

JANNAF

JOINT ARMY-NAVY-NASA-AIR FORCE
INTERAGENCY PROPULSION COMMITTEE



NEWS

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60th JPM to Meet in Colorado Springs in April *9th MSS / 7th LPS / 6th SPS Joint Subcommittee Meeting* *April 29–May 2, 2013*

The Joint Army-Navy-NASA-Air Force (JANNAF) 60th JPM / 9th Modeling and Simulation / 7th Liquid Propulsion / 6th Spacecraft Propulsion Joint Subcommittee Meeting will be held Monday through Thursday, April 29–May 2, 2013, at the Cheyenne Mountain Conference Center (CMCC), Colorado Springs, CO. The meeting chair is Mr. Bruce R. Askins, NASA Marshall Space Flight Center, Huntsville, Alabama. Currently scheduled are 46 technical paper sessions, 3 workshops, 1 specialist session, and 1 working meeting.

There will also be a tour of the Air Force Academy.

The keynote speaker is Mr. Todd May, Space Launch System (SLS) Program Manager at NASA Marshall Space Flight Center. Mr. May's presentation, "NASA's Space Launch System: State of the Rocket," will share the plans and progress being made to field an exploration-class rocket—the first in over 40 years—for missions of national importance. Slated for its first flight in 2017, the SLS Program will be the nation's next heavy-lift vehicle for human and scientific

exploration and is on track to deliver an unsurpassed capability for missions beyond Earth's orbit. The keynote is scheduled for Tuesday, April 30, from 8:00–10:00 a.m. Prior to his role as SLS Program Manager, Mr. May was Marshall's Technical Associate Director. He managed more than 100 research projects in the Science and Mission Systems Office at Marshall, and oversaw a \$5 billion annual portfolio of space and Earth science missions as Deputy Associate Administrator in the Science Mission Directorate at NASA Headquarters.



Cheyenne Mountain Conference Center

A block diagram of the preliminary program is shown on pages 6–7. This issue provides an overview of the technical sessions scheduled. Please note that session days and times are subject to change up until the meeting. To stay informed, we recommend attendees check the meeting website and preliminary program: <https://www2.cpiac.jhu.edu/meetings/APR2013/pages/index.html>. For the full meeting preview, please go to page 4.

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The Chemical Propulsion Information Analysis Center (CPIAC), a DoD Information Analysis Center, is sponsored by the Defense Technical Information Center (DTIC) and 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.

CPIAC is responsible for the acquisition, compilation, analysis, and dissemination of information and data relevant to chemical, electric, and nuclear propulsion technology. A fee commensurate with CPIAC products and services is charged to subscribers, who must meet security and need-to-know requirements.

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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, in the form of telephoned, faxed, 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 400 inquiries per year, from over 150 customer organizations. For further information, please contact Nick Keim by email to nkeim@cpiac.jhu.edu. Representative recent inquiries include:

TECHNICAL INQUIRIES

- I_{sp} , propellant density, mass fraction, and general performance data for Peacekeeper and Minuteman III Propellant Replacement Program (PRP) stages (Req. 28041)
- Line-of-Sight Anti-Tank (LOSAT) attitude control motor (ACM) propellant formulation and mechanical properties (Req. 27918)

BIBLIOGRAPHIC INQUIRIES

- Pyrolytic graphite throat erosion for a rocket motor with aluminized propellant (Req. 27941)
- Noncompositional effects on double-base propellant gas generators (Req. 27981)
- Literature search on propellants using zirconium as the fuel, 1980 to today (Req. 27962)
- Green Monopropellant Thruster testing literature, specifically with ionic liquids (Req. 27928)

CPIAC Subscriptions—It's Never Too Late

We would like to take this opportunity to inform the community that a minimum subscription of \$1,775 entitles subscribers to unlimited free access for all employees of your organization to our Propulsion Information Retrieval System; any two online databases housed in our Chemical Propulsion Information Network (CPIN); and six hours (prepaid) of technical/bibliographic inquiry hours. For information concerning a CPIAC subscription and/or products and services, please contact Hwei-Ru Chen at 410-992-7300, ext. 212 or email hchen@cpiac.jhu.edu.

JANNAF INTERAGENCY PROPULSION COMMITTEE

JOINT ARMY-NAVY-NASA-AIR FORCE

18 March 2013

Members of the JANNAF Community,

As all of you are probably aware, the Department of Defense (DoD), NASA and other U.S. Government agencies are in the midst of a number of restrictions and challenges that are having a direct impact on the propulsion community at large. Foremost on many of our minds are the current travel restrictions and guidelines for attendance at meetings, symposia and conferences; and the degree to which they impact JANNAF and the upcoming Joint Propulsion Meeting (JPM) next month in Colorado Springs, CO.

The JANNAF Executive Committee (EC), in concert with the Chemical Propulsion Information Analysis Center (CPIAC), has been intently watching this situation unfold, and has been evaluating several options to best navigate moving forward – and maintain a vital JANNAF presence while adhering to both the spirit and letter of the current guidance from the Government.

To that end, the JANNAF JPM Meeting in April will be held as scheduled, but with a few new features designed to protect the core values of the meeting – dissemination of technical information, review of this information by your technical peers, and archive of this information to ensure it becomes a permanent resource for the field. In order to facilitate DoD participation, both as presenters and as peer reviewers, a number of sessions will be virtually enabled by providing both real time audio (via teleconference) and video to DoD attendees at their remote facilities. Virtual conference rooms will be established at many, if not all of the critical DoD research centers and facilities that traditionally participate in this JANNAF meeting, and the EC will be taking all possible measures to ensure the support of our DoD partners in this exercise. So, if you were intending to present a paper, please continue with that planning.

While these new features will greatly serve to minimize the impact of the current travel guidance, it is only part of the solution. Equally as important, if not more so, is that those of you in the contractor and academic communities continue to embrace the meeting, and attend and present your work in this forum as you have in the past; for JANNAF can only remain viable if all elements of the community come together to protect its vibrancy.

In the coming week, CPIAC will be releasing a Preliminary Program and other author and meeting information to provide additional details on the meeting; and will thereafter provide regular updates if and as the program changes moving forward.

JANNAF deeply appreciates your patience and your vigilance in this exercise, and the Executive Committee is counting on everyone to rise to the challenge and ensure a continued and vibrant JANNAF as we move forward.

