A Look at U.S. Liquid Rocket Engine History and Development, 1945–2009

By Nick Keim, CPIAC Research Engineer

Broad changes in today’s U.S. space industry have led to the potential resurgence of national interest in the development of new space access capabilities. While this interest may be driven by a number of factors including space exploration, responsive access to space, or the burgeoning space tourism market, it seems appropriate at this time to reflect on the history of liquid rocket engine (LRE) development in this country, which has a long and diverse heritage marked by periods of uncertainty and instability. A look back at LRE heritage, as with other historical perspectives, may stimulate thought and further discussion as to what the future may or may not hold for this segment of the space industry.

CPIAC has collected data on the thrust level and years of development for every major engine program to date (post-World War II to present). The research focuses specifically on large LREs and excludes small attitude thrusters and similar non-“primary” propulsion providers. This collection of information has been displayed in one chart (Fig. 1, page 4), representing the history of the LRE industry and illustrating how active the nation was in LRE development at any given time.

This drawing from 1963 shows the comparative sizes of the rocket engines used to launch the Saturn vehicles. The RL-10 and the H-1 engines were used to launch the Saturn I rockets. The J-2 engine was used on the second stage of Saturn IB and the second and third stages of Saturn V. The F-1 engine was used on the first stage of the Saturn V.

Obama Lays Out New Plans for Space Exploration

President Barack Obama addresses senior officials and industry experts inside the Operations and Checkout Building at NASA’s Kennedy Space Center, Cape Canaveral, Fla., on April 15, 2010.

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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**

- Design Trade Considerations of Separable vs. Welded Joint Connections in Aerospace Flight Vehicles (Req. 26651)
- Qualification of Major LREs for Man Rated Flight (Req. 26679)
- Burning Rate Equation Behavior Below 200 psi (Req. 26686)
- Double-base Propellant Behavior Characteristics in Shock Environment (Req. 26698)
- TVC Sizing and Power Needs (Req. 26714)
- 1st Stage SRM Failures in Space Launch Vehicles (Req. 26731)

**BIBLIOGRAPHIC INQUIRIES**

- Service Life based upon Insulation and Bondline Accelerated Aging Information on HTPB, CTPB, PBAN-based propellants (Req. 26691)
- Test Requirements for Launch, Upper-Stage, and Space Vehicles (Req. 26720)
- 1st Stage SRM Failures in Space Launch Vehicles (Req. 26731)
- Hydrocarbon Fueled Reaction Control Thrusters (Req. 26728)
- Hydrocarbon Fuel Coking (Req. 26728)
- Theoretical performance with RP, Ethane, Methane, Propane and JP-10 for Varying Conditions (Req. 26728)

Recent CPIAC Products and Publications

Meeting Reminder

40th Structures and Mechanical Behavior Subcommittee (SMBS)/36th Propellant and Explosives Development and Characterization Subcommittee (PEDCS)
27th Rocket Nozzle Technology Subcommittee (RNTS)/25th Safety and Environmental Protection Subcommittee (SEPS) Joint Meeting

December 6-10, 2010
Buena Vista Palace Hotel
www.buenavistapalace.com
Orlando, FL

Abstract Deadline:
June 20, 2010

Abstracts will be accepted in electronic form only.

The Bulletin Board

The various propulsion-related meetings listed below may be of interest to the propulsion community. To have your event included, please forward details to bulletin@cpiac.jhu.edu. Additional industry meetings are posted on the CPIAC Web site at http://www.cpia.jhu.edu/templates/cpiacTemplate/meetings/. The JANNAF Meeting Calendar appears on the back page.

NDIA Joint Armaments Conference, Exhibition, & Firing Demonstration
17-20 May 2010
Dallas, TX
POC: www.ndia.org

25th International Symposium on Ballistics
17-21 May 2010
Beijing, China
POC: www.isb2010.com

7th Heat Flow Calorimetry Symposium
17 May 2010
Rijswijk, Netherlands
POC: http://www.hfcs.nl/default.aspx

International-Mexican Congress on Chemical Reaction Engineering
6-10 June 2010
Huatulco, Oaxaca, Mexico.

