A n international team, led by Professor H.A. Fujii at the Kanagawa Institute of Technology/Ni- hon University, is developing a suborbital test of a new type of electrodynamic tether (EDT) that may lead to a generation of propellantless propulsion systems for low Earth orbit spacecraft. Japanese scientists coined the name T-Rex for the new tether experiment.

EDT thrusters work by virtue of the force that a magnetic field exerts on a wire carrying an electrical current. The force, which acts on any charged particle moving through a magnetic field (including the electrons moving in a current-carrying wire), was concisely expressed by Lorentz in 1895 in an equation that now bears his name. The force acts in a direction perpendicular to both the direction of the current flow and the magnetic field vector. Electric motors make use of this force; a wire loop in a magnetic field is made to rotate by the torque that the Lorentz force exerts on it due to an alternating current in the loop timed so as to keep the torque acting in the same sense. The motion of the loop is transmitted to a shaft, thus providing work.

Although the working principle of EDT thrusters is not new, its application to space transportation may be significant. In essence, an EDT thruster is just a clever way of getting an electrical current

continued on page 4
CPIAC offers a variety of services to its subscribers, including responses to technical/bibliographic inquiries. Answers are usually provided within three working days and take the form of telephoned, telefaxed, electronic or written technical summaries. Customers are provided with copies of JANNAF papers, excerpts from technical reports, bibliographies of pertinent literature, names of recognized experts, propellant/ingredient data sheets, computer programs and/or theoretical performance calculations. The CPIAC staff responds to nearly 800 inquiries per year from over 180 customer organizations. CPIAC invites inquiries via telephone, fax, e-mail, or letter. For further information, please contact Ron Fry by e-mail to rs_fry@jhu.edu. Representative recent inquiries include:

**TECHNICAL INQUIRIES**

- Chronology of U.S. solid propulsion industrial facilities (Req. 26392)
- Carbonized rayon in the U.S. strategic reserve (Req. 26415)
- Castor 30 SRM propellant exhaust products (Req. 26424)
- Ammonium perchlorate (AP) decomposition characteristics (Req. 26463)

**BIBLIOGRAPHIC INQUIRIES**

- Operatioanl and storage requirements for HD 1.3 ordnance and materials (Req. 26652)
- Hydrazine fuel studies that statistically compared hydrazine fuel (water and assay values) for repeatability and reproducibility (Req. 26634)
- Key references to extract program related information on large liquid rocket engine programs (Req. 26613)
- Combustion research involving powder injection (Req. 26610)
- Differences between flight derived and ground measured Isp for liquid & solid rocket engines (Req. 26579)
The 57th Joint Army-Navy-NASA-Air Force (JANNAF) Propulsion Meeting (JPM) and Joint Meeting of the 7th Modeling and Simulation Subcommittee (MSS)/5th Liquid Propulsion Subcommittee (LPS)/4th Spacecraft Propulsion Subcommittee (SPS) will be held Monday through Friday, May 3-7, 2010 at the Cheyenne Mountain Resort in Colorado Springs, Colo.

The overall security classification of the conference is Unclassified. Attendance at this JANNAF meeting is restricted to U.S. citizens whose organizations are registered with an appropriately classified contract with the Defense Technical Information Center and certified for receipt of export-controlled technical data with the Defense Logistics Information Service.

For government attendees, the room rate for the Cheyenne Mountain Resort is $88 (or the prevailing government per diem). For industry attendees the rate is $164. More information on this resort property is available at www.cheyennemountain.com.

CPIAC distributed the Meeting Announcement and Call for Papers in July. Abstracts, as well as workshop and special session topics, are due November 16, 2009. Please contact Patricia Szybist at 410-992-7302, ext. 215, or by e-mail to pats@jhu.edu if you did not receive a copy or require additional information.

The Bulletin Board

Various propulsion-related meetings are listed below. If you know of an event that may be of interest to the propulsion community, please forward the details to bulletin@cpiac.jhu.edu. Additional industry meetings are posted on the CPIAC Web site, Meetings & Symposia: http://www.cpiac.jhu.edu/templates/cpiacTemplate/meetings/. The JANNAF Calendar appears on the back page.

**7th International Workshop on Structural Health Monitoring 2009**
9-11 September 2009
Stanford University, Stanford, CA
POC: http://young-sacl.stanford.edu/member.php

**2009 International Autumn Seminar on Propellants, Explosives and Propellants**
22-25 September 2009
Kunming, Yunnan, China
POC: http://www.iaspep.com.cn

**6th International Symposium on Beamed Energy Propulsion**
1-5 November 2009
Scottsdale, Arizona

**8th International Symposium on Special Topics in Chemical Propulsion**
2-6 November 2009
Cape Town, South Africa
POC: Prof. Ken Kuo at kenkuo@psu.edu, or call 1-814- 863-6270

**48th AIAA Aerospace Sciences Meeting and Exhibit**
4-7 January 2010
Orlando, Florida
POC: www.aiaa.org

**AIAA Strategic and Tactical Missile Systems Conference**
20-21 January 2010
Monterey, CA
POC: www.aiaa.org

**14th International Detonation Symposium**
11-16 April 2010
Coeur d’Alene, Idaho
POC: http://www.intdetsymp.org/detsymp2010/

**AVT-176 Symposium on Advances in Service Life Determination and Health Monitoring of Munitions**
April/May 2010
Turkey
POC: Dr. Gregory A. Ruderman at gregory.ruderman@us.af.mil or Sandra Cheyne at cheynes@rra.nato.int
ABSTRACTS STILL BEING ACCEPTED
to flow in a long orbiting wire (the tether) so that the Earth’s magnetic field will accelerate the wire and, consequently, the payload attached to the wire. The direction of current flow in the tether, either toward or away from the Earth along the local vertical, determines whether the magnetic force will raise or lower the orbit.

The bias voltage of a vertically deployed metal tether, which results from its orbital motion (assumed eastward) through Earth’s magnetic field, is positive with respect to the ambient plasma at the top and negative at the bottom. This polarization is due to the action of the Lorentz force on the electrons in the tether. Thus, the “natural” current flow is the result of negative electrons being attracted to the upper end and then returned to the plasma at the lower end. The magnetic force in this case has a component opposite to the direction of motion; therefore, it leads to a lowering of the orbit and, eventually, to re-entry. In this “generator” mode of operation, the Lorentz force serves both to drive the current and then to act on the current to decelerate the system.

One of the most important features of tether thrusters is that they use renewable energy sources to drive the electrical current flow in either the orbit-raising or orbit-lowering modes. Sources inherent to Earth orbit are used. To raise the orbit, sunlight can be converted to the electrical energy required to drive the tether current. To lower the orbit, the orbital energy itself (supplied by the Earth-to-orbit launcher when it raises the system into orbit) is the energy source of the tether current via the action of the Lorentz force.