Sincerely,

Stuart Blashill, Chair, NAWCWD
Tom Brown, NASA MSFC
Jeff Davis, NAWCWD
Brad Forch, ARL
Mike Huggins, AFRL Edwards AFB
Bob Kaczmarek, NSWC Indian Head
Jay Lilley, AMRDEC
Bob Mercier, AFRL Wright Patterson AFB
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JOINT PROPULSION MEETING

The JANNAF Joint Propulsion Meeting (JPM) encompasses research and applications at the systems level.



Keynote Speaker Todd May

Topics covered include tactical propulsion; missile defense and strategic propulsion; propulsion systems for space access; gun and gun-launched propulsion; propulsion and energetics test facilities; and sensors for propulsion measurement applications. The JPM is held each year in conjunction with standing JANNAF subcommittee meetings on a rotating basis. In April, JPM will meet with the MSS, LPS, and SPS. Along with the standard rotation, sessions

from the Combustion Subcommittee (CS) and Propulsion Systems Hazards Subcommittee (PSHS) will be held.

Paper sessions at the JPM will cover reduced sensitivity propulsion, solid rocket motor test and evaluation, minimum signature propulsion, gun propellant formulation for insensitive munitions, rocket propulsion test facilities, and sensors for propulsion and munitions management. A National Institute for Rocket Propulsion Systems (NIRPS) status and web capabilities demonstration, and blast environment testing and simulation for rocket engine test facilities comprise the focus of the two specialist sessions. A workshop on Thursday afternoon will discuss the utilization of excess RS-34 stages.

Together, the JPM and CS will host sessions on gun propulsion: gun charge ignition systems, gun propellant characterization and formulation, gun propulsion modeling, and small-caliber gun systems. The CS will also host a paper session on solid propellant characterization for rocket motors. The PSHS will host sessions on propulsion systems hazards.

MODELING AND SIMULATION SUBCOMMITTEE

The Modeling and Simulation Subcommittee (MSS) will discuss activities involving virtual engineering (VE); integration of propulsion components and integration of propulsion systems with other vehicle systems; uncertainty assessment and management; and integrated health management (IHM). Modeling and simulation ranges from hard computing, to soft computing, to knowledge-based

computing. It involves simulations ranging from ground-based testing to subscale and flight testing. The credibility assessments of models and simulations include verification and validation (V&V), but exclude certification or accreditation. Also discussed may be guides, procedures, or standards developed for conducting V&V and for managing simulation uncertainty. Modeling and simulation for understanding of phenomena and propulsion components, and for developing components of propulsion systems are excluded.

The MSS will host regular paper sessions, a workshop on computational fluid dynamics (CFD) modeling of solid rocket motor performance and environments, and a classified specialist session on the Conventional Prompt Global Strike ground test matrix. In addition, the Integrated Health Management, Simulation Credibility, and Virtual Engineering Panels will each hold their regular meetings to discuss progress and improvements in the areas of simulation techniques; model development; sensors and applications; and verification, validation, and uncertainty quantification for simulations.

Simulation Credibility, Verification, Validation, and Risk Panel

The panel's overall objective is to facilitate credible modeling and simulations, ranging from hard computing, to soft computing, to knowledge-based computing. The meeting will include virtual reality simulations for design, manufacturing, health management, and tests. The panel will also report on progress to date on the development of a JANNAF guide for uncertainty quantification and simulation credibility. Results from the Simulation Credibility Panel workshop held in Monterey in December 2012 will be presented, and participation in the development and review of the guide will be solicited.

Virtual Engineering (VE) Panel

The VE panel's objectives are to address issues in 1) the advancement and development of software tools to simulate propulsion devices, 2) the integration of subsystems into a propulsion system, and 3) the integration of the propulsion system with other systems to form a "system of systems." In line with these objectives, the panel also estimates system life-cycle cost and system risk. The VE panel will be soliciting ideas for tasks of tool developments, comparisons, and recommendations in the area of virtual engineering, for applications that may include CFD, trajectory analysis, cost modeling, and design tools.

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MSS Integrated Health Management (IHM) and LPS Engine Health Management (EHM) Panels

The IHM and EHM panels will hold a joint meeting to open the discussion to emerging technologies and challenges in the realm of sensors and sensing techniques, real-time monitoring, and information management and analysis. In addition, a status update on the progress towards a Joint Sensors Database spearheaded by the IHM and EHM panels will be given. The IHM Panel's objectives are to address issues in the management of off-nominal conditions that systems may encounter during their operational life cycle, including IHM system design, vehicle safety, and intelligent systems. The panel addresses all technologies required to build diagnostic (health state determination), prognostic (future health state determination), and data management/mining systems for managing the health of propulsion elements.

Conventional Prompt Global Strike (CPGS) Specialist Session

The CPGS is a classified session that will be held at a contractor facility. This all-day session details the Ground Test Matrix (GTM) developed for the CPGS system. The goal of the session will be to provide information on the GTM for subsystems such as guidance, navigation, and control; propulsion; warhead; aerodynamics; and thermal environments and systems. The aim is to collaborate with the JANNAF community for feedback on these test matrices as well as the CPGS data repository.

LIQUID PROPULSION SUBCOMMITTEE

The Liquid Propulsion Subcommittee (LPS) addresses technical problems and liquid engine systems issues of greatest national need. Topics include (1) technology, (2) components, and (3) engines; of (1) main propulsion, (2) divert and attitude control, (3) reaction control, and (4) post boost systems; applied to (1) tactical, (2) ballistic missile defense and strategic, (3) in-space, and (4) access to space propulsion. Liquid propulsion technology issues examined include overall engine system, component combustion, and propellant feed systems. Components issues that may be examined include liquid engine systems (thruster assembly and thrust vector control); liquid combustion elements (thrust chamber and gas generator/preburner); and liquid propellant feed systems (turbomachinery, tubes and ducting, pressurization systems, and propellant management). Fuel types include liquids, slurries, gels, endothermics, and cryogenics. Characterization of system and component performance is done through analysis, modeling and simulation, and engine testing and validation.

The LPS is hosting a *Test Practice and Standards Panel's* working meeting on a liquid rocket engines (LRE) test guide for liquid engine components. In addition, the LPS has six active panels meeting this spring:

The *Advanced Materials Panel* addresses rocket engine requirements for materials, process, and structures research in such areas as low-cycle fatigue, probabilistic design requirements, and thermal and chemical environmental effects. The panel has been working on a compiled list of materials testing capabilities in the USA in environments unique to rocket engines. A number of planned tasks are being considered. These include a task on identifying the materials and processes needs for NASA's exploration program; an advanced materials task identifying propulsion components and their materials requirements for improving performance, weight, cost, and productivity; and a task for recommending the best techniques for materials technology maturation to reduce time and cost.