European Material Research Society 2010 Spring Meeting
7-11 June 2010
Strasbourg, France
POC: www.emrs-strasbourg.com

Gordon Conference on Energetic Materials
13-18 June 2010
Tilton, NH

41st International Annual Conference on Energetic Materials
29 June-2 July 2010
Karlsruhe, Germany
POC: http://events.dechema.de/enmat2010

34th Department of Defense Explosives Safety Board (DDES B) Seminar
13-15 July 2010
Portland, Oregon
POC: www.ddesbseminar.org or e-mail: service@ddesbseminar.org

46th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit
25-28 July 2010
Nashville, TN
http://www.aiaa.org/content.cfm?pageid=230&lumeetingid=2347

For additional information, contact CPIAC Meeting Planner Pat Syzbist at 410-992-7302, ext. 215, or by e-mail to pats@jhu.edu. The Web page for this Meeting is available at: https://www2.cpia.jhu.edu/meetings/Dec2010/.
Figure 1 displays two key items of information. The sum total of all the LREs in development in any given year is indicated by the blue line, and the years in which a specific engine was in development are shown by the red bars. The chart does not reflect the years in which an engine was in production after development was completed. This figure is instructive as it indicates three distinct periods of LRE development in the United States: the period after World War II, when LRE research and development became a national priority (1945–1955); the period that started with the race to orbit continued on page 5.
and ended with the completed development of the Saturn V (1955–1965); and the years from 1965–today, which encompass the development of Shuttle, Evolved Expendable Launch Vehicle (EELV), NASA Commercial Orbital Transportation Services (COTS), and Constellation Ares Rockets.

Table 1 shows the average number of engines under development in a given period of LRE history, as well as the average number of years any given engine stayed in development during that period. While the average length of an engine development program has decreased over each period, the data may be skewed by engine upgrade programs, which are inherently shorter in length. However, the information is still useful in terms of the work that was actually performed in any given time period, irrespective of whether new engines were developed or existing engines upgraded.

More than 50% of the LRE models produced in the U.S. from 1945 to today were developed during a single decade (1955–1965). In 1955, the most powerful U.S. LRE was the Rocketdyne A-7 (78 klbf thrust), although more powerful engines were in development, e.g., Rocketdyne G-26, S-3, and MA-1. By 1965, the thrust level had reached 550 klbf with the emergence of Aerojet LR87-AJ-11, and the Rocketdyne F-1 program was almost complete, developing over 1500 klbf of thrust (F-1 qualified in 1966).

During the current era of LRE development (1965–2010), the F-1 production was cancelled, making the pre-1965 Aerojet LR87-AJ-11 the most powerful U.S. LRE until the Rocketdyne RS-68 was qualified in 2002 at 650 klbf. The RS-68 was also one of only eight new LREs developed between 1965 and 2010, including the Aerojet AJ10-137, Rocketdyne RS-18, RS-27, TRW TR-201, Rocketdyne SSME, and SpaceX Merlin and Kestrel. Further examination reveals that of these eight new engines, five were developed between 1965 and 1981, with only three falling between 1982 and 2009, a period of 27 years and counting.

Today, there are two engines in development, the Rocketdyne RS-68A and J2-X, with the RS-68A currently undergoing certification testing for flight readiness. Figure 2 shows the thrust history of U.S. LREs — past, present, and future (excluding F-1).

The current U.S. launch vehicles utilizing LRE primary propulsion include the Atlas V, Delta II, Delta IV, Falcon 1, and Space Transportation System (as of this writing the Falcon 9 has not yet flown). A total of five operational vehicles utilize eight distinct U.S. engines including the (Atlas V) RL10A-4-2, (Delta II) RS-27C, AJ10-118K, (Delta IV) RS-68, RL10B-2, (Falcon 1) Kestrel, Merlin, and (STS) SSME. With the Shuttle set to retire this year and the Delta II potentially retiring after 2011, the number of in-production engines is set to decrease further (RS-27C and SSME are already out of production; AJ10-118K is used on the Delta II).

While this work does not include an examination of technology programs or demonstrator engines that were never intended to fly, and as such does not provide a complete representation of the history of LRE industries, it does however illustrate several salient points: the LRE industry today is not as active as it was 40 years ago, the road from 1965 to the present has been a bumpy one, efficiency has increased but single engine thrust of LREs has not, and the retiring of launch vehicles has caused the number of production engines in the U.S. to decrease.