Electrodynamic tethers can be directly applied to a wide spectrum of uses in space. As a propulsion system, they include satellite de-orbit, transfer of a satellite from one orbit to another, altitude maintenance for large spacecraft such as the International Space Station, and—since it works wherever there is a magnetic field and an ionosphere—planetary exploration missions.

An electrodynamic tether upper stage could be used as an Orbit Transfer Vehicle (OTV) to move payloads within low Earth orbit. The OTV would rendezvous with the payload and launch vehicle, grapple the payload, and maneuver it to a new orbital altitude or inclination without the use of boost propellant. The tug could then lower its orbit to rendezvous with the next payload and repeat the process. Conceivably, such a system could perform several orbital maneuvers without resupply, making it relatively inexpensive to operate.

T-Rex will launch from Uchinoura, Kagoshima, Japan, using an S-520 sounding rocket. During ascent, and above approximately 100 km in attitude, the 300-meter-long tape tether will be deployed at a rate of approximately 4 m/s. Once deployed, the tape tether will serve as an anode, collecting ionospheric electrons. The electrons will be expelled into space by a hollow cathode device, thereby completing the circuit and allowing current to flow. An artist’s concept of the mission in flight is shown in the illustration on page 1.

The first objective of T-Rex is to fully deploy the tape tether using a “new” deployment scheme that is actually derived from a very common technique used by firefighters in paying out very long fire hoses. The tape will be folded and stacked into a box with an opening on one end—resembling a tissue box. A spring will eject an endmass attached to the rocket by the tether. As the endmass separates, the tether will be deployed to a total length of 300 meters. The tether is made of aluminum, and as it passes through the Earth’s magnetic field and ionosphere, it will collect electrons along part of its length. The total amount of current collected will be used to assess the validity of ionospheric current collection models.

The tether generates and forms part of a unique type of electrical circuit, which has been successfully demonstrated in space by flights of the Plasma Motor Generator in 1993 and the Tethered Satellite Systems (TSS-1 and TSS-1R) in 1992 and 1996, respectively. Both missions deployed long conducting tethers from orbiting spacecraft and successfully generated a current. The tethered system extracts electrons from the ionospheric plasma at one end (upper or lower, depending upon the deployment direction and intended thrust motion) and then carries them through the tether to the other end where they are returned to the plasma. The circuit is completed by currents in the plasma.

T-Rex will launch this fall. For more information about this new tether experiment, contact Les Johnson at 256-544-7824 or by e-mail to charles.l.johnson-1@nasa.gov.

About the Author

The CPIAC Launch Log

By Nick Keim, CPIAC Research Engineer

The Chemical Propulsion Information Analysis Center (CPIAC) recently completed a survey of space launches that occurred over the period of 2004 to 2008. The goal of this survey was to gather data for a paper on worldwide space utilization, in terms of both national space launch capability and national and commercial spacecraft launched. While collecting this data, the issue of source reliability was of utmost importance; consequently, CPIAC gathered data from multiple sources and cross-checked each for accuracy. As a result of this effort, the CPIAC Launch Log was born.

The CPIAC Launch Log includes the launch vehicle, pad, and payload of each launch attempt. Failed launches are included along with the successful ones, as long as the launches are considered to have been legitimate attempts. Development launches, for example, may be excluded, especially if they carry no payload or a dummy payload. The launch must be orbital; ballistic trajectories are not included.

The log will be made available for download in two formats. The first is a Microsoft Excel file, which includes all of the launches collected thus far in addition to a key for the various launch vehicle and launch site designations. Currently, the log automatically calculates the total number of launches in a given year and the total number of spacecraft launched in a given year. In addition, the number of launches and spacecraft are delineated by nation or geographic area, such as South America. The second format for the log is a yearly comma-separated variable text file; this file includes only the launches that have occurred in a specific year. The launch log itself will be updated on a quarterly basis. Figures 1 and 2 show the types of data that can be extracted from the launch log directly.

Users are free to download and manipulate the data as they see fit, and additional analysis such as launch vehicle success rates can be easily obtained. CPIAC expects that this log will become a useful tool for those interested in tracking space utilization.

Questions or comments about the launch log may be directed to Nick Keim at nkeim@cpiac.jhu.edu. The CPIAC Launch Log may be found on CPIAC’s homepage under “CPIAC Tools & Resources.” Check it out at http://www.cpiac.jhu.edu!

![Figure 1. Launches by Nation per Year.](image)

![Figure 2. Spacecraft Launched by Nation per Year.](image)
CPIAC is pleased to announce that the Propellant and Explosive Ingredients Database (PEID), available through the Chemical Propulsion Information Network (CPIN), has been updated. It will now be even more useful to investigators who need information on energetic material ingredients and their supply status. PEID currently has information on 309 ingredients, with corresponding data on 138 present and past suppliers.

The most significant recent enhancement is the addition of spectroscopic data, namely Raman, ultraviolet, and mass spectra. PEID now contains 133 spectra of ingredients plus related compounds and formulations. These data were kindly provided by Dr. James Carver of the Army Research, Development, and Engineering Command at Redstone Arsenal, Alabama. Spectra are presented in both graphic and tabular formats. Figure 1 shows a typical spectrum.

In addition to the spectral data:

- Information on 45 ingredient suppliers was added or updated.
- Information on the criticality of ingredient supplies was updated, based on the outcome of the 2009 meeting of The Technical Cooperation Program (TTCP).
- Wording for the Orange and Yellow criticalities was changed to make it more consistent with the User’s Manual.
- Environmental information on perchlorates was updated in accordance with recent EPA actions.

It is necessary to have a Chemical Propulsion Information Network (CPIN) account to access PEID. CPIN is the secure Internet portal to CPIAC’s suite of chemical propulsion-related technical and bibliographic databases, and online publications. Information on how to obtain a CPIN account is available by calling CPIAC Customer Service at 410-992-7300, ext. 211 or 212. Other information on PEID can be found in an article published in the November 2007 issue of the CPIAC Bulletin: http://www.cpiac.jhu.edu/images/media/bulletins/nov07.pdf.

![Figure 1. Typical electron-impact mass spectrum; partial tabular listing shown.](image-url)
Disappointment for ATK and NASA as ARES I First Stage Five-Segment Solid Rocket Motor Test Fire is Delayed

On Thursday, August 27th, ATK was set to test fire their DM-1 or Ares I rocket at their Utah test facility. The launch would have marked the first major ground test of the NASA Constellation program, but it was delayed at the 20-second mark due to a complication in one of the Auxiliary Power Units (APU), a system in the Thrust Vector Control that moves the nozzle. The rocket could have been fired without correcting the faulty APU, but if fired, the engineers would not have been able to test the rocket nozzle’s agility. By choosing to scrub the firing, the ATK crew has not compromised any of the motor’s components, thereby preserving their ability to meet all of their 46 test objectives during the rescheduled static test.