The *Hydrocarbon Fuels Panel* addresses requirements and standards for hydrocarbon fuels and their impact on engine systems performance and operability, and facilitates the exchange of properties, test methodology, and modeling for development and evaluation of new and existing hydrocarbon fuels. The primary task of the panel is to review, recommend, and work to implement updates to the specifications for hydrocarbon fuels (including rocket grades of kerosene and methane). The panel actively works with government collaborators and propulsion contractors on engine and launch vehicle system requirements, and impacts on fuels systems, including safety, ground operations, and transportation. The panel also works with the fuel manufacturing community to ensure understanding of potential compositional variability impacts. Multiple tasks, including establishing guidelines for the specification of rocket-grade kerosene, and supporting the current military specification for rocket-propellant-grade methane, are ongoing. The panel also has an endothermic kerosene research and development task focused on (1) dissemination of results from R&D efforts to identify potential JP-7 replacements, and (2) prioritizing specified properties and performance criteria for fuel and catalyst systems. The task also includes recommending improved specification test methods for the identification of hydrocarbon classes and physical/chemical properties of endothermic kerosene.

The *Engine Health Management Panel* examines the potential use of health management technology to improve operability, reusability, and safety of liquid rocket engine systems. The EHM panel has identified several tasks to undertake, including the creation of an EHM roadmap

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Block Diagram
60th JANNAF Propulsion Meeting / 9th Modeling and Simulation /
7th Liquid Propulsion / 6th Spacecraft Propulsion Joint Subcommittee Meeting
April 29 – May 2, 2013

Cheyenne Mountain Conference Center	EPR Amphitheater	Colorado I	Colorado II	Colorado III	White River I	White River II	Arkansas / Platte	Rio Grande / Gunnison	Centennial II	Centennial III
Monday PM 4/29/2013	(1K)	(1L) LPS Liquid Engine Systems – I	(1M) LPS Combustion Stability and Dynamics	(1N) MSS Integrated Health Management Sensors and Sensing Systems – I	(1O) SPS Advanced Monopropellants ----- SPS Advanced Propellant Modeling and Analysis	(1P) SPS Hall Thrusters – I	(1Q) LPS Advanced Materials for Liquid Propulsion Applications	(1R) JPM Reduced Sensitivity Propulsion ----- JPM Solid Rocket Motor Test and Evaluation	(1S)	(1T)
Keynote Address 8:00 – 10:00 a.m. Tuesday, April 30 – Centennial Ballroom										
Tuesday AM 4/30/2013	(2A)	(2B)	(2C) LPS Chamber and Igniter Testing	(2D) JPM/CS Gun Charge Ignition Systems	(2E)	(2F) SPS Advanced Propulsion Instruments on the AEHF Satellite	(2G) LPS Liquid Engine Systems – II	(2H) MSS Integrated Health Management Sensors and Sensing Systems – II	(2I) LPS LRE Test Guide (Components) Working Meeting	(2J)
Tuesday PM	(2K)	(2L)	(2M) SPS Thermal Protection Systems	(2N) MSS Integrated Health Management Sensors and Sensing Systems – III	(2O) SPS State of the Art Monopropellants & Bipropellants	(2P) JPM Minimum Signature Propulsion	(2Q) LPS Turbomachinery – I	(2R) MSS Modeling and Simulation of Systems	(2S)	(2T)

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Cheyenne Mountain Conference Center	EPR Amphitheater	Colorado I	Colorado II	Colorado III	White River I	White River II	Arkansas / Platte	Rio Grande / Gunnison	Centennial II	Centennial III
Wednesday AM 5/1/2013	(3A)	(3B) LPS Hydrocarbon Boost – I	(3C) JPM Rocket Propulsion Test Facilities ----- JPM-VI Sensors for Propulsion and Munitions Management	(3D) SPS Pulsed Inductive Plasma Propulsion	(3E) SPS NanoSats – I	(3F) CS/LPS Modeling and Kinetics ----- CS/JPM Gun Propellant Characterization and Formulation	(3G) LPS Turbomachinery – II	(3H) MSS Virtual Engineering	(3I)	(3J)
Wednesday PM	(3K)	(3L) LPS Liquid Engine Systems – III	(3O) JPM Blast Environment Testing and Simulation for Rocket Engine Test Facilities Specialist Session	(3N) MSS Simulating Solid Rocket Motor Environments and Performance with Computational Fluid Dynamics Workshop	(3O) SPS NanoSats – II	(3P) SPS Hall Thrusters – II	(3Q) LPS Hydrocarbon Fuels Characterization of Properties and Performance	(3R) CS/JPM Gun Propulsion Modeling	(3S)	(3T)
Thursday AM 5/2/2013	(4A)	(4B) LPS Recent Developments in Hydrocarbon Fuels: Thermal Performance Characterization Workshop - I	(4C) SPS In-Space Propulsion Systems	(4D) SPS Hall Thrusters – III	(4E) PSHS Propulsion Systems Hazards – I	(4F) CS/JPM Small Caliber Gun Systems	(4G) LPS Turbomachinery, Feed Systems, and Pressurization	(4H) MSS Simulation Credibility, Verification and Validation	(4I) JPM National Institute for Rocket Propulsion Systems (NIRPS) Status and Web Capabilities Demonstration	(4J)
Thursday PM	(4K)	(4L) LPS Recent Developments in Hydrocarbon Fuels: Thermal Performance Characterization Workshop – II	(4M) SPS Advanced Propulsion Applications	(4N) SPS Electric Propulsion Modeling and Validation Experiments	(4O) PSHS Propulsion Systems Hazards – II	(4P) CS Solid Propellant Characterization for Rocket Motors	(4Q) LPS Injectors and Mixing Mechanics	(4R) JPM/CS Gun Propellant Formulation for Insensitive Munitions	(4S) JPM Workshop to Discuss Utilization of Excess RS 34 Stages	(4T)

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to determine the state of the art and technology readiness level; the development of a conceptual analysis of health management requirements for liquid rocket engine systems; and the determination of data analysis and fusion parameters and concepts for a liquid engine health management system—work to be done in conjunction with JANNAF MSS Integrated Health Management (IHM) Panel activities. The EHM and IHM Panels are currently working together to develop a database of sensors for propulsion systems. Other potential EHM panel tasks include examining potential synergy with turbine engine and solid rocket motor health management technology; developing a conceptual analysis of health management requirements for liquid rocket engine systems to determine similarities and differences for expendable and reusable systems, and between human-rated and non-human-rated; identifying potential concepts for data analysis and data fusion requirements for liquid EHM; determining testing requirements for liquid engine health management systems (EHMS); and developing a business case for the implementation of an EHMS in liquid rocket engines.