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**Table 1. Engines in Development and Engine Program Length.**

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<td>4</td>
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**Figure 2. Thrust History of US Liquid Rocket Engines.**

*continued from page 4

*continued on page 6
NASA FY11 President’s Budget includes technology-development activities for expendable and reusable families of engine development with RP, LCH4, and LH2 fuels; this and the new investments in commercial space could introduce new engine programs and technology into the U.S. LRE industry.

Acknowledgments
The author gratefully acknowledges Mr. Robert L. Sackheim (retired, NASA Marshall Space Flight Center) for the initial U.S. LRE timeline published in the 2006 AIAA Journal of Propulsion and Power (Vol. 22, No. 6), which served as the inspiration for this work. In addition, the chart displayed as Fig. 1 in this article would not have been possible without data on Aerojet’s LRE history provided by Mr. William L. Hoffman (retired, Aerojet).

New Talent at CPIAC!

CPIAC is happy to welcome three new staff members. Monica Luciano and DeAnna Jones have joined the IT section, and Heidi Falter is the newest addition to the Business and Marketing section. While you may have an opportunity to meet them in person—at either the CPIAC offices or an upcoming JANNAF meeting—we’ll introduce you to them now.

Monica Luciano is a document scanner for the PIRS and TEMS collections. A former librarian, Monica has a degree in library science. She joined the CPIAC staff in November and is engaged in the electronic transfer effort related to CPIAC’s technical collection.

DeAnna Jones is a librarian. She began employment with CPIAC in mid-February and works three days a week as a casual employee, taking on a variety of projects and tasks in support of CPIAC’s library operation. DeAnna’s previous position was assistant director of the R. E. Gibson Library and Information Center of the Johns Hopkins University Applied Physics Laboratory. She retired from that position in July 2010 after working at APL for 28 years. She has a B.A. in economics from Wilson College, an M.L.S. in library science from the University of Maryland, and an M.S. in information and telecommunication systems from Johns Hopkins University.

Desktop publisher Heidi Falter came on board March 1, having spent four years as a graphic designer with Maryland Pennysaver. Heidi is responsible for the production of JANNAF meeting CDs, as well as CPIAC and JANNAF marketing materials. She has an associate’s degree in graphic design from the Art Institute of Pittsburgh and is pursuing a bachelor’s degree in computer studies from the University of Maryland, University College.

Don’t miss the Deadline: 31 July 2010

Don’t miss the Opportunity to have your limited-distribution paper published in a peer-reviewed journal.

Questions? E-mail: JANNAFJournal@cpiac.jhu.edu
The release in February of President Obama’s budget request that effectively ended NASA’s Constellation program — a five-year-old effort to replace the space shuttle with new rockets and return astronauts to the moon by 2020 — was met with considerable congressional and agency criticism. In the following weeks, uncertainty and anxiety loomed for thousands of NASA employees and contractors, particularly those along the Space Coast of Florida, where efforts at Kennedy Space Center focus on closing out the remaining shuttle missions and retiring the fleet. But the atmosphere at NASA turned cautiously optimistic after Obama’s April 15 visit to Cape Canaveral, where he told a group of 200 senior officials, industry leaders, and academic experts gathered inside the Operations and Checkout Building at Kennedy that he is “100 percent committed to the mission of NASA and its future.” Responding to criticism that his budget would “kill” the human space program, Obama stressed that the space agency could not continue in the “same old way.” Rather, his plan commits NASA to a series of development milestones leading to a new spacecraft for astronauts to travel to the International Space Station, a modified Orion capsule for emergency returns, and a powerful new rocket for long journeys intended to go beyond the moon. The president’s fiscal year 2011 budget proposal increases NASA’s budget by $6 billion throughout the next five years. Approximately $3.1 billion would be dedicated to research and development for a heavy-lift rocket.

President Obama said that his initiative promises more than just extra funding; it brings more jobs than previous plans. “My plan will add more than 2,500 jobs along the Space Coast in the next two years compared to the plan under the previous administration,” he stated. “I’m proposing a $40 million initiative led by a high-level team from the White House, NASA, and other agencies to develop a plan for regional economic growth and job creation. And I expect this plan to reach my desk by Aug. 15. It’s an effort that will help prepare this already skilled workforce for new opportunities in the space industry and beyond.”