CPIAC Director Ed Liu was among the many who gathered to witness the planned test. As of the date of this publication, a new test date will be scheduled for no earlier than September 10th. Additional dry runs, technical readiness reviews, and methodical circuitry and component investigation will be done before a new launch date is announced.

The completed Ares I was first unveiled on July 20, 2009, the 40th anniversary of Apollo 11 landing on the moon. Just as Apollo 11’s accomplishment marked a big step in space exploration and travel, so does the completion of Ares I. The Ares I first stage is a five-segment solid rocket booster, and it is intended to launch the Orion crew exploration vehicle for missions to the International Space Station (ISS) and the moon. The Ares I first stage has been under development since 2005. The first stage, although based on the space shuttle’s four-stage booster, differs from its predecessors in a few ways. These differences include the addition of a fifth segment, changes to the propellant grain, a larger nozzle opening, and upgraded insulation and liner.

“As we reflect back 40 years to when man first stepped on the moon, we also look forward to continuing America’s heritage of space exploration…. The booster we unveiled today brings us a step closer to continuing that legacy,” said Mike Kahn—executive vice president, ATK Space Systems—upon the presentation of Ares I.

DM-I was installed horizontally using a modified test stand from the space shuttle’s four-segment configuration.

Steve Cook, the program director for Ares rockets at Marshall Space Flight Center in Huntsville, Alabama, announced his resignation only a few days after the scrubbed horizontal test launch. He has accepted a position at Dynetics, a defense contractor based out of Huntsville, Alabama. However, his departure will not delay or hinder the development of Ares I.
The overall security classification of this conference is Secret. Unclassified sessions will be held at the Hyatt Regency La Jolla; classified sessions will be conducted at the Naval Fleet Intelligence Training Center. Attendance at this JANNAF meeting is restricted to U.S. citizens whose organizations are registered with an appropriately classified contract with the Defense Technical Information Center (DTIC) and certified for receipt of export-controlled technical data with the Defense Logistics Information Service (DLIS). See Bulletin insert for the preliminary block diagram for this meeting.

The featured CS/APS/PSHS program will host almost 200 presentations in 33 technical sessions on combustion, air-breathing, and systems hazards technology. Workshops and specialist sessions will be conducted on the following topics: Experimental Uncertainty in Scramjet Ground and Flight Testing and Simulation; Turbine-Based Combined Cycle (TBCC) Distortion; Rocket-Based Combined Cycle (RBCC) Technology Assessment; Pulse Detonation Combustion (PDC) Technology; Scramjet Ground Testing Standards; and Air-Blast Data Collection and Analysis for Hazard Classification (HC) and Insensitive Munitions (IM) Characterization.

The Uncertainty Workshop seeks to define the origins of experimental uncertainty, its consequences on scramjet propulsion R&D, and a plan to develop recommended practices and guidelines that address the consideration, treatment, and reporting of experimental uncertainty in test data analysis and scramjet propulsion design. This workshop will be facilitated by Mr. Ron Dieck, an internationally recognized expert in uncertainty, who will also teach a day-and-a-half course on Measurement Uncertainty prior to the technical program. The course will run from Sunday, December 6, until Monday at noon on December 7; it is available to participants through advanced registration.

The RBCC Technology Workshop II will bring together a team of more than 60 technologists from government, industry, and academia to assess progress to identify system and component Technology Readiness Levels (TRLs), define technology gaps, correlate risk with levels of performance and operability, and define risk mitigation for guiding future Air Force investment in RBCC technologies.

The TBCC Distortion Workshop seeks to establish a baseline of knowledge of turbine and inlet distortion within the hypersonic community, and to discuss the application of these concepts to turbine-based combined-cycle systems and component development. Specialists hope to identify technology gaps associated with combined-cycle distortion and increase inclusion of distortion analysis and testing methodology into ongoing TBCC projects.

The PDC Specialist Sessions seek to advance APS Advanced Engine Cycle Panel Working Group efforts that began in 2006 to define a PDE technology development plan, identify community consensus on PDC technology, and execute an implementation and management plan. Technical Sessions will examine progress on performance codes, standards on nomenclature and performance measurement, and activity reviews of Vulcan and Constant Volume Combustion Technology Risk Reduction Programs.

The SJ Engine Test Standards Working Group (SETSWG) of the APS Engine Test and Validation Panel will conduct a technical interchange meeting to identify topics for maturing potential standards from existing recommended practices on scramjet propulsion ground testing and to develop a plan for community consensus on these proposed standards. The session continues successful community efforts begun in 1998 that culminated with the subsequent publication of the 1st (2002) and 2nd (2005) editions of CPIAC Publication 710, Scramjet Propulsion Testing Recommended Practices, Guidelines and Standards, and continuing evolutionary development of future standards.

The Air-Blast Workshop will bring together experts in blast measurement and analysis to assess how best to deal with the difficulties associated with the testing of solid propellant munitions, especially those of Hazard Division 1.3. Participants will consider the applicability of recent computer codes with enhanced capabilities for characterization of complex blast fields created from non-ideal explosives and non-spherical or hemispherical charges.

Other JANNAF Subcommittees, including the Propellant and Explosives Development and Characterization, the Modeling and Simulation, the Safety and Environmental Protection, and the Structures and Mechanical Behavior communities will host workshops in this program on Hydroxyl-terminated Polybutadiene (HTPB) Variability; Credibility Guide; Airborne Lead Reduction; and Wireless Sensors II, respectively.

The HTPB Variability Workshop will address operational examples of HTPB variability within DoD programs, provide feedback to the manufacturer (Sartomer), and generate a report to guide the industry. HTPB, a workhorse polymer for rocket propellant production, has shown trends toward variability for the past several years. Feedback from the April 2009 JANNAF

continued on page 9
PEDCS meeting indicates that a workshop would be the best venue to address this issue.

The Simulation Credibility Guide Workshop will continue to focus MSS community activities dating from 2007 to develop a “Guide for Uncertainty Quantification and Model Validation for Credible Simulations in Propulsion and Energetics.” Specialists are seeking to contribute to revolutionizing the way propulsion systems are engineered through the use of computer simulation. This technical interchange between the guide developers and practitioners of propulsion modeling will review progress toward describing how to use procedures, processes, and test cases for the verification, validation, uncertainty quantification, model conditioning, and predictions to determine simulation credibility for critical propulsion-related decisions.

To prevent restrictions on DoD or NASA operations and installations, airborne lead concentrations must meet a new EPA standard; in some cases this may require significant emission reductions. Participants in the Airborne Lead Reduction Workshop will address this issue by providing input on sustainable lead-free weapon systems and path-forward strategies to develop, demonstrate, qualify, and/or implement lead-free technologies for the highest priority applications.