The *Combustion Stability Panel* identifies and promotes best practices in combustion stability designs. It establishes and refines guidelines and standards for identifying instabilities and certifying stable engines. In the longer term, it advocates and promotes the steady improvement of best practices through improved empirical and physics-based design tools. The long-term goal is the accurate a priori prediction of the onset and nature of combustion instabilities in liquid rocket engines and the quantification of stability margin. The panel emphasizes that modeling, experiments, and testing all contribute to designing for stability. To this end, the panel facilitates the integration of modeling, experiments, and testing directed at this complex, multiscale, multiphysics problem. Because of this complexity, and because the different manifestations of combustion instabilities depend on factors such as throttling, propellant combination, injector type, and stability aides, the panel also emphasizes and facilitates close collaboration among organizations, researchers, and developers working on combustion stability. Finally, with respect to modeling and simulation (M&S), the panel recognizes the strongly overlapping requirements between M&S for combustion stability, and M&S for the other three critical requirements of thrust chamber design: startup and shutdown transients, injector and chamber durability, and performance. The Combustion Stability Panel's current tasks include developing a roadmap for improving combustion stability design tools, and forming a digital collection of all the references listed in *NASA SP-194 Liquid Propellant Rocket*

Combustion Instability.

The *Test Practice and Standards Panel* addresses practices and standards for the test and evaluation of liquid engines, components, and propulsion/vehicle interaction. Work areas include best practices and standards for acceptance and qualification testing, such as life testing and margin testing approaches, failure investigations and lessons learned, safety, process control, and test infrastructure and data acquisition requirements. The panel has been engaged in two main tasks: establishment of a bibliography of testing resources and lessons learned, and the development of a guideline for testing of liquid rocket engines. The recently published guideline will be used to establish the nature and extent of testing required to qualify and acceptance-test components, engines, and engine systems for flight, including booster engines, upper-stage engines, and small pressure-fed thrusters. The panel is holding a working meeting on Tuesday for its next task of developing design guidelines for engine components. Collaboration is ongoing with the LPS Hydrocarbon Fuels Panel.

The *Turbomachinery Panel* will address various technical aspects of liquid propulsion turbomachinery to support the liquid propulsion turbomachinery community's focus on relevant technology development and information dissemination. The technical focus areas of the panel include turbomachinery design, development, and testing (both component and subcomponent); database development; best practices and guidelines; and technology roadmaps. Turbomachinery panel tasks include working towards publishing both a pump nomenclature guide and an inducer cavitation technology roadmap. The panel is planning a turbomachinery test data and design technology database, and has set up an inducer cavitation working group to identify an inducer workhorse test article and produce a list of water rig test facilities and capabilities.

SPACECRAFT PROPULSION SUBCOMMITTEE

The *Spacecraft Propulsion Subcommittee* (SPS) focuses on technical problems and issues associated with technology applied to space-based primary or auxiliary propulsion. These issues (for both system and component level) include design, development, materials, lifetime, performance, ground testing, flight testing, validation, qualification, spacecraft integration, fabrication processes, standards, and cost. Technologies of interest to SPS include: spacecraft chemical propulsion, aerocapture, electric propulsion, nuclear thermal propulsion, propellant management, solar sails, solar thermal propulsion, thermal protection systems, tether systems, and in-space propulsion infrastructure.

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Possible applications to these technologies are orbit-to-orbit transfer, attitude control, nonterrestrial ascent/descent, station keeping, deep space, formation flying, drag makeup, and orbital rephasing. SPS has three active panels meeting this spring:

The *Chemical Propulsion Panel* serves to provide a forum for the exchange of technical information relevant to the design of liquid propellant spacecraft propulsion systems for Earth orbital and planetary missions. The panel is tasked with a “spacecraft chemical propulsion system best practices” report encompassing design, test, and operation; it is also tasked with providing data for a technical database of propulsion systems for fielded spacecraft.

The primary interests of the *Electric Propulsion Panel* include orbit transfer, station-keeping, repositioning, and de-orbit. The panel is tasked with the characterization of electric propulsion capability needs for the member organizations (NASA, DoD, and industry). The goal of this task is to conduct a capability needs analysis based on intended electric propulsion uses of the Air Force, Army, Navy, and NASA. A comparison of these capability needs will be performed to identify common areas and need, and technology gaps. Other panel tasks may include electric propulsion databases and guidelines.

The *Micro-thrust Propulsion Panel* addresses technical problems and issues associated with the research, development, and application of micro-thrust propulsion technologies. The panel is primarily interested in miniature control, spacecraft precision control, and distributed structural control applications. The panel is tasked with characterizing the need and technical hurdles for using micro-thrust propulsion technology to enhance the capabilities of the Air Force, Army, Navy, and NASA. Panel activities will focus on identification and assessment of current capability gaps that micro-thrust propulsion can support, development of specific technology requirements to fill these gaps, and establishment of micro-thrust propulsion guidelines.

PRELIMINARY PROGRAM: The complete program is available on the meeting website at: <https://www2.cpiac.jhu.edu/meetings/Apr2013/pages/index.html>.

U.S. AIR FORCE ACADEMY TOUR: A tour of the U.S. Air Force Academy is scheduled for 7:30 a.m. on April 29, and will last approximately four hours. Tour attendees will visit the Space Systems Research Center, the Physics Lab, the Cadet Chapel, and the gift shop, where lunch may be purchased. The tour is limited to 45 attendees; please contact Pat Szybist at pats@jhu.edu to register.

SECURITY CLASSIFICATION: The overall security classification of this meeting is Secret. Unclassified sessions will be held at the Cheyenne Mountain Conference Center. A classified workshop will be held at a contractor facility. Please note that the classified meeting location may be further than walking distance from the hotel, and JANNAF may not always provide transportation services. For more information, please visit the meeting website.