Obama’s announcement came just one week after NASA Administrator Charles Bolden assigned new roles to field centers in states likely to lose thousands of jobs if Congress approves the agency’s plan to terminate the Constellation program. The following new centers are proposed to oversee several primarily technology-driven initiatives proposed in lieu of the Constellation program:

- Ames Research Center (Mountain View, Calif.): Exploration Scouts Program Office; Small Satellite Subsystem Technology Program Office; Edison Small Satellite Demonstrations Program
- Dryden Flight Research Center (Edwards, Calif.): Flight Opportunities Program Office
- Glenn Research Center (Cleveland): Exploration Technology Development and Demonstration Program Office; Space Technology Research Grants Program Office
- Johnson Space Center (Houston): Flagship Technology Demonstration Program Office
- Kennedy Space Center (Cape Canaveral, Fla.): Commercial Crew Program Office; 21st Century Launch Complex Program Office
- Langley Research Center (Hampton, Va.): Game Changing Development Program Office
- Marshall Space Flight Center (Huntsville, Ala.): Heavy Lift Propulsion Research and Development Program Office; Exploration Precursor Robotic Program Office; Space Technology Demonstrations Program Office; Centennial Challenges Program Office

Of the 14 new program offices that would be established, the program office with the largest budget would be based at Johnson Space Center in Houston. Kennedy Space Center, however, would oversee more total program dollars between the two new offices to be stationed there.

“Early in the next decade, a set of crewed flights will test and prove the systems required for exploration beyond low Earth orbit. And by 2025, we expect new spacecraft designed for long journeys to allow us to begin the first-ever crewed missions beyond the Moon into deep space. So we’ll start — we’ll start by sending astronauts to an asteroid for the first time in history. By the mid-2030s, I believe we can send humans to orbit Mars and return them safely to Earth. And a landing on Mars will follow. And I expect to be around to see it.

But I want to repeat — I want to repeat this: Critical to deep space exploration will be the development of breakthrough propulsion systems and other advanced technologies. So I’m challenging NASA to break through these barriers. And we’ll give you the resources to break through these barriers. And I know you will, with ingenuity and intensity, because that’s what you’ve always done.”

President Barack Obama
April 15, 2010
Chemical Propulsion Information Network (CPIN)

CPIAC’s portal to 10 databases — updated regularly as new information becomes available

Accidents and Incidents Database (AID)

AID contains detailed technical information on industrial accidents and incidents involving propellants and explosives. It is intended to assist the US Department of Defense, either directly or through contractors, with assessment of industrial base issues, promotion of safety, and analysis of trends in the aerospace/defense manufacturing sector.

Hazards of Chemical Rockets and Propellants (PUB-394)

CPIAC Publication 394 is intended solely as a source of information and basic guidelines for the processing, handling, storage, and transportation of chemical propellant ingredients. The original version of PUB-394 was issued in 1984. Because PUB-394 is frequently utilized as a reference document and compliance specification for procurements, it will be updated as much as available resources permit.

Liquid Propellants & Fuels Database (LPFD)

LPFD contains detailed technical information on all common U.S. rocket propellants and airbreathing fuels, compiled in detailed individual unit records which include data on thermochemical properties, safety and handling, and compatibility. Propellants of interest can quickly be identified and located using LPFD’s robust search and indexing capabilities.

Liquid Rocket Engine Database (LRED)

LRED is an electronic migration of the CPIAC MS/Liquid Propellant Engine Manual (MS) into a searchable, online database environment. It is used to retrieve data on liquid rocket engines for access to space, strategic, tactical and in-space applications.

Propellant and Explosives Ingredients Database (PEID)

PEID contains detailed physical, thermochemical and production status data on developmental and mature ingredients used in propellants, explosives, and pyrotechnic formulations, as well as detailed information on ingredient suppliers.

Propulsion Information Retrieval System (PIRS)

CPIAC produces and maintains a comprehensive database of propulsion technology information. The Propulsion Information Retrieval System (PIRS) consists of over 97,000 document citations that relate to missile, space, and gun propulsion research and technology. PIRS contains citations of technical documents covering the years 1960 through the present.