CPIAC now provides JANNAF meeting programs (complete with agendas), information for authors and session chairs, and administrative details concerning hotel accommodations, registration, remittance, etc. on the JANNAF Web site at www.jannaf.org. Specific information for this meeting is located at: http://jannaf.org/Dec_2009_meeting.php. Questions concerning the program should be directed to Pat Szybist at (410) 992-7302, ext. 215 or by email to pats@jhu.edu.

EXPERIMENTAL UNCERTAINTY, CONCEPTS AND APPLICATIONS TUTORIAL

The Chemical Propulsion Information Analysis Center (CPIAC) is sponsoring a tutorial entitled “Experimental Uncertainty, Concepts and Applications.” This tutorial will be conducted in conjunction with the 43rd Combustion Subcommittee/31st Airbreathing Propulsion Subcommittee/25th Propulsion Systems Hazards Subcommittee Joint Meeting being held Monday to Thursday, December 7-11, 2009, at the Hyatt Regency La Jolla in La Jolla, California. The course will be conducted on Sunday and Monday, December 6 and 7, and is intended to complement an Airbreathing Propulsion Workshop on “Experimental Uncertainty in Scramjet Ground and Flight Testing and Simulation.”

This course is designed for scientists and engineers interested in evaluating experimental accuracy. It is in complete harmony with the principles of the ISO and other international standards on measurement uncertainty. Included are the basics of the measurement uncertainty model, the use of correlation, curve fitting problems, probability plotting, combining results from different test methods, calibration errors, and error propagation for both independent and dependent error sources. Extra attention is devoted to the personal problems of developing confidence in uncertainty analysis results and on using measurement uncertainty to select instrumentation systems. Special emphasis on understanding is achieved through discussion, class experiments, and the in-class working of problems. After this course, the students will be able to apply uncertainty analysis techniques to most experimental test problems in order to help achieve test objectives in a more productive and cost-effective manner. Students will need to bring calculators to work the experiments and problems.

The fee for the tutorial will be approximately $550 and covers all course materials including a complete set of notes and a copy of the course text, Measurement Uncertainty, Methods and Applications, 3rd Edition, by Ron Dieck. Course registration will be limited to the first 30 applicants. Registration information for this meeting and tutorial is located on the following Web site: http://jannaf.org/Dec_2009_meeting.php. Questions should be directed to Pat Szybist at pats@jhu.edu or (410) 992-7302, ext. 215.

JANNAF Journal of Propulsion and Energetics

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The committee to review U.S. human space flight plans, known as the Augustine commission, was tasked by the president to present options for the future direction of our human space flight program. On the table are choices regarding the retiring of the Space Shuttle; International Space Station (ISS) operations; target lift capacity to low Earth orbit (LEO); new launch vehicle designs; government, commercial, international, or combined crew capability to LEO; in-space fuel depot and refueling; the first destination beyond LEO; and the role of commercial partners in the overall architecture. Each of these areas to be considered carries with it several options that need to be evaluated. As a result of this evaluation, seven choices were given to the president along with the committee’s evaluation of each but with no explicit recommendation for one over the other.

The committee at previous meetings has heard and deliberated on such issues as the cost and risks associated with continued Space Shuttle operation, the possibility of EELV-derived launch vehicles, shuttle-derived launch vehicles, and the status and feasibility of the current Ares I and Ares V launch vehicles under development. As committee member Ed Crawley stated in his presentation to the panel on August 12th, the decisions to be made could be based on answers to the following critical questions:

- What is the phase out plan of the Shuttle?
- What is the future of the ISS?
- Should the government-developed launch system be based on NASA/Shuttle heritage or an EELV-based system?
- How should crew be carried to LEO (ISS in particular)?
- What is the first destination for exploration beyond LEO?

August 5th marked the final opportunity for presentations to the committee prior to their narrowing down the choices for the manned space program on August 12th. The primary issues at hand were the scientific benefit of manned space endeavors and the potential for European Union participation in the U.S. space program.

Scientists presented the results of a decadal review on their respective fields, focusing on the effect the future manned space program would have on their science. From these decadal reviews it was apparent that the ISS is an important laboratory for microgravity biological research and should be maintained beyond 2016. On the other hand, manned space missions to either LEO or beyond do not greatly enhance research in the fields of Earth, climate science, and astronomy except in cases where increased payload capacity by new manned launchers enables the design of larger space telescopes. The argument was made for both human and robotic exploration of other planets as a necessity to planetary science. The scientific value of human space exploration is proportional to the complexity of the environment to be explored. In this respect, humans on Mars can contribute the most scientific value compared to humans on the moon or any other potential destination within reach. Dr. Robert Zubrin from the Mars Society presented a passionate call for landing a man on the surface of Mars to inspire NASA’s engineers to do their best work and to inspire the country by making history.

The committee also heard presentations by Dr. Jean-Yves Le Gall, CEO of Arianespace, and Mark Kinnersley of EADS Astrium on the capability of the European Union to assist in the U.S. space program. Dr. Le Gall emphasized that the Ariane 5 and the European Automated Transfer Vehicle (ATV) are already suited for ISS cargo resupply missions and will be available for purchase by NASA for that role. There are 46 Ariane 5 vehicles currently in production, and the Ariane 5 has the capability of lifting 20mT to LEO, 7mT to lunar transfer orbit, and 5mT direct to Mars. When asked by the commission whether a heavier lift version of the Ariane is currently in development, Dr. Le Gall stated that while a study had just been started to examine that possibility, the decision to proceed will likely not be made for another two to three years, and the vehicle itself would not be available before the end of the next decade. While the Ariane 5 was originally intended to be man-rated, it is not currently rated as such, and no plans exist for Europe to undergo man-rating the Ariane 5. Mark Kinnersley from EADS Astrium elaborated on the potential for the European ATV. Currently, the ATV is set for production at a rate of 1 per year and the lead time to obtain an ATV is 36 months. If the U.S. would like to make use of the ATV for ISS resupply in 2012, then an order would need to be placed very soon. Kinnersley also mentioned that there are plans to evolve the ATV with a cargo return capability and that studies have been performed which show that a lunar lander version of the ATV could deliver 2mT of useable payload to the lunar surface. The committee stated that for all the options they will present to the president, a strong desire for international cooperation will be included.

