CPIAC BULLETIN
Chemical Propulsion Information Analysis Center
A DoD Information Analysis Center
Sponsored by JANNAF and DTIC
Vol. 34, No. 6 | News and Information for the Greater Propulsion Community | November 2008

Liquid Propellants and Fuels Database: A Single Source for Rocket Propellant and Airbreathing Fuel Properties

By Nick Keim, CPIAC Staff Engineer

The database formerly known as the Liquid Propellants Database (LPD) has been greatly overhauled in the past months, giving rise to a new tool for the Propulsion Community: the Liquid Propellants and Fuels Database (LPFD). While the name has changed, the basic principle has not; LPFD exists to provide a single location for the compilation of information on liquid rocket oxidizers, rocket fuels, and monopropellants. In addition, the database now includes airbreathing fuels for scramjet/ramjet and turbine applications. CPIAC has worked with the Defense Energy Support Center (DESC) Aerospace Energy Business Unit, the Air Force Research Laboratory (AFRL), and the National Institute of Standards and Technology (NIST) to gather the most up-to-date information and provide the best tools for the industry.

REFPROP Equations of State

Many individuals in our community are already aware of the work that NIST does in testing and characterizing industrial fluids, ultimately producing high accuracy Helmholtz energy equations of state for each and packaging these equations as part of the NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP). REFPROP allows users to generate data at user-specified state points, graphically or in tabular form. With cooperation from NIST, this functionality has been implemented for the following LPFD fluids through CPIAC's Web interface: ammonia, fluorine, hydrogen, methane, propane, oxygen, and nitrogen trifluoride.

continued on page 4

JANNAF MSS/LPS/SPS to Convene in Orlando December 8 - 12, 2008

The meeting invitation and preliminary program for the Joint Army-Navy-NASA-Air Force (JANNAF) 6th Modeling and Simulation/4th Liquid Propulsion/3rd Spacecraft Propulsion Joint Subcommittee Meeting have been distributed. This meeting will be held Monday through Friday, December 8-12, 2008, at the Hilton Walt Disney World (WDW) in Orlando, Florida. Dr. James M. Haas, Air Force Research Laboratory, Edwards AFB, California, will chair this year's meeting. Attendance 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.

Keynote Speaker
Mr. Richard S. Matlock

Mr. Richard S. Matlock, Program Director for the Ballistic Missile Defense System (BMDS) Kill Vehicles program, will deliver the Keynote Address.

continued on page 6

Inside This Issue

CPIAC's Technical/Bibliographic Inquiry Service

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

- Preferred techniques for quantitative analysis of the traces of sodium and potassium that can occur in ammonium perchlorate. (Req. 26113)
- Effects of porosity on Burning Rate for NC-based composite propellants. (Req. 26111)
- Influence of droplet particle size on combustion characteristics and efficiencies of liquid fuel burning. (Req. 26158)
- Physical properties of MON-25 and papers on engine development with MON. (Req. 26166)
- Survey of solid propellant mixer capability in the United States, circa 1997. (Req. 26180)

BIBLIOGRAPHIC INQUIRIES

- Effect of spin-rate on end-burning rocket motors or flares. (Req. 26197)
- Rocket engine health monitoring by spectroscopic measurement of plume metallic species. (Req. 26228)
- Assembly of JANNAF papers on X-43A technology into single publication. (Req. 23920)
- RCS fluid system designs for manned systems. (Req. 26236)

Recent CPIAC Products and Publications

Liquid Propellants and Fuels Database (LPFD), November 2008.

Let us know....

if you've moved or if your contact information has changed.

Send your current e-mail address to update@cpiac.jhu.edu.

The Chemical Propulsion Information Analysis Center (CPIAC), a DoD Information Analysis Center, is sponsored and administratively managed by the Defense Technical Information Center (DTIC). CPIAC is responsible for the acquisition, compilation, analysis, and dissemination of information and data relevant to chemical, electric, and nuclear propulsion technology. In addition, CPIAC provides technical and administrative support to the Joint Army-Navy-NASA-Air Force (JANNAF) Interagency Propulsion Committee. The purpose of JANNAF is to solve propulsion problems, affect coordination of technical programs, and promote an exchange of technical information in the areas of missile, space, and gun propulsion technology. A fee commensurate with CPIAC products and services is charged to subscribers, who must meet security and need-to-know requirements.

The *Bulletin* is published bimonthly and is available free of charge to the propulsion community. Reproduction of *Bulletin* articles is permissible, with attribution. Neither the U.S. Government, CPIAC, nor any person acting on their behalf, assumes any liability resulting from the use or publication of the information contained in this document, or warrants that such use or publication of the information contained in this document will be free from privately owned rights. The content of the *Bulletin* is approved for public release, and distribution is unlimited.

Paid commercial advertisements published in the *Bulletin* do not represent any endorsement by CPIAC.

Editor: Rosemary Dodds
410-992-1905, ext. 219; Fax 410-730-4969
E-mail: rdodds@jhu.edu

The Johns Hopkins University/CPIAC
10630 Little Patuxent Parkway, Suite 202
Columbia, Maryland 21044-3286
CPIAC Director: Dr. Edmund K. S. Liu

CPIAC is a JANNAF- and DTIC-sponsored DOD Information Analysis Center operated by The Johns Hopkins University Whiting School of Engineering under contract W91QUZ-05-D-0003
http://www.cpiac.jhu.edu

Meeting Reminders

56th JANNAF Propulsion Meeting and 39th Structures and Mechanical Behavior/ 35th Propellant and Explosives Development and Characterization/ 26th Rocket Nozzle Technology/ 24th Safety and Environmental Protection/ 17th Nondestructive Evaluation Joint Subcommittee Meeting

April 14-17, 2009
Las Vegas, Nevada

Abstract Deadline:
November 3, 2008

The Meeting Announcement and Call for Papers have been distributed. For additional information, contact JANNAF Meeting Planner Pat Szybist at 410-992-7302, ext. 215, or by e-mail to pats@jhu.edu.

Visit www.jannaf.org for updates.

The *Bulletin* Board

Various meetings and events of interest are listed below. We welcome all such announcements, so that the propulsion community can be better served with timely information. For information on additional industry meetings, visit the CPIAC calendar of ***Meetings & Symposia*** available at http://www.cpia.jhu.edu/templates/cpiacTemplate/meetings/. The JANNAF Calendar appears on the back page.

AIAA Missile Sciences Conference
18-20 November 2008
Monterey, CA
POC: www.aiaa.org

Airbag 2008
1-3 December 2008
Karlsruhe, Germany
POC: www.ict.fraunhofer.de

47th AIAA Aerospace Sciences Meeting
5-8 January 2009
Orlando, FL
POC: www.aiaa.org/events/asm

33rd Annual Conference on Composites, Materials, and Structures
26-29 January 2009
Cocoa Beach, FL
POC: www.advancedceramics.org

35th Annual ISEE Conference
8-11 February 2009
Denver, CO
POC: www.isee.org

11th International Symposium on Fireworks
20-24 April 2009
Puerto Vallarta, Mexico
POC: www.isfireworks.com

2009 Insensitive Munitions and Energetic Materials Technology Symposium
11-14 May 2009
Tucson, Arizona
POC: www.ndia.org

40th ICT Annual Conference
23-26 June 2009
Karlsruhe, Germany
POC: www.ict.fhg.de

8th International Symposium on Special Topics in Chemical Propulsion
2-6 November 2009
Cape Town, South Africa
POC: http://www.8-isicp.org.za

LPFD....*continued from page 1*

In addition to the propellants mentioned, AFRL staff at both Wright-Patterson AFB and Edwards AFB have been working with NIST to perform the same characterization treatment to S-8 (a sulfur-free Fisher-Tropsch fuel to replace/blend with JP-8), as well as to RP-1 and RP-2 kerosene rocket propellants. As of this writing, S-8 and RP-1 have been fully characterized, while RP-2 is undergoing testing at NIST's laboratories in Boulder, Colorado. Once these tests are completed, S-8, RP-1 and RP-2 will be added to a new version of REFPROP, which will subsequently be made available online to users of LPFD.