Rocket Motor Electronic Database (RMED)

RMED is the national technical reference database for solid rocket motor systems, and contains all of the heritage data from the long-standing and voluminous CPIA/M1 Rocket Motor Manual, while offering advanced search capabilities and a high degree of functionality representative of advanced relational database systems. Users can search for motors by designation, by physical or performance characteristics, or by browsing a convenient set of electronic indexes.

Rocket Propulsion Test Facilities Database (RPTF)

The RPTF is CPIAC’s database tool for U.S. rocket propulsion test facilities. The RPTF is a Web-based relational database that provides access to detailed capabilities data for over 250 DoD, NASA, and commercial rocket test stands.

Spacecraft Chemical Propulsion Database (SCPDB)

SCPDB is an ongoing database project that 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, other industry, university, and government applications are expected to be added. Most of the spacecraft in SCPDB have already flown, but the database may contain data for fully integrated and tested systems that have not yet flown.

Solid Propellant Database (SPD)

SPD is the national technical reference database for solid propellants used in U.S. rockets, missiles, launch boosters, jet-assist units, gas generators, ejection devices, orbit transfer systems, and large guns. SPD contains propellant data for nearly every qualified and operational U.S. system, as well as many systems of historical significance dating to the 1950s. Users can easily search for propellants by designation, by performance characteristics, by ingredient, or by browsing a convenient set of electronic indexes. Various reports and output options are available.

Availability of CPIN

CPIAC is a limited-distribution service, as prescribed by Department of Defense Directive 5250.24. Access is restricted to U.S. Government organizations and contractors who meet the requirements for receipt of militarily critical technical data and have a current contract registered with the Defense Technical Information Center. Details about eligibility to receive CPIAC products and services are on CPIAC’s web site, http://www.cpiac.jhu.edu. Click on Customer Eligibility at the bottom of the Home page.

CPIAC services are available to U.S. Government organizations and their contractors. If you would like more information about CPIAC’s products, services, and registration procedures, please call (410) 992-7300.
Propulsion News Highlights

NASA Partners with Hawaii on Space Exploration, Science (4-13-10)
Source: NASA

NASA and the State of Hawaii agreed Tuesday to collaborate in a variety of activities involving small satellite development, advanced aviation, space exploration, education and science. During a ceremony at the state capital in Honolulu, NASA’s Ames Research Center Director S. Pete Worden and Hawaii Governor Linda Lingle signed a three-year non-reimbursable Space Act Agreement establishing a partnership for space exploration, scientific research and education initiatives in science, technology, engineering and mathematics, known as STEM. The agreement’s first annex provides for small satellite development with the University of Hawaii’s Hawaii Space Flight Laboratory under a new program called HawaiiSat. The Hawaii Space Flight Laboratory will train engineering and science students to design and build small satellites. Students and professors from the university will be sent to Ames to work with scientists and engineers to design, integrate and manage small satellites. During their training, the visiting students and professors also will work with other small satellite contractors in NASA Research Park, such as Santa Clara University.


ATK to Produce A2100 Satellite Bus Structures for GPS III (4-7-10)
Source: ATK

Alliant Techsystems (NYSE: ATK) was awarded a contract with a potential value of more than $30 million by Lockheed Martin Space Systems (NYSE: LMT) to manufacture the A2100 satellite bus structures required for the next-generation Global Positioning System (GPS) known as GPS III. The first block of the new generation satellites, known as GPS IIIA, will deliver significant enhancements over current GPS space vehicles. The ATK contract includes fabricating a GPS III Non-flight Satellite Testbed structure and the first two GPS IIIA satellite bus structures, with the first delivery projected for early 2011. The contract includes options for up to 10 additional satellite bus structures. The ATK-manufactured GPS IIIA bus structure is made from lightweight, high-strength advanced composite materials and is designed to withstand the accelerations and vibrations generated during launch. The bus structure also supports the spacecraft navigation system. ATK has been Lockheed Martin’s A2100 bus structure supplier of choice since the first A2100s were launched in 1996 for the company’s commercial satellite customers. The ATK-manufactured GPS IIIA bus structure is made from lightweight, high-strength advanced composite materials and is designed to withstand the accelerations and vibrations generated during launch. The bus structure also supports the spacecraft navigation system. Full press release: http://www.atk.com