At the conclusion of the presentations, the committee identified the seven leading candidates for the future of the U.S. manned space program. Among these plans are the following three primary options:

1. Continuing on the current path of retiring the Space Shuttle after the remainder of manifested flights is completed (which they estimate to most likely occur in 2011) and building Ares I and Ares V to take us back to the moon while ending U.S. support of the ISS in 2016. In order to approach the projected budgets for NASA over the program, the schedule for returning to the moon will be allowed to slip.
2. Employing an ISS-focused option that extends U.S. involvement in the ISS and relies on either the Ares I, international partners, or COTS providers to launch crew
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**Keynote Address**
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Tuesday, December 8, 2009
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<td><strong>Wednesday AM</strong></td>
<td>(3A/B) PSHS IM Technology for Rocket Motors</td>
<td>(3C) APS Hypersonic Flight Experiments</td>
<td>(3D 3F) CS Reactive Materials</td>
<td>(3E) CS Combustion Instability and Combustion Modeling</td>
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<td>(3H) NESC Materials Durability Course</td>
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<td><strong>Wednesday PM</strong></td>
<td>(3J/K) PSHS IM Technology for Bombs and Warheads</td>
<td>(3L) APS Scramjet Technologies</td>
<td>(3M) CS Enhanced Blast II</td>
<td>(3N) CS Aluminum and Thermite Combustion</td>
<td>(3O)</td>
<td>(3P) SEPS Airborne Lead Reduction Workshop I</td>
<td>(3Q) NESC Materials Durability Course</td>
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<td><strong>Thursday AM</strong></td>
<td>(4A) PSHS IM Technology</td>
<td>(4B) CS High-Speed Combustion</td>
<td>(4C) APS Combined-Cycle Propulsion</td>
<td>(4D) CS Enhanced Blast Modeling</td>
<td>(4E) CS Thermal Decomposition and Condensed Phase Kinetics</td>
<td>(4F)</td>
<td>(4G) SEPS Airborne Lead Reduction Workshop I</td>
<td>(4H) NESC Materials Durability Course</td>
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<td><strong>Thursday PM</strong></td>
<td>(4J) PSHS IM Technology</td>
<td>(4K)</td>
<td>(4L) APS Falcon Combined-Cycle Engine Technology</td>
<td>(4M) CS Reactive Materials II</td>
<td>(4N) CS Inertial Gun Primers and Igniters</td>
<td>(4O)</td>
<td>(4P) S&amp;MBS Wireless Sensors II Workshop - II</td>
<td>(4Q) NESC Materials Durability Course</td>
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to LEO. Beyond LEO exploration will be significantly delayed.

3. Retiring the Space Shuttle in 2011, ending involvement in the ISS in 2016, and relying on international partners and COTS providers to launch crew to LEO. By skipping the development of the Ares I and the Altair lander, NASA will be able to focus on the Ares V or another super heavy lift launch vehicle to push the manned space program beyond LEO. The destinations would initially be fly-by missions as no lander will be developed.

Four additional options were presented, which were expected to come in at more than the current budget projection for NASA. While these options (or some variant thereof) may be proposed, Chairman Augustine stated that he does not want to include any options that are dead on arrival. The four increased-budget options all extend U.S. support of the ISS to 2020 and reflect concepts that are similar to the three within-budget options. There also remains the possibility of an EELV-based launch vehicle, as well as an option to skip the moon and go directly to Mars with the potential for a lunar test flight. At the conclusion of the August 5th meeting, Augustine stated that, of all they have learned, one priority for exploration beyond low Earth orbit is the development of a sufficient heavy launch vehicle, and he emphasized, “don’t skimp on the heavy-lift part.”

The options along with their projected budgets and schedules were presented in Washington, D.C., on August 12th. The integrated options were reviewed in a presentation by Ed Crawley. Former Astronaut Sally Ride presented the budget analysis for the seven scenarios. Dr. Ride pointed out multiple times that the U.S. cannot run an exploration program on the current budget. Dr. Ride also mentioned that NASA’s original planning costs for the Constellation program were very accurate, thus implying that budget cuts, not NASA’s estimates, were to blame for the current cost overruns. Among the scenarios presented, the MARS Direct was the only one to have considerably higher costs than the other scenarios. When that option was eliminated, Chairman Augustine stated that Mars is still the most interesting target for exploration, thus all options have to be framed as part of a longer-term effort toward a manned mission to Mars.

It was determined by the committee that retirement of the ISS in 2016 was not going to be acceptable within the international and scientific community, and thus the options presented should reflect extending U.S. involvement in the ISS to 2020. Of all of the options, the panel was most animated about a deep space scenario in which there were various destinations beyond LEO. While the deep space option did not include the budget for lunar landings, it appeared to have the greatest number of possible achievable milestones when given a reasonable budget. The panel determined that they were to provide the options, but not a recommendation onto which heavy lift vehicle variant is the right path to follow. The options were discussed from the perspective of overall program costs and possible milestones to be achieved. The committee proceeded to give a positive, neutral, or negative rating to each option in the categories of Exploration Preparation, Technology Innovation, Science Knowledge, Human Civilization Expansion, Economic Expansion, Public Engagement, Global Partners, Sustainability, Safety Challenge, NASA and Industry Workforce, National Skills, Schedule & Program Risk, and Life Cycle Costs.

The final report was due to the president on August 28th. Presentations and documents are available on NASA’s Web site: http://www.nasa.gov/offices/hsf/related_documents/index.html.

31st International Electric Propulsion Conference (IEPC) to be Held at the University of Michigan

The 31st International Electric Propulsion Conference (IEPC) is scheduled to be held from Sunday, September 20 to Thursday, September 24, 2009 on the campus of the University of Michigan in Ann Arbor.

A conference representing the worldwide electric propulsion and spacecraft community, the IEPC is held every other year, alternating between a United States and a non-United States venue. The IEPC brings together over 300 researchers, developers, managers, and scholars from more than 15 countries. It is the perfect forum to present findings in electric propulsion and provides an unequaled opportunity to learn the latest developments, meet with colleagues, and establish new business contacts.

In September 2009, the IEPC will be held in Michigan for the first time. More than 80 years ago, the University of Michigan offered the first program in aeronautical engineering in the United States, just 11 years after the historic flights at Kitty Hawk. Since then, Michigan has graduated more than 4,000 aeronautical and aerospace engineers. Graduates from Michigan have gone on to distinguished careers in the aerospace industry and other related fields, including positions in government and academia.

In addition to the history that Michigan offers, Ann Arbor possesses a backdrop of fall’s natural beauty rivalled by few other locations. The climate in Ann Arbor is generally temperate during September, and Detroit is just 30 minutes away. For more information about the IEPC, please visit the Web site: http://www.iepc2009.org.
SENSIAC, the Military Sensing Information Analysis Center, is a Department of Defense (DoD) Information Analysis Center (IAC), operated by the Georgia Institute of Technology, under contract to the Defense Technical Information Center (DTIC). IACs are chartered by the DoD to provide support in key technology areas such as sensors, advanced materials, chemical and biological defense, chemical propulsion, information assurance, reliability, software, survivability and vulnerability, and weapons systems.

