evaluation. He also is very giving of his free time, and has volunteered with PR's Project Helping Hands, which assists underprivileged families in the local community. In addition, he volunteered many hours to Habitat for Humanity as part of WPAFB CGO team, and he represented AFRL at the Ohio State Career Day. Lt Jacobson is well-deserving of this recognition. (W. Harrison, AFRL/PRTG, (937) 255-6601)

1Lt Andy Jacobson