This implementation of REFPROP capabilities could not have come at a more opportune moment than at the JANNAF Combustion Subcommittee (CS) and Airbreathing Propulsion Subcommittee (APS) Joint Meeting in May 2008. During a CS/APS panel and town meeting (CS Fuel Properties and Kinetics Panel/Liquids Town Meeting/APS Liquid Fuels Panel Meeting), Richard Wills from Wright-Patterson AFB, on behalf of Tim Edwards, gave a presentation on REFPROP's capabilities and asked the community to suggest additional fuels for characterization and inclusion in REFPROP. REFPROP is increasingly becoming a de facto industry standard; adding more fuels and propellants that are of interest to the Community will only increase its usefulness and effectiveness.

Airbreathing Fuels

In addition to the REFPROP capabilities that LPFD offers, the database now includes all of the airbreathing fuels presented in the unclassified CPIA/M6 *Airbreathing Propulsion Manual*, i.e., RJ-4, RJ-5, RJ-6, JP-4, JP-5, JP-7, JP-8, JP-9, JP-10, Methylcyclohexane, Decalin, and the Russian fuels T-6 and T-15. The original scanned M6 units are available for these fuels through LPFD, as well as new information on materials compatibility, hazards and safety. As with the liquid propellants, any of the airbreathing fuels which are characterized by NIST for inclusion in REFPROP will subsequently have REFPROP capabilities implemented through LPFD. Figure 1 shows a screen shot of a Search for propellants and fuels in LPFD.

The combination of airbreathing fuels and liquid rocket propellants into a single reference makes sense: with the supplies of JP-7 for hypersonic applications limited, a replacement must be found, whether that fuel is traditionally thought of as a rocket propellant or a fuel is irrelevant to performance characteristics. In addition to replacing JP-7 for current applications, new applications such as rocket- or turbine-based combined cycles are on the horizon. A single fuel would greatly simplify the design of these systems, and a single database greatly reduces the effort required to obtain information on potential fuels.

New Features

Materials compatibility as well as hazards and safety information have also been focused on during this upgrade cycle of LPFD. Information previously accessible in the bulk electronic formats of M4/M6 units have been brought to the forefront in the online interface, including hazards and compatibility information not previously compiled either in LPD or in the printed editions of the manuals. Wherever possible, information on Threshold Limit Value (TLV), toxicity, Department of Transportation (DOT) and National Fire Protection Association (NFPA) classifications, and First Aid has been collected, including in most cases the Material Safety Datasheet (MSDS). For materials compatibility, the information is presented for metals and non-metals; the inclusion of compatibility information for the airbreathing fuels is entirely new and is not previously

continued on page 5

52 Records Found
(52 Selected)

Select All
Unselect All

To refine search, click **Search** and modify search criteria
For more detail on search results, click **Browse**

<< < [1-10 of 52 Found] > >>

Filter List

Save your selections when finished.

Save Selected

#		Propellant	CAS Registry No.	CPIAC Unit No.	Type	Empirical Formula	View	Print
1	☑	Aerozine-50		M4 No. 7	Liquid Rocket Fuels	$C_{0.6956}H_{5.3911}N_{2.0}$	View	Print
2	☑	AF-M315E		M4 No. 37	Liquid Monopropellants		View	Print
3	☑	Ammonia	7664-41-7	M4 No. 15	Liquid Rocket Fuels	NH_3	View	Print
4	☑	Bromine Pentaflouride	7789-30-2	M4 No. 9	Liquid Rocket Oxidizers	BrF_5	View	Print
5	☑	Chlorine Pentafluoride	13637-63-3	M4 No. 21	Liquid Rocket Oxidizers	ClF_5	View	Print
6	☑	Chlorine Trifluoride	7790-91-2	M4 No. 3	Liquid Rocket Oxidizers	ClF_3	View	Print
7	☑	Decalin	91-17-8	M6 No. 10	Airbreathing Fuels	$C_{10}H_{18}$	View	Print
8	☑	Fluorine	7782-41-4	M4 No. 14	Liquid Rocket Oxidizers	F_2	View	Print
9	☑	Halox 20		M4 No. 25	Liquid Rocket Oxidizers		View	Print
10	☑	Hydrazine	302-01-2	M4 No. 2	Liquid Monopropellants	N_2H_4	View	Print

Figure 1. Screen shot of Search that found 52 records for propellants and fuels in LPFD.

LPFD....continued from page 4

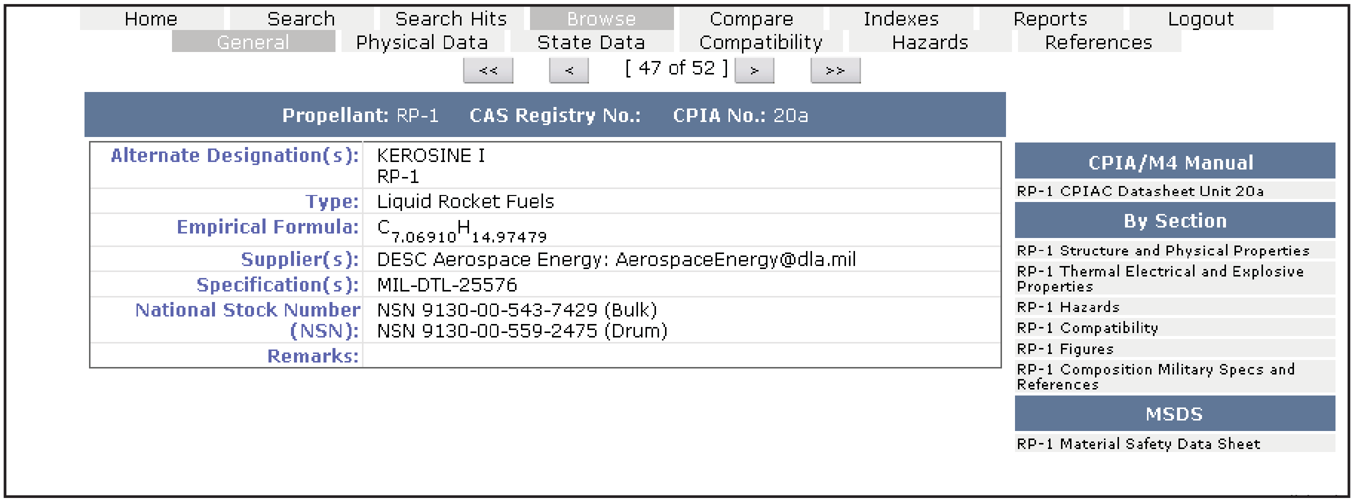


Figure 2. Starting tab for propellant and fuel properties.

available in the CPIA/M6 *Airbreathing Manual*. Figure 2 shows the starting tab for propellant and fuel properties.

The last feature implemented for LPFD is the inclusion of the reference list and corresponding abstracts, if available, including references for any new information in LPFD not available in the paper manuals. Links to scanned PDF files of handbooks, such as the *Battelle Liquid Propellants Handbook* and the U.S. Air Force *Propellant Handbook*, supplement the information available online and contained within the scanned M4/M6 units.

The creation of LPFD would not have been possible without the guidance of CPIAC Senior Staff Engineer Ron Bates and the technical efforts of Eric Lemmon and Peter Linstrom at NIST Boulder and Gaithersburg (Maryland), respectively, and the support of Charlene Smoot at DESC.

Users of LPD will have automatic access to LPFD. A Chemical Propulsion Information Network (CPIN) account is required for access. CPIN is the secure Internet portal to CPIAC's suite of chemical propulsion-related technical and bibliographic databases, online publications, and searchable JANNAF papers.

Information on how to obtain a CPIN account is available by calling CPIAC Customer Service at 410-992-7300, ext. 212.

The Technical Steering Groups of the various JANNAF subcommittees select the best papers presented at their meetings, in order to increase public recognition of the exceptional work accomplished by JANNAF participants. Specific titles of papers are not published due to possible sensitivity. The following subcommittee is featured in this issue of the Bulletin.