Aerojet’s Advanced Third Stage Technology Demonstration Motor Successfully Tested by Air Force (3-25-10)
Source: Aerojet

Aerojet and the U.S. Air Force conducted a successful static test of Aerojet’s Advanced Third Stage (A3S) technology demonstration motor in support of the U.S. Family of Motors for military and commercial applications. The A3S motor is being developed on the Propulsion Application Program (PAP) under contract to the 526th ICBM Systems Group at Hill Air Force Base, Utah. The test was conducted at altitude conditions by the Air Force Research Laboratory (AFRL) at Edwards Air Force Base, Calif. Aerojet’s A3S technology demonstration motor design incorporates numerous advanced technologies and materials selected in Phase I of the program and demonstrated via a Super BATES motor test in the initial portion of Phase II. The program’s primary goal is to develop a new generation of ICBM-sized motors with increased propulsion performance and lower manufacturing and operational costs. In order to meet these goals, the A3S technology demonstration motor consists of an advanced carbon-carbon exit cone assembled using environmentally friendly materials and a high energy solid propellant that was mixed and cast at Aerojet’s Sacramento, Calif., facility.


These excerpts have been taken from press releases approved for public release.
### Calendar of Propulsion-related Training Opportunities*

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<tr>
<th>Event</th>
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<td>Fundamentals of Explosives: a short course on chemical and physical</td>
<td>University of Rhode Island, Chemistry Department, Kingston, RI</td>
<td>May 4-6, 2010</td>
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<td>principles including blast effects, detonation, and forensics</td>
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<td>E-mail: <a href="mailto:Joxley@chm.uri.edu">Joxley@chm.uri.edu</a></td>
<td><a href="http://www.ATIcourses.com">http://www.ATIcourses.com</a></td>
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<td>Explosives Applications and Effects: Pyrotechnics</td>
<td>University of Rhode Island, Chemistry Department, Kingston, RI</td>
<td>June 7-10, 2010</td>
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<tr>
<td>E-mail: <a href="mailto:Joxley@chm.uri.edu">Joxley@chm.uri.edu</a></td>
<td><a href="http://www.ATIcourses.com">http://www.ATIcourses.com</a></td>
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<tr>
<td>Modern Missile Analysis</td>
<td>ATI Courses, Beltsville, MD</td>
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<td>ATI Courses, Beltsville, MD</td>
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<td>Concepts NREC, Wilder, VT</td>
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<td>Advanced Solid Rocket Technologies</td>
<td>AIAA Course, Nashville, TN</td>
<td>July 29-30, 2010</td>
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<td>Air Breathing Pulse Detonation Engine Technology</td>
<td>AIAA Course, Nashville, TN</td>
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<td>Advanced Space Vehicle Control and Dynamics</td>
<td>AIAA Course, Toronto Ontario</td>
<td>July 31-Aug 1, 2010</td>
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<td>Explosives Applications and Effects: Instrumentation</td>
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<td>July 2010 (TBD)</td>
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<td>Explosives Chemistry: Synthetic Processes for Energetics</td>
<td>University of Rhode Island, Chem. Dept. Held at Picatinny Arsenal, NJ</td>
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<td>Cryogenic Engineering</td>
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Calendar of Propulsion-related Training Opportunities

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<td>September 27-29, 2010</td>
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<td>Explosives Technology and Modeling</td>
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<td>October 4-7, 2010</td>
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*The Propulsion Training Calendar is published biannually. If your organization sponsors a course offering that you would like to publicize, please send an e-mail with course information, points of contact, and the dates of the event to bulletin@cpiac.jhu.edu.*

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People in Propulsion

Roca to Step Down as APL Director

The Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Md., will see a change in leadership soon—perhaps by this summer—when Director Dr. Richard T. Roca steps down to make way for his successor. Roca, 65, told the APL board of managers in January of his upcoming departure, and he sent an e-mail to staff, explaining his decision. Roca made clear that he is not retiring but stated that “every organization requires a change in leadership in reasonable intervals.” He added, “The phrase ‘stepping down’ was deliberately chosen. But, I have purposefully put off thinking about my future—I did not want to have any consideration of it to distract me from my current responsibilities. As I get closer to the summer, I’ll gather information and start to make some decisions. For now, however, APL is foremost in my mind.”