HOTEL RESERVATIONS: JANNAF has negotiated special discounted room rates with the Cheyenne Mountain Conference Center; negotiated concessions include free wireless internet access in guestrooms; waived facility service charge fee; and complimentary parking. These concessions are available only to attendees who are staying at the CMCC and make their reservations before Monday, April 8, 2013. The room rate per night for all attendees is at the prevailing government per diem rate (currently \$83.00), plus tax (currently 9.4%). Reservations may be made either by telephone at 719-538-4000 or on the Web at: https://reservations.ihotelier.com/crs/g_reservation.cfm?groupID=843306&hotelID=15476. Please refer to JANNAF when making your reservations to assure the negotiated rates.

QUESTIONS: Technical questions may be addressed to the following CPIAC technical representatives:

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- SPS: David Owen
(dowen@cpiac.jhu.edu/443-718-5006)

For all other meeting-related matters, please contact Patricia Szybist (pats@jhu.edu/410-992-7302).

The 45th Combustion, 33rd Airbreathing Propulsion, 33rd Exhaust Plume and Signatures, and 27th Propulsion Systems Hazards Subcommittees Convene in Monterey

From December 3–6, 2012, the Joint Army-Navy-NASA-Air Force (JANNAF) Interagency Propulsion Committee's longest-running subcommittee meeting was held at the Hyatt Regency Monterey and the Naval Postgraduate School. Last year marked the 45th time the Combustion Subcommittee (CS) gathered to discuss and advance the state of the art in combustion research, modeling, and applications to propulsion. With the Exhaust Plume and Signatures Subcommittee joining in 2008, the pairing of the Combustion, Airbreathing Propulsion (APS), and Propulsion Systems Hazards (PSHS) Subcommittees has been a staple of JANNAF since 1997.

In total, 315 members of the propulsion community attended the meeting and presented 236 technical papers across each of the 4 subcommittee technical areas. Attendance was impacted by travel restrictions and, as a result, many of the CS and PSHS papers originally scheduled to be presented in December will be shown at the April 2013 JANNAF Propulsion Meeting (JPM). In addition, the December meeting proceedings will contain 14 papers that were unable to be presented in Monterey. CPIAC thanks all December meeting participants and everyone who tried their best to attend.

KEYNOTE

Attendees enjoyed a keynote address given by Mr. Curtis Johnson from Blue Origin, LLC. Mr. Johnson's long-time participation in JANNAF within the Combustion, Liquid Propulsion, and Exhaust Plume and Signatures Subcommittees gave insight into what would pique the interests of those gathered in Monterey: a keynote with lots of steam and fire(!) from Blue Origin's development efforts of the BE-3 engine. In 2007, Mr. Johnson joined Blue Origin to lead the development of its 100,000 lbf thrust liquid hydrogen/oxygen booster engine. This engine represents the first attempt at a tap-off cycle flight engine in the U.S. and will eventually power a reusable booster system. Mr. Johnson shared with the JANNAF community the specific design philosophy and trades that informed the decision for the engine. He also provided background information on Blue Origin and the booster system.



Curtis Johnson presents the development efforts of the BE-3 engine.

Mr. Michael Weiderhold of New World Solutions, a small business supporting the development, deployment, and operation of the national geospatial intelligence infrastructure, presented an invited briefing titled "New Directions in Persistent GEOINT Remote Sensing." This briefing covered the gamut of national capabilities and described the technical aspects of legacy, new, and planned persistent geospatial intelligence (GEOINT) remote sensing systems. The JANNAF community can be a valuable source of input to geospatial-intelligence professionals in the areas of combustion, flowfield, and signature phenomenology, and Mr. Weiderhold's participation at the meeting offered an opportunity for the two communities to connect. At the conclusion of the briefing, attendees discussed the JANNAF community's need for GEOINT sensing systems data to validate predictive capabilities; they also explored ideas on improvements to the sensing capability



Attendees converse before the keynote address.

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Subcommittees Convene in Monterey...continued from page 10

to increase its accuracy and effectiveness. This briefing was held at the classified level; the presentation may be requested from CPIAC's Facility Security Officer Mary Gannaway (mtg@jhu.edu).

HIGHLIGHTS

The *Airbreathing Propulsion Subcommittee (APS)* had numerous sessions on propulsion systems, components, and technologies, including scramjets, turbine-based combined cycle systems, expendable turbine engines, combustion control, inlets/isolators/combustors, fuels, and lightweight structures. A number of sessions were specifically dedicated to results of the Hypersonic International Flight Research Experimentation (HIFiRE) Flight 2. These sessions featured details on the launch and payload systems as well as flight data (including analysis and validation of models) using the HIFiRE Flight 2 Data Set. Progress towards HTV-3X was examined in a session dedicated to configuration development and Medium Scale Critical Components (MSCC) testing. A classified session on the X-51A scramjet engine demonstration program provided updates on test flight 2, information on the investigation into the engine unstart, and the Air Force's plans moving forward.

Technologies presented at the APS meeting and the discussions held between members of the community are essential to the development of hypersonic propulsion systems and vehicles that will move beyond the realm of technology development and demonstration and into use as reliable fielded systems.

The *Combustion Subcommittee (CS)* meeting held sessions dedicated to aluminum combustion, gun technology and modeling, enhanced blast, reactive systems, kinetics, and explosive performance. Despite restrictions preventing many of the regular CS community members from traveling to the December meeting, over 100 individuals met in Monterey for CS, and over 50 papers were presented. In addition to the papers presented in December, CS will be holding seven sessions at the April 2013 JANNAF meeting in Colorado Springs, in the areas of guns (in collaboration with the JPM) and solid rocket motor

propellant characterization.

The work presented by the combustion community at this JANNAF conference is critical to the development of high-performance, green, and safe propulsion systems necessary to advance the state of the art in airbreathing propulsion, liquid and solid propulsion, insensitive munitions, and explosives.

The *Exhaust Plume and Signatures Subcommittee (EPSS)* meeting included sessions on the phenomena associated with the exhaust from rockets, ramjets, aircraft, space, and gun propulsion systems.

These phenomena can be divided into three technical areas: plume flowfields, plume radiation, and a broad area incorporating other plume effects. Some of the best papers from the EPSS session focused on new applications and validation cases for existing plume flowfield and signature codes. Examples included an analysis of the Orion launch abort system plume flow over the capsule body, a comparison of signature prediction when using pure and multicomponent particulate models, and a look at overhead sensor data from a hypersonic vehicle flight test.