24th Propulsion Systems Hazards Subcommittee, May 2008 Meeting

Topics	Authors of Best-in-Session Papers
Thermal Decomposition and Cookoff, Testing	M. A. Cooper, W. W. Erikson, D. Sandoval, and M. J. Kaneshige, Sandia National Laboratories, Albuquerque, NM
Thermal Decomposition and Cookoff, Modeling	S. Jackson, L. G. Hill, L. L. Davis, and J. S. Morris, Los Alamos National Laboratory, Los Alamos, NM
Impact/Shock-Induced Reactions, Overview	J. J. Starkenberg, S. Kukuck, and W. Lawrence, Army Research Laboratory, Aberdeen Proving Ground, MD; D. E. Kooker, American Systems Corporation, Chesapeake, VA
Impact/Shock-Induced Reactions, Modeling	S. Kukuck, A. Birk, and R. Benjamin, Army Research Laboratory, Aberdeen Proving Ground, MD; V. Boyle, Dynamic Sciences Incorporated, Aberdeen Proving Ground, MD
Insensitive Munitions Sub-Scale Testing	D. W. Richards, E. Hottle, J. A. Harris, and T. R. Krawietz, Air Force Research Laboratory, Eglin AFB, FL
Reduced-Sensitivity Propellant Formulations	M. H. Mason, K. Hall, M. B. Celestine, A. Daniels, S. L. Mason, D. J. Irvin, L. C. Baldwin, S. Hawkins, and Q. T. Lightbourn, Naval Air Warfare Center Weapons Division, China Lake, CA
Safety/Hazard Classification	W. B. Thomas, Applied Propulsion Technology, Huntsville, AL; R. Nance, Corvid Technologies, Mooresville, NC; P. S. Vittitow, Space and Missile Defense Command, Huntsville, AL

Best Overall Paper: Christine M. Michienzi, Christine Knott, and Steven Dunham, Naval Surface Warfare Center, Indian Head, MD (Gun Propellant Vulnerability)

JANNAF Meeting in December....continued from page 1

The Kill Vehicles program is leading the transformation of the Nation's mid-course missile defense weapons systems.

Mr. Matlock's broad-based 32-year career in government service includes major acquisition and scientific positions with the U. S. Navy, the Ballistic Missile Defense Organization, the Strategic Defense Initiative Organization and the U.S. Air Force. During his tenure with Naval Sea Systems Command, he was the Program Manager for the Department of Defense's U.S./Japan Cooperative Ballistic Missile Defense Research Project. He led the development and implementation of this joint missile defense research program with the Japan Defense Agency. Prior to employment with the Navy, he was Program Manager for Interceptor Technology Integration in the Ballistic Missile Defense Organization (BMDO). Mr. Matlock developed the Lightweight ExoAtmospheric Projective (LEAP), a primary building block for the nation's missile defense programs. As Program Manager for the BMDO/Navy Terrier LEAP Technology Demonstration Program, he established the experimental pathfinder for the Aegis Ballistic Missile Defense Program. He also built, launched and operated several Earth-observing satellites, proving the value of micro-satellites for complex missile defense and space control missions. Prior to his appointment to the Senior Executive Service in 2003, he proved the ability to use Overhead Non-Imaging Infrared satellites to guide an interceptor for destruction of enemy ballistic missiles in the boost phase. These tests lay the foundation for the Kinetic Energy Interceptor acquisition program. Mr. Matlock also conceived and developed the Near Field InfraRed Experiments or NFIRE spacecraft for demonstrating kinetic kill of ICBMs from a space-based platform.

This year's program consists of forty-three technical sessions, three working groups, a specialist session, and numerous panel meetings. A full day will be dedicated to a legacy session on how Integrated Health Management could have prevented real-life propulsion failures; and three workshops will be held on the following topics: "A Modeling and Simulation Credibility Guide," Development of a Health Management Business Case," and "Health Management Sensors." A preliminary block diagram of the meeting is included on page 14.

The Hilton Walt Disney World is located directly across the street from Downtown Disney. Complimentary shuttles run from the hotel parking lot to all of the Disney Theme Parks.

Poolside at the Hilton Walt Disney World.

Disney World offers Convention Delegate tickets for JANNAF meeting attendees. After-2pm and after-4pm tickets are available for purchase on the Web at http://www.disneyconventionear.com/jhu. Attendees staying at the Hilton WDW may take advantage of extended park hours. Each day one of the Disney Theme parks opens an hour early or stays open up to an extra three hours. Once inside the parks, guests of the Hilton may present their room key and receive a wristband in order to enjoy extra time in the parks. In addition, the JANNAF room rates will be honored three days prior and three days post-meeting subject to availability.

For a copy of this invitation and program, contact CPIAC Meeting Planner Patricia Szybist at 410-992-7302, ext. 215, or by e-mail to pats@jhu.edu.

JANNAF Journal of Propulsion and Energetics
~ Volume 3 ~
Call for Papers

A limited-distribution technical journal
dedicated to the publication of scholarly work in the fields of aerospace propulsion and energetic materials research and development.

***Volume 2** of the JANNAF Journal is scheduled for release at the JANNAF Propulsion Meeting and Joint Subcommittee Meeting in April 2009.*

The Call for Papers for future issues is ongoing; however, authors who wish to have their manuscript considered for publication in ***Volume 3*** should submit their manuscript ***now***,
but no later than July 30, 2009
to allow sufficient time for the peer review.

Visit www.jannaf.org for additional details.

CPIAC Releases Special Publication: *Ignition and Thermal Hazards of Selected Aerospace Fluids*

The NASA Johnson Space Center White Sands Test Facility (JSC/WSTF) and CPIAC recently completed republication of a reference document formerly available only on request to JSC/WSTF. NASA initially released *Ignition and Thermal Hazards of Selected Aerospace Fluids* in 1988. The republished document is now available from CPIAC on CD ROM, as Special Publication SP-0802.

The 677-page document includes 1054 references and 360 figures and has been widely used for data citations and hazard assessments. It describes ignition and thermal hazards associated with many fluids used in aerospace systems, along with property data useful for assessing such hazards. The fluids mentioned are primarily flammable materials; oxidizing fluids (such as dinitrogen tetroxide and liquid oxygen) are not included. In many cases, NASA JSC/WSTF performed testing to obtain data not available in the literature.

The document consists of two main sections, a bibliography, and appendices. The main sections consist of an Overview and Data on specific fluids. The Overview section contains the following topics:

- General information on spacecraft fuels, aircraft fuels, and non-propellants (such as lubricants)
- Ignition hazards and their assessment by means of flash points, fire points, burning rates, flammability limits, autogenous ignition phenomena, ignition delays, and activation energies
- Thermal hazards – including theory and application to unstable compounds, unstable mixtures, and catalysts
- Thermal hazard ratings
- Estimation of heats of reaction and temperature increases from exothermic reactions
- Experimental methods for determination of thermal hazards
- Explosions – including deflagrations, thermal runaway reactions, detonations, blast effects, and blast protection measures
- Unusual hazards encountered in aerospace applications – including high altitude, vacuum, and microgravity hazards

The Data section includes property data for the following fluids: methanol, ethanol, 2-propanol (isopropanol), ammonia, diethylenetriamine, hydrazine, monomethylhydrazine (MMH), 1,1-dimethylhydrazine (UDMH), Aerozine-50, JP-4, JP-5, JP-7, JP-8, Jet A, Jet A-1, Jet B, JPTS, RJ-1, kerosene, methane, propane, and selected hydraulic fluids, lubricants and coatings. Presented in a standard tabular format, this section provides easy comparison of fluid properties.

Frank J. Benz, Craig V. Bishop, and Michael D. Pedley authored the original document. Currently Mr. Benz is Manager of NASA JSC/WSTF; Mr. Pedley is NASA's Constellation Materials and Processes Lead; and, Mr. Bishop is the president and owner of The Best Mode Inc., which specializes in intellectual property development. The generation of the original document, including acquisition of test data in support of it, was funded by the Office of Chief Engineer at NASA Headquarters in Washington, DC. Joyce McDevitt served as the Headquarters Project Manager. An ad hoc committee with members from NASA Johnson Space Center, NASA Lewis Research Center, NASA Kennedy Space Center, and Rockwell International reviewed the technical content of the document.

Recent efforts by JSC/WSTF and CPIAC led to the document being converted to a searchable, electronic PDF version on CD. The document was previously available only as a hard copy or scanned image from JSC/WSTF. Figures were re-mastered using vector-based graphics. Minor editing enabled the document to meet CPIAC technical and publication requirements.