Roca assumed APL’s top spot in January 2000 after a lengthy career at AT&T, including as director of AT&T Labs in New Jersey, the company’s research and development arm.

During his decade as director of APL, Roca made illustrious contributions to its development. “On his watch, the Laboratory has further strengthened its position as a key contributor to national security. Its scientists and engineers have worked diligently and with great success to help protect the United States, its military men and women and its citizens against threats from sea, land and air; from outer space and cyberspace; and from sources conventional and non-conventional,” JHU Trustee Chair Pamela Flaherty wrote in a January announcement to JHU faculty and staff. “Since Dr. Roca became APL director in January 2000, the Lab has significantly increased its contributions toward solving the nation’s toughest technical challenges.”

The Laboratory responded to Sept. 11 by developing significant capabilities in areas such as homeland protection, cyber defense and “infocentric” operations.

In addition, Roca promoted more robust partnering and collaboration among Hopkins divisions. He also currently serves on several advisory bodies to federal government agencies including the United States Strategic Command Strategic Advisory Group and the Homeland Security Science and Technology Advisory Committee. At the APL, he leads a not-for-profit University Affiliated Research Center that performs research and development work on behalf of the Department of Defense, primarily the U.S. Navy, the National Aeronautics and Space Administration, and other Federal agencies.

Roca is a Fellow of the American Society of Mechanical Engineers and a past vice president of its Board on Engineering Education. He is also a former member of the Accreditation Board for Engineering and Technology which accredits U.S. engineering schools.

The search for Roca’s replacement is headed by the Board’s Search Committee under the leadership of Board Chair Stuart Janney. The Committee is comprised of various Hopkins trustees and advisors to the APL committee who serve the federal government. Internal and external candidates from within the government, universities, research facilities and industries have been solicited for interest in the position.

This article includes excerpts from The Johns Hopkins Newsletter, issue date: 2/4/10, M. Ramakrishnan and JHU press release, 1/7/10.

APL Engineer Gary Sullins Receives MDA Technology Achievement Award

Dr. Gary Sullins, an aerospace engineer at the Johns Hopkins University Applied Physics Laboratory (APL) was presented with a Missile Defense Agency (MDA) Technology Achievement Award March 24 during the eighth annual U.S. Missile Defense Conference in Washington, D.C.

Sullins, a supervisor within the Laboratory’s Air and Missile Defense Department, was honored for his critical role in Burnt Frost, the 2008 operation to shoot down a potentially dangerous non-functioning U.S. spy satellite. Burnt Frost demonstrated the ability of the U.S. military and its contractors to respond to an unconventional threat through quick adaptation of the Ballistic Missile Defense System. Sullins relied on his 20 years of experience in air and missile defense as he led an analysis team from APL, Raytheon and Lockheed Martin. They determined how to modify the weapon system, predict how the system would perform, and define how this one-time mission could be executed. Modifications were made to the Aegis Weapon System and the Standard Missile-3 (SM-3) — elements of the sea-based BMDS component known as the Aegis BMD system — and the resulting direct hit destroyed the satellite, preventing it (and the large amount of toxic hydrazine fuel it carried) from reaching Earth.

A resident of Ellicott City, Sullins holds doctorate, master’s and bachelor’s degrees in aerospace engineering from the University of Maryland. He is a member of the American Institute of Aeronautics and Astronautics.

This article includes information excerpted from the Johns Hopkins University APL press release, 3/29/20, K. Marren.
People in Propulsion

**Dr. Rose Pesce-Rodriguez Appointed ARL Fellow**

Honoree active in JANNAF and STEM

Dr. Rose Pesce-Rodriguez, a research chemist in the Weapons and Materials Research Directorate of the U.S. Army Research Laboratory (ARL), was recently named ARL Fellow, the highest honor awarded to ARL scientists and engineers. Dr. Pesce-Rodriguez’s nomination was made by active ARL Fellows, and her election was awarded based on the successful satisfaction of criteria as established in the Fellows Charter.