New code advancements, including updates to the Standard Plume Ultraviolet Radiation Code (SPURC) 3.0, Spacecraft/Orbiter Contamination Representation Accounting for Transiently Emitted Species model (SOCRATES-P), Fast Line-of-sight Imagery for Target and Exhaust Signatures radiation transport solver (FLITES), the PLume Simulation (PLUS) solver, and Rocket Plume Flowfield Model (RPFM), were presented. In addition, new models for multiphase particulates, chemistry and radiation models for hypersonic wake signatures, turbulent extinction models, and advanced radiation transport models were presented.

The advancements in modeling plume flowfield, plume signature, and hardbody effects discussed at this JANNAF meeting demonstrate significant progress in the plume and signatures community to predict, quantify, and validate these phenomena. The EPSS community

continues to make improvements in these areas and the body of work assembled for this meeting is an affirmation of its

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Subcommittees Convene in Monterey...continued from page 11

efforts.

The *Propulsion Systems Hazards Subcommittee (PSHS)*'s technical program consisted of eight sessions, with a total of 52 papers covering safety classification, insensitive munitions technology, impact- and shock-induced reactions, and thermal decomposition of energetic materials.

The Propulsion Systems Safety and Hazard Classification Panel held a session on energetic liquid hazards. This session included papers on the hazard classification of monopropellants including AF-M315E and the behavior of liquid monopropellants AF-M315E, AF-M205B, and LMP-103S in slow cookoff tests.

PSHS will be holding two sessions at the upcoming JPM in Colorado Springs in April 2013. These sessions provide an opportunity for authors not able to participate in the Monterey PSHS meeting to present their work without the need to wait for the April 2014 PSHS meeting.

WORKSHOPS

Workshops held at the December meeting provided a forum for discussion of issues requiring the attention of the entire community. The topics under investigation included hydrocarbon fuels, fuel properties and kinetics, pressure-gain combustion, turbine-based combined cycle (TBCC) distortion, large scramjet engine testing, and simulation credibility.

Large Scramjet Engine Testing

Over 90 dedicated community members worked Tuesday evening to participate in the Airbreathing Propulsion Large-Scale Testing Workshop. The group discussed large-scale engine testing techniques (LSETT), analysis and uncertainty of results, and best practices that can be established and shared amongst the community. An overview of the medium-scale critical components (MSCC)/medium-scale freejet (MSFJ) and performance analysis was given and open for discussion.

Simulation Credibility Workshop

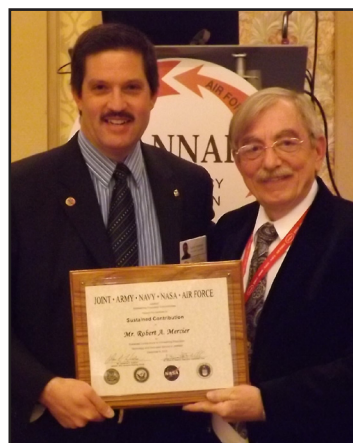
The Modeling & Simulation Subcommittee's Simulation Credibility Panel met to continue work on its development of a guide to verification, validation, and uncertainty quantification in simulations. In an effort to gain a complete perspective on this project, the workshop was the 7th held out of cycle. A presentation of progress reports on four chapters of the guide demonstrated that these chapters

appear to be progressing towards a guide release in 2014. Identified as the primary hurdle to publication of the guide is the lack of a leader for a proposed chapter on the statistical design of experiments; however, a plan for identifying a leader for this chapter was discussed during the workshop. Following a comprehensive review of the first draft of the guide, the initial release is expected to occur in late 2014. While the Simulation Credibility Panel will meet and provide a status update on the progress of the guide, a follow-up workshop will not be held at the upcoming April 2013 MSS subcommittee meeting.

AWARDS

Mr. Bob Mercier of the Air Force Research Laboratory received the APS award for Sustained Contribution. Mr. Larry Huebner, the APS Technical Steering Group (TSG) chairman, presented the award with the following words, "Mr. Mercier has substantially and continuously contributed to the success of JANNAF and the APS subcommittee. Through tireless commitment to science and technology development of hydrocarbon scramjets and his role as Executive Committee member and liaison to the Airbreathing Propulsion Subcommittee, Mr. Mercier has made significant impact on high-speed propulsion systems and the JANNAF community."

Mr. Dan Schwartz, the PSHS TSG chairman, announced the award of Certificate of Appreciation for Sustained Contributions to Propulsion Systems Hazards Technology to Ms. Alice Atwood of the Naval Air Warfare Center Weapons Division. Mr. Schwartz stated,



Larry Huebner (left) presents Bob Mercier with the APS Award for Sustained Contribution.

"Ms. Atwood's research, publications, presentations, and involvement in the areas of propellant and energetic ingredients characterization and hazard testing are consistently of the highest quality and are the benchmark for exemplary service to JANNAF, PSHS, and the international hazards community. In addition to the contributions listed above, Alice has been an exceptional mentor and the inspiration for many of the researchers at China Lake

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Subcommittees Convene in Monterey...continued from page 12

who have become an integral part of PSHS and conducted world-class research in propulsion systems hazards.” Ms.



Jeff Davis (right) accepts a Certificate of Appreciation for Alice Atwood from Dan Schwartz.

Atwood was not able to attend the JANNAF meeting and Dr. Jeff Davis accepted the award on her behalf.

Dr. C. Rao Surapaneni of the U.S. Army Armament Research, Development & Engineering Center received the JANNAF Executive Committee Lifetime Achievement Award, but, unfortunately, could not attend the meeting due to travel restrictions. While his award was not presented at the meeting, it was mailed to his organization for presentation at a later date, with the words, “This award is made in recognition of outstanding contributions to JANNAF and the international

research community in the area of energetic materials. Under his leadership, the Army has qualified many explosives, propellants, and pyrotechnics that found application in mortars, artillery, reactive armor, and small and medium caliber guns. He has received more than 20 commendations,

citations, and medals; published more than 40 papers; received 4 U.S. Army R&D Achievement Awards; and was selected as the Honorary Fellow of the High Energy Materials Research Society of India in 2009. Through personal dedication, he has strengthened the U.S. capability in this critical technical area.



PROCEEDINGS

Meeting chair Marty Venner with award presenters Larry Huebner (left) and Dan Schwartz (right).