This unclassified/limited-distribution document contains information that falls under the purview of the U.S. Munitions List as defined in the International Traffic in Arms Regulations, 22 CFR 120-130, and is accordingly export-controlled. The cost is $180 to CPIAC customers, $360 for non-customers. Qualified recipients may contact CPIAC's Customer Service Manager, Ms. Lisa Nance, at 410-992-7305, ext. 212, or by e-mail to lnance@cpiac.jhu.edu to obtain a copy.

Looking for an article that appeared in a previous issue of the Bulletin?

CPIAC has archived all of the Bulletins dating back to 1974!

These Bulletins are available in PDF on the CPIAC Web site at http://www.cpia.jhu.edu/templates/cpiacTemplate/products/index.php?action=bulletin_arch.

NASA's In-Space Propulsion Technology Project

Products for the Near-term, Part II

By Dr. Tibor Kremic, PE, ISPT Project Manager,
NASA Glenn Research Center, Cleveland, Ohio

The In-Space Propulsion Technology (ISPT) Project was established in 2001 to develop in-space propulsion technologies that will enable or benefit near- and mid-term NASA space science missions through significant reduction of risk, cost, mass and travel times of NASA's robotic science missions. Funded by NASA's Science Mission Directorate (SMD), ISPT continues to invest in propulsion technologies, seeking answers to questions about the solar system and beyond, and assisting with the delivery of spacecraft to target destinations. Presented herein is the second part of a two-part article providing an overview and development status of ISPT products in electric propulsion, chemical propulsion, aerocapture, and systems analysis. Part I of this article was published in the September 2008 issue of the CPIAC *Bulletin* and highlighted technologies in the areas of electric and chemical propulsion. Part II features ISPT products related to aeocapture and systems analysis.

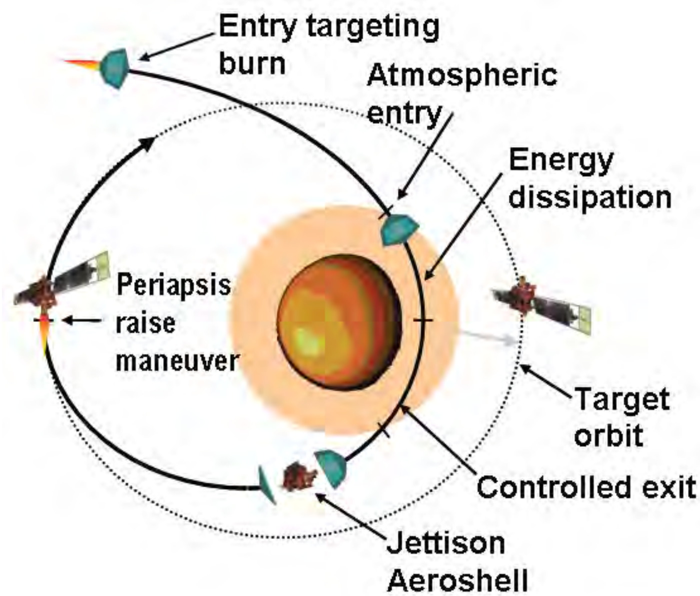


Figure 1. Illustration of the aerocapture maneuver.

Aerocapture

ISPT investment priorities are determined by NASA's Science Mission Directorate (SMD) and, more specifically within the SMD, by the Planetary Science Division. A large investment by ISPT is in aerocapture system technologies. Aerocapture is the process of entering the atmosphere of a target body and using that atmosphere to generate controlled drag so that the chemical propulsion requirements for orbit capture are reduced. Aerocapture is similar to aero-braking, which relies on multiple passes high in the atmosphere to reduce orbital energy. Aerocapture, as illustrated in Fig. 1, maximizes this benefit from the atmosphere through a single pass maneuver. Successful aerocapture is accomplished through lightweight thermal protection systems, accurate atmospheric models, and sufficient guidance during the maneuver.

Efforts in aerocapture-related technologies have included development of low- and medium-density (14 to 32 lbs/ft^3) thermal protection systems and their related sensors, development of a carbon-carbon rib-stiffened rigid aeroshell, and higher temperature structures and adhesives. Progress is being made through improvement of models for atmospheres, aerothermal effects, and algorithms and testing of a Guidance, Navigation and Control (GN&C) system. Figure 2 shows that these efforts have resulted in an aerocapture system that is ready for a number of destinations in our solar system.

The majority of investment in aerocapture technology has been in furthering the technology readiness level (TRL) of the rigid aeroshell systems. Low-density thermal protection systems (TPS) materials carrying the identifier "SRAM" have been developed under a competitively awarded contract with Advanced Research Associates (ARA). These materials have a density range between 14 and 24 lbs/ft^3, with the variable performance achieved by adjusting the ratios of constituent elements. They are applicable for heating rates up to 150 W/cm^2 and 500 W/cm^2, respectively, and could be used on missions with destinations to small bodies such as Titan and Mars. The SRAM family of ablators has been tested both in arcjet and solar-tower facilities at the coupon level – 1-ft^2 and 2-ft^2 flat panels – as well as on 1-m blunt body aeroshell structures. Medium density TPS systems range in density between 20 and 32 lbs/ft^3 and are applicable for heating rates between 200 and 1,100 W/cm^2.

ISPT has funded the testing of higher temperature adhesives and development of higher temperature structures effectively increasing the allowable bond-line temperature from 250 to 325˚C, or 400˚C, depending on the adhesive. Sensors that measure recession with accuracy of hundredths of millimeters have also been developed and are currently planned for use on the Mars Science Laboratory (MSL) mission.

Models that predict the thermal environments that will be seen by the TPS system have been developed. One feature has revealed that previous heating estimates have been overly conservative. Coupled models updated with the most current data reveal that aerocapture at Titan will load the TPS system at less than 20 W/cm^2 versus prior predictions of 150 to 200 W/cm^2. ISPT is also updating the atmospheric models for all planetary bodies except Earth.

continued on page 9

NASA ISPT Project....continued from page 8

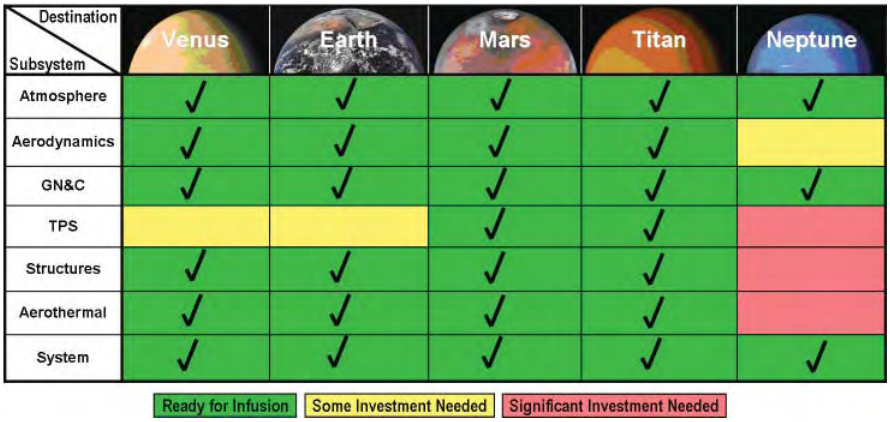


Figure 2. Aerocapture readiness for various targets.

Additionally, plans are underway to complete the ground development of the ablative aeroshell system. This includes continuation of improving aerothermal models, atmospheric models and real-time testing GN&C algorithms with flight software and hardware in the loop. The GN&C work is to be completed in 2009. There are also plans to test the TPS materials for space environmental effects.

Systems Analysis

The ISPT Project implements various mission analysis and system trade studies. Systems analysis is used during all phases of any propulsion hardware development. The systems analysis area serves two primary functions: to help define the requirements for new technology development and the figures of merit for new technology, and to develop new tools to easily and accurately determine the mission benefits of new propulsion technologies allowing a more rapid infusion of the propulsion products.

Systems analysis is critical prior to investing in technology development. In today's environment, advanced technology must maintain its relevance through mission pull by demonstrating a significant benefit to specific science missions of interest. Current systems analysis tasks include Radioisotope Electric Propulsion System (REPS) requirements, lifetime qualification of gridded-ion and Hall thrusters, active mixture ratio control, and the evaluation of commercial electric propulsion systems for possible application to science mission needs.