SENSIAC is one of the newest full-service IACs and is located in the Harry L. Baker Building on the Georgia Tech Campus in Atlanta, Georgia. It replaced IRIA, the Infrared and Information Analysis center, initially founded at the University of Michigan’s Willow Run Laboratories. IRIA operated there—under various contractor organizations—for nearly 50 years until Georgia Tech won the contract in December 2004.

SENSIAC serves government, industry, and educational institutions as a center for acquisition, compilation, analysis, and dissemination of information relevant to military sensing technology (MST). Its objective is to facilitate the use of scientific and technical information for the design, development, testing, evaluation, operation, and maintenance of DoD systems and the industrial/research base which provides and supports such systems.

MST technologies include, but are not limited to, the following:

- Intelligence, surveillance, and reconnaissance (ISR)
- Camouflage, concealment, and deception
- EO/IR and RF countermeasures
- Laser-based systems for sensing and energy projection
- Electronic warfare (EW) and missile defense technologies
- Optical and infrared materials and detectors
- Radar and passive RF Systems and related technologies
- Passive optical, electro-optical, UV, and infrared sensors and seekers and their supporting technologies
- Sensor and data fusion
- Signal and communications sensing
- Underwater acoustics
- X ray, chemical, and other sensing for homeland defense
- Acoustic, seismic, magnetic, electric field and gravitational sensors, and related technologies

SENSIAC’s MST knowledge base consists of basic and refined information. As a value-added center, SENSIAIC is charged with anticipating information needs of the community and synthesizing information products to satisfy those needs. Digitization and electronic migration of SENSIAIC’s library of over 60,000 documents continues today to ensure rapid access to pertinent information. SENSIAIC also maintains an extensive network of subject matter experts (SMEs) covering the MST field and continues to add SMEs to fill knowledge gaps.

SENSIAIC’s information products and services include on-call problem solving, automated alerts, knowledge-based products, and the Sensing Horizons quarterly newsletter. SENSIAIC distributes numerous databases and models, including the well-known NVThermIP infrared sensor model, as well as various state-of-the-art reports (SOARs) and technical handbooks.

SENSIAIC’s products and services include research, analysis, development, prototyping, training, consulting, T&E, and direct support activities through Technical Areas Tasks (TATs). SENSIAIC can support the military sensing needs of government, academic, and private sector organizations involved in national defense and homeland security initiatives through the TAT process.

The SENSIAIC Educational Program (SEP) provides continuing education and training designed to fill the workforce gap caused by the loss of skilled professionals from the defense sector. Expert instructors from SENSIAIC’s multi-university team cover all aspects of military sensing. The SEP is constantly evolving to reflect the needs and trends of the MST community.

Individual and certificate programs are available in focused technology areas such as Infrared and Electro-Optical, Radar, Electronic Warfare, Sensors and Data Fusion, Modeling and Simulation, and Airborne/Space, just to name a few. Basic certificate programs also require course completion in related technology areas, reflecting the increased emphasis on integrated sensor approaches required to solve today’s complex sensing problems and to prepare for tomorrow’s challenges.

SENSIAIC conducts the meetings for the eleven specialty groups of the Military Sensing Symposia (MSS). These annual meetings, which began in 1956, enable government, academic, and industry experts to gather and exchange information about classified projects in a protected environment. Proceedings of the meetings are generated, archived, and distributed to eligible recipients. The MSS proceedings provide the most comprehensive record of MST advances at a classified level.

To find out more about the Military Sensing Information Analysis Center, visit SENSIAIC’s web-site at [www.sensiac.gatech.edu](http://www.sensiac.gatech.edu) or contact SENSIAIC by telephone at 404/407-SENS (7367) or send e-mail to [sensiac@gtri.gatech.edu](mailto:sensiac@gtri.gatech.edu).
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Spacecraft Chemical Propulsion Database (SCPD) Makes Its Debut
By David B. Owen II, CPIAC Research Scientist

CPIAC is pleased to announce the online release of the Spacecraft Chemical Propulsion Database (SCPD) within the Chemical Propulsion Information Network (CPIN).

The goal of this database project is to capture historical satellite chemical propulsion data that are of interest for a variety of uses including, but not limited to, investigating design precedents, anchoring mass estimates and design approaches for concept and trade system studies, comparing propulsion system architectures and schematics, examining precedents and best practices, and understanding lessons learned. A fundamental objective of SCPD is to capture propulsion-specific design and operational knowledge that is too frequently lost. The searchable database is currently limited to U.S. spacecraft with one or more chemical, liquid, or gas propulsion systems.

By capturing the spacecraft propulsion system information in a database format, the material is presentable to the propulsion community through a useful, accessible, and secure method. SCPD contains data tables displayed in a tabular Web interface, bibliographic references, and design documentation on a variety of spacecraft propulsion systems. Table 1 shows a synopsis of the six sub tabs under the database’s browse function and the data content contained in each.

Rich text format reports can be generated on demand, providing the researcher with the data in a useful format for printing and copying into trade study tables, mass estimates, and design reports. Figure 1 displays the general data tab in SCPD.

SCPD was made possible through the cooperation of various JANNAF-participating organizations. CPIAC produced the SCPD database structure based on information from the JANNAF Spacecraft Propulsion Subcommittee’s (SPS) Chemical Propulsion Panel. NASA Marshall Space Flight Center (MSFC) contributed funds, data, data review, and additional support to the project. MSFC’s data collection was assisted by the University of Alabama at Huntsville. NASA Goddards Space Flight Center (GSFC) contributed data, data review, and additional support to the project. The Defense Technical Information Center (DTIC) provided additional funding for CPIAC involvement. The Johns Hopkins University Applied Physics Laboratory (JHU/APL) provided data input from its systems. The MSFC/GSFC/APL team assisted CPIAC in providing input to the data fields and requirements for the database throughout the project. NASA Jet Propulsion Laboratory (JPL) recently joined the team to provide data input. Various other organizations participating in the JANNAF SPS Chemical Propulsion Panel also provided support and data for SCPD.