Starting with the April 2012 meeting, CPIAC will be publishing the proceedings from the JANNAF meeting separately from the final reports of the workshops.

The proceedings of the December JANNAF meeting are available now; qualified customers may contact CPIAC at 410-992-7300 for more information or to order.

A separate JANNAF workshop compilation will include this past December’s workshops as well as the workshops from the previous April meeting.

NETWORKING NIGHT

Attendees were invited to the CS/APS/EPSS/PSHS Joint Subcommittee networking night on Wednesday. The well-received event provided an opportunity for collaboration and discussion in an informal setting.



LPS Subcommittee Releases the 1st Edition of *JANNAF Test and Evaluation Guidelines for Liquid Rocket Engines*

The Test Practices and Standards Panel (TPSP) of the Joint Army-Navy-NASA-Air Force (JANNAF) Liquid Propulsion Subcommittee (LPS) recently completed and released the initial volume of the *JANNAF Test and Evaluation Guidelines for Liquid Rocket Engines* (JANNAF-GL-2012-01-R0), dated December 2012 (see ad on following page). This first release of the guideline is the result of many years of effort by the membership of JANNAF's LPS TPSP. The product represents inputs from senior technical membership from over twenty distinct organizations and work sites. Whereas the content therein does not represent the official or approved position of any of the organizations involved in its preparation, it nevertheless provides an initial starting point for the rocket propulsion community's further discussion about the appropriate general and specific test requirements for liquid rocket engines (LREs). Furthermore, it provides users and their organizations with the benefit of several decades of practitioner's knowledge and lessons as captured in the subject matter of the volume.

Approved for public release, the focus and content of this first edition and volume relate primarily to launch vehicle LRE engine-level testing and associated integrated vehicle propulsion system level testing. The document features the following items:

- 1 SCOPE*
- 2 REFERENCE DOCUMENTS*
- 3 GENERAL TEST GUIDELINES*
- 4 DEVELOPMENT AND QUALIFICATION TESTS*
- 5 ACCEPTANCE TESTS*
- 6 PRELAUNCH VALIDATION AND OPERATIONAL TESTS*
- APPENDICES:
 - A: DEFINITIONS AND DESCRIPTIONS*
 - B: OTHER RELEVANT DISCUSSION*
 - C: REPRESENTATIVE CAMPAIGNS AND TEST TURNAROUND RATES FOR A VARIETY OF R&D AND FLIGHT LRE TESTING*
 - D: HUMAN-RATING CONSIDERATIONS FOR LRE TESTING AND EVALUATION*
 - E: SAMPLE CASES OF USING TEST GUIDELINES TO PLAN TEST PROGRAMS*
 - F: ACRONYMS*

Although testing at the component level is not discussed in detail, it is also recognized by the TPSP as important and valuable. Therefore, detailed treatment of component testing will be incorporated into planned subsequent volumes of the guideline. An extension of the current document to include stage-level test considerations is also planned. Similarly, although reaction control systems (RCS) and spacecraft propulsion are not addressed in the current draft edition, these areas will also be incorporated into planned future volumes of the guideline.

For additional questions about obtaining this manuscript, please contact Mr. Ron Bates at rbates@cpiac.jhu.edu, or call CPIAC at 410-992-7300 to order. For matters pertaining to technical topics within the guideline, and for participation in development of subsequent volumes of this document, please contact current TPSP Chair Dr. Kendall Brown at kendall.brown@nasa.gov, or former TPSP Chair Dr. Wayne Van Lerberghe at wayne.m.vanlerberghe@aero.org.

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JANNAF-GL-2012-01-R0

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42nd SMBS / 38th PEDCS / 29th RNTS / 27th SEPS To Meet

December 9–12, 2013, Charleston, SC

Plans are underway for the Joint Army-Navy-NASA-Air Force (JANNAF) 42nd Structures and Mechanical Behavior (SMBS) / 38th Propellant and Explosives Development and Characterization (SEPS) / 29th Rocket Nozzle Technology (RNTS) / 27th Safety and Environmental Protection (SEPS) Joint Subcommittee Meeting, to be held Monday through Thursday, December 9–12, 2013, at the Charleston Convention Center. The host hotel is the Embassy Suites; a classified meeting site, if required, is to be determined.

CALL FOR PAPERS: The call for papers will be released in April; abstracts are due **June 27, 2013**.

MORE INFORMATION: Program and keynote information will be available soon. Please visit www.jannaf.org for updates. A preview of the meeting will be featured in the Fall 2013 issue of *JANNAF News*.

QUESTIONS: Technical questions may be addressed to the following CPIAC technical representatives:

- SMBS, PEDCS, and RNTS: David Owen (dowen@cpiac.jhu.edu/443-718-5006)
- SEPS: Andrew Taylor (ataylor@cpiac.jhu.edu/443-718-5001)

For all other meeting-related matters, please contact Patricia Szybist (pats@jhu.edu/410-992-7302).

Davis Appointed to JANNAF EC

Dr. Jeffery Davis has been appointed to the JANNAF Executive Committee as the new Navy EC member. Since 2010, Dr. Davis has been head of the Naval Air Warfare Center Weapons Division's Energetics Research Division in China Lake, CA. He received his M.S. in Physics from American University in 1990, and became a Research Physicist for White Oak and then China Lake. He completed his Ph.D. in Physics in 1997, also from American University, and, in 2003, was sent to the Massachusetts Institute of Technology Sloan School of Management, where he earned his M.B.A. in 2005. Upon returning to China Lake, Dr. Davis led various Lean Six Sigma projects; one of these drove the development of the Naval Air Systems Command-China Lake's technical education strategy and included the creation of a Weapons 101 course. In 2008, he returned to the technical world, becoming the head of the Weapons Lethality Analysis Branch and the team lead for Novel Lethality and Missions. In the latter role, he was heavily involved in national and international communities in the area of novel energetics.

Dr. Davis is committed to maintaining JANNAF as the premier activity in the United States for propulsion technology collaboration.

Students Save on Registration

Did you know college and university students can attend and present at JANNAF meetings? And you can save at least \$650 off your registration fee! Students qualify if they are U.S. citizens attending a U.S. university that has a government contract. Students follow the same registration process as other attendees. When completing the registration form, ask your university's Facility Security Officer (FSO) to sign and provide a DLIS number. Your FSO will be an advisor, professor, department administrator, or human resources representative within your university. To get the student rate of only \$200, just select the student fee when you register, and show your student ID when you pick up your badge at the registration desk. If you have any questions on the student registration process, please contact CPIAC FSO Mary Gannaway at 410-992-7304, ext. 211.