The second focus of the systems analysis project area is the development and maintenance of tools for the mission and systems analyses. Improved and updated tools are critical to understanding and quantifying mission and system level impacts of advanced propulsion technologies. Having a common set of tools also increases confidence in the benefit of ISPT products, both for mission planners as well as for potential proposal reviewers. Tool development efforts have been completed on the Low-Thrust Trajectory Tool (LTTT) and the Advanced Chemical Propulsion System (ACPS) tool.

Low-thrust trajectory analyses are critical to the infusion of new electric propulsion technology. Low-thrust trajectory analysis generally requires considerable tool specific expertise. Heritage tools have proven to be extremely valuable; but many require good initial guesses to achieve convergence due to the indirect optimization techniques, adding difficulty in rapidly and independently verifying solutions.

The ability to calculate the performance benefit of complex electric propulsion missions is also intrinsic to the determination of propulsion system requirements. The ISPT office has invested in multiple low-thrust trajectory tools that can independently verify low-thrust trajectories at various degrees of fidelity. The ISPT low-thrust trajectory tools suite includes Mystic, the Mission Analysis Low Thrust Optimization (MALTO) program, Copernicus, and the Simulated N-body Analysis Program (SNAP). Mystic is a high fidelity tool capable of N-body analysis and is the primary tool used for trajectory design, analysis, and operations of the Dawn mission. MALTO is a medium fidelity tool for trajectory analysis and mission design; Copernicus is suitable for both low and high fidelity analyses as a generalized spacecraft trajectory design and optimization program; and SNAP is a high fidelity propagator. While some of the tools are export-controlled, the ISPT Web site does offer publicly available tools and includes instructions for requesting tools with limited distribution (see http://www.inspacepropulsion.com/).

The user community's ability to rapidly and accurately assess the mission level impacts of in-space propulsion technologies is vital to promote technology infusion and utilization. In addition to the tools currently available, there are ongoing activities to develop an Aerocapture Quicklook tool and an Integrated Aero-assist tool, and an effort to establish a standard for electric propulsion thruster lifetime qualification, including lifetime modeling tools. Every effort will be made to have these tools validated, verified, and made publicly available. Initial versions of all of the tools have been released or should be available early in 2009. Please check the ISPT Web site for updates as tools become available.

Known future missions of interest for NASA and the science community, as outlined in the decadal survey and NASA roadmaps, will continue to demand propulsion systems with increasing performance and lower cost. Aerocapture and electric propulsion are frequently identified as enabling or enhancing technologies. ISPT will continue to invest in these areas to complete the current developments to TRL 6 in the next 1 to 3 years. ISPT will also continue to look for ways to reduce system level costs and enhance the infusion process as it applies to the four product areas discussed.

Global Hypersonic R & D: Ground Test and University Activities

By Peter Montgomery, Arnold AFB, and Ronald Fry, CPIAC

The exciting and diverse global hypersonic activities reported upon in the September 2008 issue of the CPIAC *Bulletin* are complemented by equally interesting ground test and University activities. In cooperation with the AIAA Hypersonic Technologies and Aerospace Planes (HyTASP) Program Committee (PC), this article provides a continuing synopsis of these activities. As we mentioned our previous article, the HyTASP Committee helps to coordinate the activities of AIAA Technical Committees across the many disciplines related to hypersonic technology and aerospace planes and reviewed these activities in its inaugural newsletter, published April 2008. The full text of the *AIAA HyTASP Newsletter* is available at: http://www.aiaa.org/Participate/Uploads/April%202008%20HyTASP%20Newsletter.pdf.

Courtesy of U.S. Air Force

Figure 1. AEDC Tunnel 9 project engineers Joe Norris and Inna Kurits examine the illuminated TSP coating on the NASA CEV model prior to a run. Kurits was a graduate student at the University of Maryland at time of photograph.

Hypersonics Ground Test Activities

AEDC Tunnel 9 Unveils Temperature-Sensitive Paint Capability: In a cooperative effort between the Arnold Engineering Development Center (AEDC), LeaTech LLC, and the University of Maryland, a new global heat-transfer measurement system has been launched at the AEDC Hypervelocity Wind Tunnel 9 culminating a 4-year effort. Tunnel 9 is a hypersonic blowdown tunnel that uses nitrogen as its working fluid. Recent efforts to move from a qualitative to quantitative system focused on data collected on a model of the NASA Orion Crew Exploration Vehicle (CEV) capsule painted with temperature-sensitive paint (TSP). Completion of a data reduction method that provides quantitative heat-transfer rates has been largely supported by master thesis work at the University of Maryland as shown in Fig. 1. A data reduction method was developed for reducing the TSP model surface temperature data into a heat-transfer rate using a standard transient, one-dimensional (1-D), finite-difference heat-transfer conduction model. The developed in-situ calibrated reduction model allows data to be represented in the form of quantitative heat-transfer rate maps at various points in time, providing important qualitative information about the spatial gradients and the flow features on the surface of the model (Fig. 1). The test articles are typically made of stainless steel to withstand the high Reynolds number and dynamic pressure environment of the facility and are located in the flow (not injected) while the facility is started. These and other unique facility features make the development of a quantitative global heat-transfer measurement system challenging. Surface heat-transfer rate is a critical design parameter for all hypersonic vehicles.

USAF Accepts Advanced Hypersonic Test Combustor: The AEDC has completed acceptance testing of a state-of-the-art combustion air heater (CAH). Designed and built by ATK under contract with AEDC, the CAH features an injector array and combustor that will be used to heat test gases to conditions that simulate airflow at speeds up to Mach 8 for hypersonic systems development. Figure 2 shows the CAH installed in AEDC's Aerodynamics and Propulsion Test Unit (APTU), where it can be connected to a suite of supersonic and hypersonic nozzles to produce a variety of test conditions. The U.S. Department of Defense and industry partners are making significant investments in hypersonic flight vehicles for atmospheric flight, and the APTU/CAH allows for efficient, lower cost test programs for risk reduction ahead of actual flight tests.

Courtesy of U.S. Air Force

Figure 2. New Combustion Air Heater (CAH) installed in the AEDC APTU Test Facility.

continued on page 11

AEDC Arc Heater Test Capabilities Advanced: The AEDC H3 arc heater facility successfully completed its first production test run on March 25, 2008. The H3 arc heater facility has been under development for many years, demonstrating an increasing capability to simulate the extreme conditions encountered by vehicles maneuvering at hypersonic speeds within the Earth's atmosphere as well as those encountered by reentry systems. With a test rhombus about three times the size of that provided by the AEDC H1 arc heater facility, H3, as shown in Fig. 3, provides a new capability to test nosetip, wedge, and antenna window materials at sizes that more closely approximate those used in flight. Additional improvements have been completed recently to all of the AEDC arc heaters, which serve to increase arc heater test capabilities to meet current and future needs of the hypersonic and reentry vehicle programs.

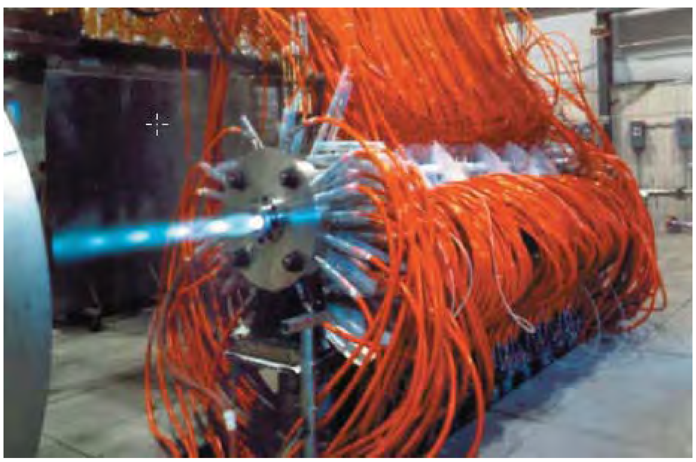

Courtesy of U.S. Air Force

Figure 3. AEDC H3 Arc Heater Test Facility.

The AEDC H2 arc heater facility successfully completed operational validation and a first production test run with a new nozzle on January 29, 2008. The production test run used a modified 48-in. cathode and a new Mach 3.8 conical supersonic nozzle. The test series was the latest of three since March 2007 for the NASA Orion CEV Thermal Protection System (TPS) Advanced Development Project. Figure 4 shows a NASA Orion TPS sample in the AEDC arc heater facility.