SCPD is an ongoing database project that continues to grow. Currently, the database consists of spacecraft that were mostly government-funded projects. These spacecraft cover a wide variety of mission profiles, including Earth-orbiting scientific satellites, interplanetary spacecraft, upper stage systems, interplanetary Landers, transfer vehicles, and even human-rated spacecraft. As the collaborative effort continues, the propulsion systems of satellites used for telecommunication, defense, and other industry, university, and government applications are expected to be added. Most of the spacecraft in SCPD have already flown, but the database may contain data for fully integrated and tested systems that have not yet flown. Organizations wishing to participate in the expansion of the SCPD data set should contact David Owen at 443-718-5006, or dowen@cpiac.jhu.edu. A year subscription to SCPD can be purchased for only $650.00. For further information on how to gain access to SCPD, please contact CPIAC Customer Service at 410-992-7300, ext. 211 or 212.
Propulsion in the News

AFOSR and NASA Launch First-Ever Test Rocket Fueled by Environmentally-Friendly, Safe Aluminum-Ice Propellant


The Air Force Office of Scientific Research (AFOSR) and NASA recently announced the launch of an environmentally-friendly, safe propellant comprised of aluminum powder and water ice (ALICE). “By funding this collaborative research with NASA, Purdue and The Pennsylvania State University, AFOSR continues to promote basic research breakthroughs for the future of the Air Force,” said Dr. Brendan Godfrey, director, AFOSR. Earlier this month, the collaborative team, Drs. Steven F. Son and Tim Pourpoint of Purdue, Rich Yetter and Grant Risha of Penn State, Vigor Yang of Georgia Tech, Harold Bell and Frank Bauer of NASA, and Mitat Birkan and Thomas Russell of AFOSR watched as the rocket soared high into the sky, to 1300 feet near Purdue University. Son said the success of the flight can be attributed to “a sustained collaborative research effort on the fundamentals of the combustion of nanoscale aluminum and water over the last few years.”


Welcome, Bruce Dennett
CPIAC IT Manager

CPIAC would like to welcome its newest staff member, Bruce Dennett. Bruce is CPIAC’s IT Manager and will be overseeing Information Systems (IS) and the IS staff. At JANNAF meetings, you will see Bruce in the IT room, beside other staff members, offering technical support for presentations.

Before joining CPIAC in August, Bruce spent ten and a half years as the Director of Computer Network Services at The Johns Hopkins School of Nursing. Bruce holds a bachelor of science degree in Information Systems Management from the University of Maryland, Baltimore County. He also has certifications in System Engineering from Novell and Microsoft.

Bruce can be reached at 443-718-5003 or by e-mail to bdennett@cpiac.jhu.edu. We hope that many of you have the opportunity to meet him soon.

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Send updated contact information to updateinfo@cpiac.jhu.edu
Aero Optics, Inc. is an engineering research and development company with broad experience in optical-signature modeling and simulation, measurements and analysis, and systems and software for the U.S. Department of Defense and associated prime contractors. AOI principal scientists share long associations with the development and application of JANNAF-standard rocket engine/plume flow codes and plume/atmosphere radiation codes for the Army and Air Force on behalf of the Missile Defense Agency (MDA). Recent work funded by MDA SBIR has focused on the development of an advanced plume signature simulation tool that consolidates and extends the legacy-code technology through generalized unified multi-physics models contained in modern computation software applicable to all flow regions and flight regimes. This work was accomplished at AOI under two coordinated MDA SBIR Phase II projects for plume flow and radiation managed by the Space and Missile Development Center (SMDC) and Arnold Engineering Development Center (AEDC). The technology/software products of this work are being combined and transitioned at AOI under a current MDA SBIR Phase II Transition project managed by Mr. Stan Smith of SMDC.

The integrated multi-physics technology (Fig. 1) spans all regions (low/high altitude, near/far field) and regimes (equilibrium/kinetic relaxation, continuum/rarefied transport) to enable continuous seamless transition from region-to-region and regime-to-regime using a single unified physical model and computation method. A key enabling element is a natural-coordinate flow computation grid with physics-adaptive resolution that is coupled to a conservative finite-element formulation for conservation and transport. Chemical/internal/phase/radiative nonequilibrium are coupled through relaxation. Turbulent/laminar/rarefied exchange are bridged through transport. Radiative spectra incorporate nonequilibrium molecular line statistics and exact hot-through-cold path integration.

This advanced technology constitutes a natural evolution in plume phenomenology from early specialized research/diagnostic tools (subsequently incorporated in standard codes) toward modern unified simulation/analysis tools. The new tool incorporates important lessons learned from the legacy standard plume codes with notable improvements that include coupled first-principles physical models that account for nonequilibrium/noncontinuum effects to enable continuous/seamless application throughout the boost/post-boost phases. The parallel goals of generalization and unification were achieved simultaneously with the dual benefits of simplification and rigor. A single unified flow tool treats the engine-plume-trail regions and the afterburning-trough-enhancement regimes. A single unified radiation tool treats the core-interaction-atmosphere regions and the equilibrium-kinetic-rarefied regimes. The combined flow/radiation tool consolidates the collisional/radiative relaxation kinetics for all regions and regimes.

A well-known limitation of the legacy standard plume codes is the gap between computations for lower altitudes

![Figure 1. Integrated Multi-Physics Signature Simulation Technology.](image-url)

![Figure 2. Flow/Radiation Multi-Physics.](image-url)
Plume Signature Tool...continued from page 16

(afterburning rolloff) and higher altitudes (enhancement onset) that results from regime-specific restrictions in each code that preclude smooth transition at handover. Without such restrictions, the new unified technology enables continuous simulations of the progressive transition through the trough region (Fig. 3) in which the inner/trail regions become dimmer while the outer/nose regions become brighter.

A lesser-known limitation of legacy standard radiation band models is the restriction to a common temperature for all molecular energy modes (as for equilibrium). Reprocessing of the line strength/frequency statistics (Fig. 4) enables the determination of separate band parameters (including curve-of-growth) for each energy mode. These parameters are combined with mode-specific temperatures (from molecular kinetics) to determine the nonequilibrium spectral radiance.

The new simulation/analysis tool is being used to support pre-flight planning and post-flight analysis of MDA flight experiments. Those data include multi-band imagery for targets of interest throughout the entire boost phase: afterburning rolloff, trough plateau, enhancement onset, extended plume, and near-vacuum. A single unified seamless simulation tool applicable to and anchored by this broad range of engagement conditions adds confidence in the fidelity (and convenience in the generation) of boost-phase plume-signature simulations for BMDS.

The current MDA SBIR Phase II Transition project encompasses three major tasks: (1) extension-maturation (models), (2) validation-closure (measurements), and (3) software-support (users). Task 1 includes model enhancements, refinements, and experiments to extend and test the functionality and fidelity of each component. Task 2 includes data analysis, interpretation, and reconciliation to obtain definitive traceable closure for diverse conditions within quantitative uncertainty limits. Task 3 includes code optimization, automation, and collaboration to enhance code utility and exploit user feedback during the transition period.

The transition period extends through December 2010. Interested qualified organizations are invited to participate in the ongoing technology/software transition process. For information about joining this process or questions about the technology described in this article, please contact primary author Dr. G.N. Freeman at 310-541-1933 or by e-mail to gnf@aero-optics.com.

Figure 3. Trough Region Plume Temperature Evolution:100 klb (altitude=km; image=m)

Figure 4. H2O Mode-Specific Line/Band Spectra (1200K, 5cm⁻¹.)