In Memoriam



Our dear friend and colleague, **David Wilburn Booth**, 70, passed away January 13, 2013, in Greensboro, NC. David's exciting career in solid rocket propellant research carried him all over our country. He was born in Tuscaloosa, AL, and received his B.S. in Chemical Engineering from Mississippi State University in 1965. While in school, he married his sweetheart, Phyllis, and logged time with the Army National Guard. His first job out of college was with West Virginia Pulp and Paper in Charleston, SC. He came home after one year for his mother-in-law's funeral in Huntsville and Phyllis's uncle pointed him toward a job on Redstone Arsenal. He worked for Rohm & Haas for four years, then went across Redstone Road and worked for Thiokol Corporation from 1970 to 1990. He then heard the call of the Advanced Solid Rocket Motor (ASRM) program and joined GenCorp/Aerojet in Iuka, MS, from 1990 to 1993, followed by a one-year stint with United Technologies Chemical Systems in San Jose, CA. After a hiring freeze lifted, he headed south to Ridgecrest, CA, and worked from 1995 to 1999 for the Naval Air Warfare Center Weapons Division (NAWCWD). He then left the U.S. government to enter an entirely entrepreneurial world by working for Technanogy/Nano-Technology from 1999 to 2003 (Irvine, CA). He "made the big loop" (as he would say), when he came back to Aerojet via ARC in 2003, working both in Gainesville, VA, and then moving with the company to Orange, VA, where he retired in 2008.

David's many accomplishments included development and scale-up of numerous fielded propellants that are still in production today, most notably the Sidewinder flight motor reduced-smoke propellant. He saw the first 420-gallon mix of Sidewinder propellant prepared at Thiokol/Huntsville, Hercules/ABL, and Atlantic Research Corporation/Camden. He pioneered the incorporation of nano-aluminum into propellants to achieve high burning rates. He was instrumental in transitioning Patriot MSE and ESSM to production, and improving the processing and aging parameters of these propellants. In his over 40 years of experience, he had an intimate knowledge and understanding of propellant characteristics, such as hazards sensitivity, processing, rheology, mechanical properties, aging, ballistic properties, combustion stability, and bonding. David's propellant subspecialty was the use of bonding agents in AP-containing propellants—he was a lifelong student and teacher of the mechanisms, properties, and utility of bonding agents. He was a member of the Propellant Development and Characterization Subcommittee (PDCS), and initiated, sponsored, and conducted two Tepanol® processing workshops at JANNAF meetings. He was also an invited speaker at several nanoaluminum processing workshops sponsored by JANNAF over the years. David published over 100 papers, reports, and patents during his career, and was awarded the CPIAC/JANNAF Lifetime Achievement Award in 2008.

David's greatest contribution to the propulsion industry, however, was his mentoring of the next generation. David always found time to explain the chemistry, the process, and the mechanisms for propellant formulation. There are people all over this nation who can claim David Booth taught them something about solid propellant and our greater purpose, always with a smile, and always as a friend. He leaves behind his wife of 51 years, their daughter Mary Beth, a grandson, and a granddaughter.

Volume 5 of the JANNAF Journal of Propulsion and Energetics is Available!

Volume 5 of the *JANNAF Journal of Propulsion and Energetics* was released in April 2012 and distributed at the 2012 JPM and joint subcommittee meeting. The issue features papers in the areas of hypersonic propulsion, exhaust plume, solid propulsion, and electric propulsion technologies. If you have not yet received Volume 5, be sure to pick up a copy at the next JANNAF meeting in April 2013. You may also order one by calling CPIAC at 410-992-7300.

The *JANNAF Journal Call for Papers* is ongoing. Submit your manuscript now for consideration in Volume 7. For questions about manuscript style or preparation, figures and graphics, submission procedures, and deadlines, please contact Journal Managing Editor Nicole Miklus at nmiklus@cpiac.jhu.edu. For matters related to technical topics, special focus areas, research, and data, please contact Technical Advisor Ron Bates at JournalTA@cpiac.jhu.edu.



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Calendar of JANNAF Meetings

60th JPM / 9th MSS / 7th LPS / 6th SPS: April 29–May 2, 2013

Cheyenne Mountain Conference Center, Colorado Springs, CO

Deadlines:

- | | |
|----------|--|
| April 1 | Papers and paper clearance forms due to CPIAC |
| April 8 | Deadline for hotel reservations at the Cheyenne Mountain Conference Center |
| April 15 | Registration forms due. Deadline for discounted registration fee of \$850; after April 15, the fee is \$975. |
| | Presentations due |

For additional information and registration, please visit: <https://www2.cpiac.jhu.edu/meetings/Apr2013/pages/index.html>.

42nd SMBS / 38th PEDCS / 29th RNTS / 27th SEPS: December 9–12, 2013

Charleston Convention Center, Charleston, SC

Deadlines:

- | | |
|---------|---|
| June 27 | Abstracts due |
| Nov 11 | Deadline for hotel reservations at Embassy Suites, Charleston |
| | Papers and paper clearance forms due |
| Nov 25 | Registration forms due. Deadline for discounted registration fee. |
| | Presentations due |

Additional details will be available soon. Please visit: www.jannaf.org for updates.

61st JPM / 46th CS / 34th APS / 34th EPSS / 28th PSHS: May–June 2014

Location TBD

10th MSS / 8th LPS / 7th SPS: December 2014

Location TBD

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

Visit the JANNAF website for meeting updates: www.jannaf.org

Policy on Non-Government Attendees at JANNAF Meetings: Attendance is restricted to invited U.S. citizens. Non-government attendees must have their employment confirmed with an organization certified with the Defense Logistics Agency (DLA) to obtain export-controlled technical data AND be certified by a sponsoring government official from one of the participating JANNAF agencies. To attend the classified sessions, attendees must also possess a personal security clearance of at least Secret with a need-to-know in the areas of rocket, missile, space, aircraft, or gun propulsion. Information concerning registrations with DLIS can be obtained by contacting DLIS at (800) 352-3572 (www.dlis.dla.mil/jcp/). Questions concerning attendance eligibility should be directed to the CPIAC Facility Security Officer, Mary Gannaway, at (410) 992-7304, ext. 211.