NASA Glenn Conducts Variable Geometry Hypersonic Inlet Research Testing: Recently, hypersonics research testing was conducted at NASA Glenn Research Center on a hypersonic inlet model with variable geometry which allows the flow to switch from a supersonic turbine-powered combustor to a scramjet combustor. The objective of the test was to demonstrate model transition between the low-speed and high-speed flow paths. Installed in the 1- x 1-ft Supersonic Wind Tunnel (1X1 SWT), the model was tested


Courtesy of U.S. Air Force

Figure 4. NASA Orion TPS Sample in the AEDC Arc Heater Test Facility.

at various Mach numbers, and the data obtained will be used to pave the way for future full scale tests in the NASA Glenn wind tunnel. Optimal bleed hole patterns were found and verified using computational fluid dynamics (CFD), and a Schlieren system was used to locate and view shock patterns. Used to support many research activities, the 1X1 SWT is a continuous flow facility designed for a maximum total pressure of 165 psia, capable of operating at discrete Mach numbers ranging from 1.3 to 6.0. A heater control system has been integrated into the system to warm the air when testing in the 1- x 1-ft hypersonic regimes (Mach 5.0-6.0).

Sierra Lobo, Inc. recently began assisting NASA Langley Research Center in the integration of a JP-7 fuel cracker system into their 8-ft tunnel in support of hypersonic testing. This system will be similar to the largest one ever built which was constructed originally for use in support of the Integrated System Test of an Airbreathing Rocket (ISTAR) project for testing at the Hypersonic Tunnel Facility (HTF) at NASA Glenn Research Center's (GRC) Plum Brook Station. The ISTAR engine was to be regeneratively cooled by the JP-7 fuel before it entered the combustion chamber. To properly simulate combustion conditions, the fuel heater system cracks the JP-7 fuel prior to introduction into the hardware. This new effort to test heat sink flow path hardware in the NASA Langley Research Center 8-ft tunnel will provide critical support for hypersonic systems testing.

University Activities in Hypersonics

University of Virginia: The Hy-V Program continues to gather momentum following the addition of three new members – ATK GASL, Aerojet and AEDC – to the existing program team comprised of members from the University of Virginia, Virginia Tech, NASA, NASA Sounding Rocket Operations Contract (NSROC) and Virginia Space Grant Consortium (VSGC). The Hy-V Program has been developed

continued on page 12

with the aim of examining facility effects that are present in scramjet ground-based testing. In the course of the program, ground and flight databases will be generated and compared in order to isolate the effects that ground facilities have on scramjet performance and operation. The combined university, industry and government team integrates a significant level of undergraduate and graduate student participation.

The Johns Hopkins University/Chemical Propulsion Information Analysis Center (JHU/CPIAC): JHU/CPIAC continues its role as the U.S. national clearinghouse for worldwide information, data, and technical analysis on propulsion for missile, space, and gun systems. Recent activities include the following: 1) coordinating the 55th Joint Army, Navy, NASA and Air Force (JANNAF) Propulsion Meeting (JPM) and conjoined 42nd Combustion Subcommittee and 30th Airbreathing Propulsion Subcommittee Meetings (May 2008); 2) co-sponsoring the first JANNAF specialist sessions on "Hypersonic Thermal Protection Systems (TPS) and Hot Structures" at the 32nd Annual Conference on Composites, Materials and Structures (January 2008); 3) releasing Special Publication CD ROM (SP-0801), a compilation of X-43A flight demonstration technology advances reported in over 100 technical papers presented at JANNAF Meetings from 1997 to 2006; and, 4) releasing the inaugural issue of the *JANNAF Journal of Propulsion and Energetics*, a unique publication comprised of peer-reviewed, limited-distribution, export-controlled technical articles in the fields of aerospace propulsion and energetic materials research and development.

University of New South Wales at the Australian Defence Force Academy (UNSW@ADFA): UNSW@ADFA continues a tradition of high quality hypersonics research with many exciting efforts currently underway, including the following experimentation efforts of Ph.D. students: 1) coupled experimental/CFD investigation of hypersonic transverse jet interactions; 2) numerical and theoretical analyses of the physics of planetary entry capsule wake flows; 3) numerical investigations of 3-D flow structures; 4) numerical/experimental investigations of the effect of chemistry and entropy layers on hypersonic transverse jet interactions; and, 5) experimental/numerical investigations of laser-induced scramjet ignition enhancement.

Recent Ph.D. Graduate in the Hypersonics Workforce: Dr. Jeff McGuire, recent Ph.D. graduate from UNSW@ADFA, now works for Nova Defence in Brisbane, Australia. Contact Dr. McGuire for his previously unpublished article detailing the work he and his colleagues conducted: "OH-PLIF Visualization of Radical Farming Supersonic Combustion Flows." The authors (J.R. McGuire, R.R. Boyce and N.R. Mudford) explore the issue that upstream-injection shock-induced-combustion, assisted by radical farming, is a concept that may prove critical for practical scramjet vehicles.

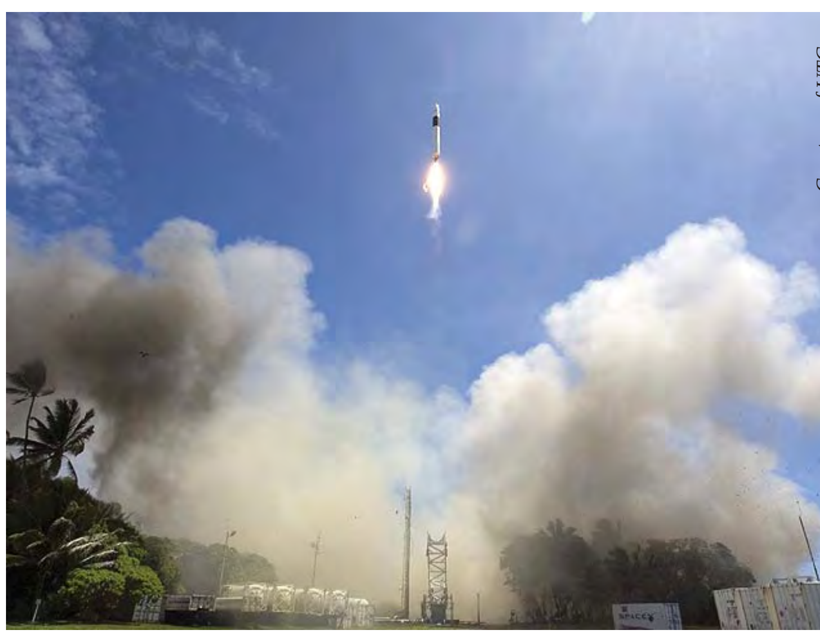
Look for the final in our series on Global Hypersonic Activities in the January 2009 issue of the CPIAC *Bulletin* where we will publish revealing interviews, hypersonic funding opportunities and a history of HyTASP:

Hypersonics Community Perspective: A Conversation with Dr. Mark Lewis, United States Air Force Chief Scientist, and An Electronic Conversation with Professor Russell Boyce, DSTO Chair for Hypersonics at the University of Queensland.

Hypersonics Technology Research and Development Funding Opportunities*:* Details are provided on 1) R&D funding opportunities by the NASA Hypersonics Project of the Fundamental Aeronautics Program, Dr. James Pittman, NASA Langley Research Center; and 2) T&E/S&T High Speed/Hypersonic Test Focus Area Releases, FY09 Broad Area Announcement, Capt. Rod Koch, Arnold Engineering Development Center.

HyTASP History: Finally, the History of HyTASP is presented, highlighting the genesis of the HyTASP Committee, which started as an ad hoc committee in 1991.

Success for Falcon 1, Flight 4
Congratulations, Space X!



Falcon 1, Flight 4 liftoff from Kwajalein Atoll on September 28, 2008.

Joint NIST/AFRL Workshop on Rocket Propellants and Hypersonic Vehicle Fuels held in Boulder, Colorado

The Joint National Institute of Standards and Technology (NIST)/Air Force Research Laboratory (AFRL) Workshop on Rocket Propellants and Hypersonic Vehicle Fuels was held on September 25 and 26, 2008 at the Boulder, Colorado, laboratories of NIST. The workshop included oral presentations and panel discussions centered on recent physical and chemical measurements and thermal stability testing of RP-1 and RP-2. Attendance included technical staff from NIST (Boulder and Gaithersburg), AFRL (Edwards AFB and Wright-Patterson AFB), CPIAC, NASA Glenn Research Center, The Aerospace Corporation, Aerojet, Pratt & Whitney Rocketdyne, ATK, United Technologies, United Launch Alliance (Boeing and Lockheed Martin), and Stanford University.