Dr. Pesce-Rodriguez’s research is focused on conceiving, performing, and leading fundamental and applied research in the areas of analytical chemistry, instrumental analysis, and the scientific analysis of physicochemical properties, chemical stability, and reactivity of high-performance propellants, explosives, and novel energetic materials for next-generation Army and DoD weapons systems. Other areas of research expertise include polymer chemistry, nano-materials, and environmental research. She has authored or coauthored more than 170 government reports, conference papers, book chapters, articles, and open literature publications in the fields of analytical chemistry and analytical methods pertaining to research in propellants and energetic material and has given over 300 technical, programmatic, leadership, and educational presentations to a broad array of audiences. Much of her published research is restricted in its distribution and generally not permissible for dissemination in refereed journals. However, for the past two decades she has been extremely active within the JANNAF community, publishing over 50 papers within the restricted U.S. arena.

“The creation of the JANNAF Journal of Propulsion and Energetics is truly a great accomplishment and will provide new opportunities for the publishing of peer-reviewed, restricted work,” Pesce-Rodriguez said. She has been a member of the JANNAF Propellant and Explosives Development and Characterization Subcommittee (PEDCS) technical steering group (TSG) since 1996; served as PEDCS Chair for three years; chaired two conferences and many TSG meetings and panels; been an active member of several PEDCS panels; chaired numerous Combustion Subcommittee (CS) sessions at conferences; and organized several CS workshops.

“I have always had a lot going on outside my normal research projects and see my election to the Fellows as another opportunity to contribute to ARL and the broader Army mission,” she said. These activities include scientific scholarship focused on the promotion of educational opportunities in science and technology through programs that provide hands-on chemistry lessons to elementary, middle and high school-aged children.

“I just wish that becoming a Fellow meant that I have a few more hours a day to play in the lab,” she concluded.

Dr. Pesce-Rodriguez may be reached at rose.pescerodriguez@us.army.mil.

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**In Memoriam**

**Duke M. Wong**

Duke M. Wong, who had a 30-year career at Aerojet, passed away April 9, 2010 due to cancer. He was 53. A Sacramento native, Wong received his B.S. in mechanical engineering and material science with a minor in macroeconomics from the University of California, Davis in 1979.

Following graduation from UC Davis, Wong joined Aerojet and helped build America’s strategic nuclear deterrence force as a solid rocket nozzle designer, working on the second stages for both Peacekeeper and Small ICBM from design through qualification and flight testing. He rose through the ranks at Aerojet to become Chief Engineer of the Navy’s Standard Missile (SM) 2 Blk IVA program for the Dome Cooling system for the IR Seeker. Wong also led the design of the nozzle for the huge Atlas V solid rocket booster, which helped propel the fastest man-made object in the solar system on its way to Pluto. Last year, Wong was the Chief Engineer for Analysis on the SM-3 Blk IVA program, and he most recently was serving as the Chief Engineer of the Large Class Stage 2 program.

“Duke was a highly sought after mentor for the next generation of rocket designers and analysts, graciously providing his valuable insight – committed to making teams successful,” according to Marshall Cousineau, Aerojet Technical Director for SM-3 TDACS Propulsion Programs. “His tireless devotion to his craft and the camaraderie that he shared with others in the propulsion industry fueled his work, which he continued up until his passing,” Cousineau added.

Wong is survived by his wife, Cindy Castronovo, and his sons, Ryan and Jonathan.
Calendar of JANNAF Meetings

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

40th Structures and Mechanical Behavior Subcommittee (SMBS)/36th Propellant and Explosives Development and Characterization Subcommittee (PEDCS)/27th Rocket Nozzle Technology Subcommittee (RNTS)/25th Safety and Environmental Protection Subcommittee (SEPS) Joint Meeting
December 6-10, 2010
Buena Vista Palace Hotel, Orlando, FL, www.buenavistapalace.com

Deadlines:
- Abstracts: June 20, 2010
- Manuscripts and paper clearance forms to CPIAC: Nov. 7
- Hotel Reservations: Nov. 15
- Security clearance certification and Reg. Fees to CPIAC: Nov. 21
- Presentations to CPIAC: Nov. 21
- Meeting’s Web page for additional information and registration: https://www2.cpiac.jhu.edu/meetings/Dec2010/

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

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).

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