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For guidelines on preparing an article for publication, visit http://www.cpia.jhu.edu/media/cpia_guidelines_for_sbir_technical_articlesaug09.pdf. For additional information, contact Editor Rosemary Dodds at 410-992-7303, ext. 219, or by e-mail to rdodds@jhu.edu.
On July 15, 2009, the U.S. Senate confirmed Charles Frank Bolden, Jr. as the new administrator of NASA. Lori Beth Garver was confirmed as NASA’s deputy administrator. While Bolden is the twelfth administrator to lead NASA since its inception in 1958, he is only the second astronaut, and the first African American, to hold the agency’s top spot. As administrator, Bolden will lead the entire NASA team and manage its resources to advance the agency’s mission and goals.

On his confirmation Bolden said, “It is an honor to have been nominated by President Obama and confirmed by the Senate to lead this great NASA team. Today we have to choose. Either we can invest in building on our hard-earned world technological leadership or we can abandon this commitment, ceding it to other nations who are working diligently to push the frontiers of space.”

“If we choose to lead, we must build our investment in the International Space Station, accelerate development of our next generation launch systems to enable expansion of human exploration, enhance NASA’s capability to study Earth’s environment, lead space science to new achievements, continue cutting-edge aeronautics research, support the innovation of American entrepreneurs, and inspire a rising generation of boys and girls to seek careers in science, technology, engineering, and math.”

Bolden’s confirmation marks a return to NASA for the 62-year-old retired Marine Corps major general who spent 14 of his 34 years with the Corps as a member of NASA’s Astronaut Office. He traveled to orbit four times aboard the space shuttle between 1986 and 1994, commanding two of the missions. Bolden’s flights included the deployment of the Hubble Space Telescope and the first joint U.S.-Russian shuttle mission, which featured a cosmonaut as a member of his crew. During his time at NASA, Bolden also served as assistant deputy administrator, Astronaut Office safety officer, technical assistant to the director of Flight Crew Operations, special assistant to the director of the Johnson Space Center (JSC), chief of the Safety Division at JSC, and lead astronaut for vehicle test and checkout at the Kennedy Space Center.

Bolden retired from the Marine Corps in 2003. He then joined JackandPanther LLC, a military and aerospace consulting firm, where he held the position of Chief Executive Officer up until the time of his NASA nomination. A resident of Houston, Bolden received a bachelor of science degree in electrical science from the U.S. Naval Academy, a master of science in systems management from the University of Southern California. In addition, he is a graduate of the U.S. Naval Test Pilot School at Patuxent River, Maryland.

As deputy administrator, Garver, too, will be returning for a second stint at NASA. From 1996 to 2001, Garver served initially as a special assistant to the NASA administrator and senior policy analyst for the Office of Policy and Plans and then as the associate administrator for the Office of Policy and Plans. From 2001 until her NASA nomination as deputy administrator, Garver worked as a full-time consultant as the president of Capital Space, LLC, and senior advisor for space at the Avascent Group.

Garver commented on her new role at the space agency: “I am very excited about the opportunity to serve under Charlie Bolden’s leadership. My previous five years at NASA exposed me to the incredible talent of the workforce there. The unbelievable achievements of this team over its 50-year history are unmatched. I look forward to working with Charlie and the NASA team to make our agency work as effectively as it can for the American people.”

In her new position, Garver will be NASA’s second in command, responsible to the administrator for providing overall leadership, planning, and policy direction for the agency. A 1983 graduate of Colorado College, Garver earned a bachelor’s degree in political science and economics. Her career in the space industry began when...
Zachary J. Lemnios was confirmed as the new Director of Defense for Research and Engineering (DDR&E) on June 19, 2009. As DDR&E, Lemnios will serve as the principal staff advisor to the Under Secretary of Defense (AT&L) and to the Secretary and Deputy Secretary of Defense for research and engineering matters. The DDR&E is also the Chief Technology Officer for the Department of Defense.

Before his DoD appointment, Lemnios was Chief Technology Officer at MIT Lincoln Laboratory, where he was responsible for coordinating technology strategy for the entire Laboratory. His strategic efforts included working with the MIT Campus to develop and leverage research projects in support of defense and related activities and developing strategic external relationships to support current and future Laboratory missions.

From 2003 to 2005, Lemnios was Director of the Defense Advanced Research Projects Agency (DARPA) Microsystems Technology Office, and from April 2002 until July 2003, he served as Deputy Director of the Information Processing Technology Office.

Within industry, Lemnios has held various positions at Hughes Aircraft Company, Westinghouse Electric Corporation, and Ford Microelectronics, Inc. He has served on numerous DoD, industry, and academic committees.

Lemnios holds a bachelor of science degree in electrical engineering from the University of Michigan and a masters in electrical engineering from Washington University in St. Louis. He attended the Harvard Kennedy School of Government Program for Senior Executives in National and International Security. He is also a Senior Member of the IEEE, has authored over 40 papers, holds 4 patents, and has been awarded the Office of the Secretary of Defense Medal for Exceptional Public Service.

As the new DDR&E, Lemnios’s responsibilities will include supporting research initiatives with the intention of further extending the mission of Defense Research & Engineering by ensuring that current and future warfighters have the best technology to support their missions and giving them revolutionary capabilities to win the war.

**Bolden…continued from page 18**

she accepted a job working for Sen. John Glenn from 1983 to 1984. Since then, she has held a variety of senior positions in nonprofit, government, and commercial organizations.

Bolden and Carver made their first staff appearance before agency employees at Washington headquarters on July 21st.

This article includes excerpts from NASA press release 09-165, dated 7/15/09.
Calendar of JANNAF Meetings

JANNAF 43rd Combustion Subcommittee (CS)/
31st Airbreathing Propulsion Subcommittee (APS)/
25th Propulsion Systems Hazards Subcommittee (PSHS) Joint Meeting
December 7-11, 2009
Hyatt Regency La Jolla at Aventine; La Jolla, CA
www.lajolla.hyatt.com

Deadlines:
Manuscripts and paper clearance forms to CPIAC: 11/2/09
Hotel Reservations: 11/6/09
Security clearance certification and Registration Fees to CPIAC: 11/23/09
Presentations to CPIAC: 11/23/09

57th JANNAF Propulsion Meeting (JPM)/
7th Modeling and Simulation Subcommittee(MSS)/
5th Liquid Propulsion Subcommittee (LPS) /
4th Spacecraft Propulsion Subcommittee (SPS) Joint Meeting
May 3-7, 2010
Cheyenne Mountain Resort; Colorado Springs, CO
www.cheyennemountain.com

Abstracts deadline: November 16, 2009

For additional information on the above JANNAF meetings, contact CPIAC
Meeting Planner Pat Szybist at 410-992-7302, ext. 215, or by e-mail to pats@jhu.edu
Visit the JANNAF Web site for meeting updates: www.jannaf.org

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