Presentations at the workshop included the following:

- Data from NIST physical and chemical measurements of RP-1 and RP-2, along with modeling activities for equation of state and transport properties for development of REFPROP modules for both fluids.
- Overview of AFRL hydrocarbon fuel development programs and activities at both Edwards AFB and Wright-Patterson AFB.
- Thermal stability test results for RP-1, RP-2 (along with additives intended to enhance thermal stability) from NIST static ampoule testing and Stanford University Aerosol Shock Tube testing.
- Recent heat transfer and coking limit test results for RP-2 from both the AFRL High Heat Flux Facility and the NASA/GRC Heated Tube Facility, including comparisons to previous RP-1 and JP-7 results.
- Results from testing of RP-1, RP-2, and JP-7 in endothermic testing at United Technologies Research Center (UTRC).

Panel discussions focused on identifying current needs in both rocket and hypersonic applications of hydrocarbon fuel systems, including additional data near thermal breakdown conditions, surface tension and lubricity, compositional variability, and thermal decomposition kinetic mechanism development. Specification history and current testing practices were also discussed.

A notable point of discussion during the workshop was based on the idea that although RP-2 meets the RP-1 specification and has extremely low total sulfur levels (less than 100 ppb by specification), thinking of it as ultra-low sulfur RP-1 can be misleading. In fact, the chemical composition of RP-2 differs from that of RP-1 and that, as well as the low total sulfur levels, leads to its improved thermal stability over RP-1 and JP-7.

A summary of the workshop findings and further results from presenters will be given during the upcoming JANNAF Joint Subcommittee Meeting (Modeling and Simulation Subcommittee /Liquid Propellant Subcommittee/Spacecraft Propulsion Subcommittee) to be held in December 2008.

Proceedings of this meeting will be published on CD ROM and available through CPIAC. Qualified recipients may contact CPIAC's Customer Service Manager Lisa Nance at 410-992-7305, ext. 212, or by e-mail to lnance@cpiac.jhu.edu.

Preliminary Block Diagram

6th Modeling and Simulation Subcommittee / 4th Liquid Propulsion Subcommittee / 3rd Spacecraft Propulsion Subcommittee Joint Meeting

December 8-12, 2008 • Hilton Walt Disney World, Orlando, FL

Hilton Walt Disney World	Grand Ballroom II	Grand Ballroom III	Grand Ballroom IV	Grand Ballroom V	Grand Ballroom VI	Grand Ballroom VII	Grand Ballroom VIII
Monday AM December 8, 2008	(1A)	(1B)	(1C) LPS Liquid Rocket Engine Test Guideline Working Group	(1D)	(1E)	(1F)	(1G)
Monday PM	(1H) MSS IHM Sensors and Sensing Systems - I	(1I) LPS Turbomachinery Component Design and Analysis	(1J) LPS Developments in Liquid Engine Systems	(1K) SPS Propellantless Propulsion ------------------ Advanced Concepts	(1L) LPS Materials for Propulsion Systems	(1M) SPS Hall Thrusters - I	(1N) LPS FAST Specialist Session
Tuesday AM December 9, 2008	Keynote Address 8-10am International Ballroom South						
	(2A) MSS Abort Conditions, Failure Monitoring and Data Analysis - I	(2B) MSS Uncertainty Modeling	(2C) LPS Status and Evolution of the RS-68 Engine	(2D) SPS Mars Lander Propusion	(2E) LPS Tactical Missile Propulsion - I	(2F) SPS Hall Thrusters - II	(2G) LPS Non-Toxic Thruster Technology
Tuesday PM	(2H) MSS Abort Conditions, Failure Monitoring and Data Analysis - II	(2I) MSS Credibility Guide Workshop	(2J) MSS/LPS Modeling of Physical Phenomena – I: Liquid Systems	(2K) LPS Lander Propulsion System Integration	(2L) LPS Tactical Missile Propulsion - II	(2M) SPS Hall Thrusters - III	(2N) SPS Chemical Propulsion Modeling and Program Status
Wednesday AM December 10, 2008	(3A) MSS IHM Legacy Session: Propulsion Failure History - I	(3B) MSS Virtual Engineering - I	(3C) MSS Modeling and Simulation of Systems – I	(3D) LPS Lander Descent Propulsion Technology	(3E) SPS Ion Thrusters - I	(3F) SPS Hall Thrusters - IV	(3G) SPS Chemical Propulsion Hardware Development
Wednesday PM	(3H) MSS IHM Legacy Session: Propulsion Failure History - II	(3I) MSS Virtual Engineering - II	(3J) MSS/LPS Modeling of Physical Phenomena - II	(3K) LPS Lander LOX/CH4 Ascent Propulsion Technology	(3L) LPS AF Hydrocarbon Boost Technology Demonstrator	(3M) SPS Technology Infusion for Spacecraft TacSat-2 Results	(3N) SPS Advanced Chemical Propellants
Thursday AM December 11, 2008	(4A) MSS IHM Sensors and Sensing Systems - II	(4B) MSS/LPS Modeling and Simulation of Systems - II	(4C) MSS/SPS Modeling and Development of Atmospheric Reentry Systems	(4D) LPS Liquid Injection Systems	(4E) LPS USET - I	(4F) SPS EP Life Qualifications Standards Working Group	(4G) SPS Technology Infusion for Spacecraft Program Descriptions/ Overviews
Thursday PM	(4H) LPS Hydrocarbon Fuels	(4I) MSS/LPS Modeling of Physical Phenomena – III: Solid Motors	(4J) LPS Feed System Design and Analysis	(4K) LPS Thrust Chamber and Igniter Test and Development	(4L) LPS USET - II	(4M) SPS Colloid Thrusters	(4N) SPS Technology Infusion for Spacecraft Mission/Systems Analysis


Defense Technical Information Center
Excellence in Information Service
Acquisition and Life Cycle Management Symposium
Rapid Access to Technical Information Supporting Defense Acquisition
Sponsored by
The Honorable John J. Young, Jr.
Under Secretary of Defense for Acquisition, Technology and Logistics
November 18-19, 2008
Holiday Inn Huntsville - Research Park
Huntsville, Alabama
Questions, issues or suggestions?
Please contact DTIC's Conference Coordinator at:
confinfo@dtic.mil or (703) 767-8236 / DSN 427-8236
DTIC
For more information visit:
www.dtic.mil and click on DTIC 2008 PEO/PM Symposium
under the Announcements tab

In Memoriam

Col. Earl B. Essing, AFRPL Commander during the 1970s

Col. Earl B. Essing, a former Commander of the Air Force Rocket Propulsion Laboratory (AFRPL) and long-time propulsion community member died August 7, 2008, at his home in Comfort, Texas. Col. Essing was the Lab Commander from 1974-1978. He was previously assigned to the Edwards Rocket Site in the late 1950s and early 1960s. A key leader in both the propulsion community and the U.S. space reconnaissance program, Col. Essing was buried at Arlington National Cemetery.

A native of Corpus Christi, Texas, he joined an Army infantry unit in early 1941. He subsequently transferred to the Army Air Corps, entering flight training at Randolph Field in San Antonio, Texas. During the war, he served in many different capacities, which culminated with tours of duty on Saipan and Iwo Jima. In 1946, he attended Texas A&I, receiving a bachelor's degree in chemical engineering. He was recalled to active duty in the Korean War. He served with the USAF Security Service at Brooks AFB, Texas, until 1953. He was instrumental in developing fighter intercept techniques for use in Korea and participated in creating the National Security Agency (NSA) at Fort Meade, Maryland.

Essing was then assigned to Wright-Patterson AFB, Ohio, as Chief of the Material Laboratory's Aero Fuels and Lubricants Branch. He was responsible for the development and production of a new fuel for the U2 aircraft, which led to a close working relationship with the Central Intelligence Agency.

In 1958, he was assigned to Edwards AFB as the Atlas ICBM Systems Test Control Officer with the 6510th Test Group (Missile). In 1961, he became Chief of the Propellant Evaluation Branch, participating in the testing of the F1 Saturn engines.

In 1963, Essing attended the Air Command and Staff College. After graduation in 1964, he returned to Wright-Patterson AFB to head the Aero Propulsion Laboratory's Test and Facility Division. In 1967, he was assigned to the 6555th Aerospace Test Wing at Patrick AFB, Florida, as Chief of the Atlas-Agena Launch Division. He was assigned to the AFSC Headquarters at Andrews AFB, Maryland, in 1970, and three years later assumed command of the Air Force Rocket Propulsion Laboratory. He retired from AFRPL in 1978.

After his retirement, Col. Essing moved to the San Antonio area. He played a key role in the investigation of the Challenger disaster. He is survived by his wife, Nola; his son, John; daughter, Mary; five grandchildren; and seven great-grandchildren.

Propulsion News Highlights

DARPA's Hypersonic Blackswift Project Axed
Source: AVweb, 14 October 2008

The Blackswift project, which aimed to develop a hypersonic airplane that could fly at Mach 6, has been cancelled due to a lack of funding. The Defense Advanced Research Projects Agency (DARPA) and the U.S. Air Force had hoped to start work on an unmanned prototype later this year and fly it by 2012, but Congress was unconvinced that the program's aims were attainable, or necessary. Funding was cut from the requested $120 million to just $10 million, which DARPA says is not enough to move forward. "Obviously we are disappointed," DARPA program manager Steven Walker said, according to Aviation Week. He said lots of work already has been done to develop the hypersonic engine. "The Blackswift testbed would have been able to take off under its own power, cruise at Mach 6, maneuver at hypersonic speeds and land, and then do it again," Walker said. "Blackswift, or something very much like it, will be a required step prior to the U.S. developing an operational, reusable, air-breathing hypersonic airplane." That door may be closed for now, but DARPA already is opening other windows. Full press release: http://www.avweb.com/avwebflash/news/DARPAsHypersonicBlackswiftProjectAxed_198999-1.html

Photo credit: Bill Sweetman, AV Web

A conceptual model of DARPA's Blackswift hypersonic airplane.

ATK Rocket Motors Support Successful Flight Demonstrations of NLOS Launch System
Source: ATK, 6 October 2008

Alliant Techsystems has successfully demonstrated an innovative propulsion system for the Non Line-of-Sight Launch System (NLOS-LS) Precision Attack Missile (PAM). Three successful tests have been conducted at the White Sands Missile Range, New Mexico. ATK is under contract to Raytheon Missile Systems for the system design and development (SDD) phase of the program. The Non Line-of-Sight Launch System provides precision fires for the Army's Future Combat Systems and the Navy's Littoral Combat Ship (LCS). It is platform-independent, self-contained and compatible with current and future command and control systems. The successful Controlled Test Vehicle (CTV) missile flight tests included ATK rocket motors that feature the latest innovations in rocket motor design to meet insensitive munitions requirements. ATK has combined a set of composite and energetic technologies into a propulsion system that maintains the desired high energy ballistic performance, while at the same time improving the overall propulsion system insensitive munitions response to potential battlefield stimuli. Full press release: http://atk.mediaroom.com/index.php?s=118&item=854.

NASA to request Ares V, Altair technology ideas in January
Source: Flight International, 4 October 2008

NASA in January will ask for industry's help in conquering "key" Ares V heavylift cargo launch vehicle and Altair lunar lander design considerations and trades, For the Ares V, officials says there will be "multiple awards" for each of five work packages - Earth departure stage, core stage, first stage, avionics and shroud - to be issued next spring. NASA plans to begin detailed development of the booster in 2011, with a first test flight expected in 2018. Composite technologies will play a dominant role in the request for proposals, including solutions for how to manufacture 10m (33ft) diameter composite barrels for the core stage and other components, among the largest composite structures ever to be assembled, says NASA. Full press release: http://www.flightglobal.com/articles/2008/10/04/316683/nasa-to-request-ares-v-altair-technology-ideas-in-january.html.

These excerpts have been taken from press releases approved for public release and reprinted with permission.

People in Propulsion

Rocket Test Group meets at ORBITEC

The Rocket Test Group (RTG), formerly the Rocket Testing Facility Operators Working Group, held their 31st meeting on October 1-2, 2008, at Orbital Technologies Corporation (ORBITEC) in Madison, Wisconsin. The meeting was hosted by Joan Hoopes of ORBITEC, who was subsequently elected RTG co-chair, along with Jennifer Allred of NASA White Sands Test Facility (WSTF). The technical presentations were attended by rocket testing professionals from the government, military, universities, and industry. The meeting topics included test results, facility capability briefings, new testing technologies, and helium conservation measures. Along with the presentations, attendees enjoyed a tour of the host organization's facilities in Madison and Baraboo, Wis., witnessed a hot fire test, and attended an evening social event. The hot fire was an injector test for ORBITEC's patented Vortex-Cooled Combustion Chamber (VCCC) for liquid rocket engines. The small engine produced 2.5K lb_f of thrust.

RTG was founded with the belief that the sharing of information among testing facility operators would aid in solving problems experienced at various testing facilities. The technical discussions, test facilities tours, and professional contacts formed through the group have resulted in solutions to problems and challenges, business opportunities, and a greater understanding of the current test capabilities within the United States. The 32nd meeting of the RTG will take place in spring 2009 at NASA WSTF.

The Rocket Test Group in front of ORBITEC's largest test cell after the test of a VCCC.

SPIRITS Training Course

A 4-day course on the JANNAF SPIRITS model is being planned for the November/December 2008 time frame. The cost is $2,000 per attendee.

Those interested in this course, or one at a later time, should contact John Conant, Aerodyne Research, Inc., at 978-663-9500, ext. 292, or by e-mail to jconant@aerodyne.com.

Calendar of JANNAF Meetings

JANNAF 6th Modeling and Simulation Subcommittee (MSS)/4th Liquid Propulsion Subcommittee (LPS)/ 3rd Spacecraft Propulsion Subcommittee (SPS) Joint Meeting

Date: December 8-12, 2008
Paper/Paper Clearance Deadline: November 3, 2008
Hilton Walt Disney World; Orlando, FL
Ph. 407-827-4000/800-782-4414
(Refer to JCC for the government rate of $99.00/night; refer to LSM for the industry rate of $199.00/night)
Hotel Reservation Deadline: November 17, 2008
Presentations and Reg. Forms due at CPIAC by: November 24, 2008

56th JANNAF Propulsion Meeting (JPM) and 39th Structures and Mechanical Behavior Subcommittee (SMBS)/35th Propellant and Explosives Development and Characterization Subcommittee (PEDCS)/ 26th Rocket Nozzle Technology Subcommittee (RNTS)/24th Safety and Environmental Protection Subcommittee (SEPS)/17th Nondestructive Evaluation Subcommittee (NDES) Joint Meeting

Date: April 14-17, 2009
Abstract Deadline: November 3, 2008
Paper/Paper Clearance Deadline: March 9, 2009
Renaissance Las Vegas; Las Vegas, NV
Ph. 702-784-5700
(Refer to JANNAF government and JANNAF industry for room rates.)
Hotel Reservation Deadline: March 23, 2009
Presentations and Reg. Forms due at CPIAC by: March 30, 2009

For additional information on the above JANNAF meetings, contact CPIAC Meeting Planner Pat Szybist at 410-992-7302, ext. 215, or or by e-mail to pats@jhu.edu.

Visit the JANNAF Web site at www.jannaf.org for meeting updates.

Policy on Non-Government Attendees at JANNAF Meetings. Attendance at JANNAF meetings for non-government employees is restricted to U.S. citizens only and whose organizations are 1) registered with the Defense Logistics Information Service (DLIS) AND 2) have a government contract registered with the Defense Technical Information Center (DTIC). If the government contract is not registered with DTIC, the attendee's registration form can be certified by a sponsoring government official from one of the participating JANNAF agencies. Additional information concerning registrations with DLIS and DTIC can be obtained by contacting DLIS at 1-800-352-3572 (www.dlis.dla.mil/jcp/) or DTIC at 1-800-225-3842 (www.dtic.mil/dtic/registration/index.html).