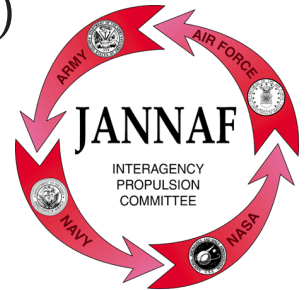


JANNAF INTERAGENCY PROPULSION COMMITTEE

JOINT ARMY-NAVY-NASA-AIR FORCE

Programmatic and Industrial Base Meeting (PIB)
11th Modeling and Simulation (MSS)
9th Liquid Propulsion (LPS)
8th Spacecraft Propulsion (SPS)
Joint Subcommittee Meeting



Meeting Invitation

Hyatt Regency Phoenix
Phoenix, Arizona

5 - 8 December 2016

Last updated 11/16/16

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited

JANNAF Meeting Invitation - December 2016

You are invited to attend the December 2016 meeting of the Joint Army-Navy-NASA-Air Force (JANNAF), which will consist of the Programmatic and Industrial Base (PIB) Meeting; and the Joint Meeting of the 11th Modeling and Simulation / 9th Liquid Propulsion / 8th Spacecraft Propulsion Subcommittees. This meeting will be held **Monday through Thursday, 5 - 8 December 2016, at the Hyatt Regency Phoenix in downtown Phoenix, Arizona.**



The Program Chair for the meeting is **Dr. Michael D. Watson**, NASA Marshall Space Flight Center, Huntsville, AL. A complete list of Program Committee Members can be found on pages 6-7.

The JANNAF Interagency Propulsion Committee coordinates fundamental research, exploratory development, and advanced development programs; standardizes procedures for nomenclature; promotes and facilitates the exchange of technical information; and accomplishes problem solving in the areas of joint agency interest on propulsion systems for missiles, rockets, boosters, spacecraft, satellites, and guns.

The **Programmatic and Industrial Base** areas of interest include integrated program plans and key decision points; industrial base assessments; risks and opportunities with respect to skills, knowledge, and experience; identification of commonality, innovative acquisition, and partnership opportunities; integrated assessments to identify rocket propulsion industrial base (RPIB) rationalization opportunities; special actions from senior agency, department, or Executive Office of the President (EOP) leadership; and information provided to decision makers for either situational awareness or policy decisions.

JANNAF subcommittees focus their resources on technical issues of interest to the JANNAF agencies.

The **Modeling and Simulation Subcommittee (MSS)** activities include modeling and simulation of systems; virtual engineering; development of software analogs of propulsion devices or systems; software integration-coupling of diverse simulation tools to enable more detailed, system-of-systems analysis and simulation; simulation credibility-uncertainty, verification, validation, reliability, and risk; and integrated health management-identification and management of off-nominal conditions in propulsion.

The **Liquid Propulsion Subcommittee (LPS)** addresses technical problems and issues of greatest national needs associated with liquid engine systems, including liquid and gel propulsion technology topics that include the overall engine system, combustion components, and propellant feed systems.

The **Spacecraft Propulsion Subcommittee (SPS)** focuses on the full array of spacecraft propulsion technology interests including electric propulsion, advanced chemical propulsion, solar thermal propulsion, nuclear thermal propulsion, aerocapture, solar sails, tether systems, and technologies for the future.

Table of Contents

Meeting Scope	2
Meeting Site / Hotel Information	3
Transportation and Parking	3
Registration Information	4
DoD Meeting Approval	4
General Meeting Information	5
Upcoming JANNAF Meetings	5
Program Planning Committee	6-7
Program Highlights / Keynote	8-10
Daily Schedule	10-13

Johns Hopkins University Whiting School of Engineering Energetics Research Group (JHU WSE ERG) provides technical and administrative support to the JANNAF Interagency Propulsion Committee.
JHU WSE ERG - 10630 Little Patuxent Parkway, Suite 202, Columbia, MD 21044-3286
Telephone: (410) 992-7300 • Telefax: (410) 730-4969 • Email: info@erg.jhu.edu • Web: www.erg.jhu.edu

JANNAF Meeting Invitation - December 2016

Hotel Information



Sleeping rooms have been reserved with the **Hyatt Regency Phoenix**, located at 122 North Second Street, Phoenix, AZ 85004. Amenities include complimentary high speed internet access in guestrooms and discounted parking.

The JANNAF room rate per night for all attendees will be at the

FY2017 GSA per diem rate, currently \$118 plus tax (12.57% at this time), for single or double occupancy.

These discounted rooms will be held for JANNAF attendees until the deadline of Friday, 18 November 2016 at 5:00

p.m. MST, or until they sell out, whichever comes first.

Each individual is responsible for his/her own reservation.

Reservations may be made either on the Web (recommended) or by telephone.

MAKE YOUR RESERVATION ONLINE:

Click on the reservation link on the [Hotel Page](#) of the meeting website to make your reservation. **Using this link will give you direct access to the JANNAF meeting discounted room block.** Changes to your reservation can also be made via this weblink.

For additional reservation assistance, please call (888) 421-1442. Be sure to reference the JANNAF Propulsion Meeting.

Need to cancel your reservation? Be sure to do so no less than 48 hours prior to arrival to avoid paying a cancellation penalty.

Transportation and Parking

The Phoenix Sky Harbor International Airport (PHX) is located just 6 miles from the Hyatt Regency Phoenix. The hotel does not offer airport shuttle service. However, [SuperShuttle](#) is offering a discounted rate to JANNAF attendees for shared-ride van service between the airport and hotel. See below for more information.

There may be specific **travel guidelines/restrictions for DoD employees**. Please check the [meeting website](#), with respect to restrictions regarding use of personal vehicles or rental cars.

Airport transportation costs range from \$2 per person for the Valley Metro Light Rail, which stops less than one block from the Hyatt, to \$13-18 for a cab or Uber, or [SuperShuttle](#), which costs \$11 per person each way when booked online with the JANNAF attendee discount code. More information can be found on the [Hotel Page](#) of the [meeting website](#).

For those driving personal vehicles or renting a car, a 25% discount on self-parking in the hotel's garage is offered to JANNAF attendees staying at the Hyatt. The standard overnight self-parking rate is currently \$19 per day before discount, with in/out privileges if charged to your guest room. For those not staying at the hotel, the daily parking rate is currently \$12. Parking rates are subject to change. Other parking options near the hotel are provided on the [Hotel Page](#) of the meeting website.

Meeting Site

All sessions will be held at the **Hyatt Regency Phoenix** in downtown Phoenix, Arizona. For attendance at this meeting, please see the Security/Attendance Requirements and Registration instructions below.

Security/Attendance Requirements

The overall security classification of this meeting is Unclassified.

To qualify to attend this meeting, all attendees must be employed by a DoD, DoE, or NASA facility, or with a DoD, DoE, or NASA contractor facility eligible for receipt of militarily-critical technical data. All attendees must also be **U.S. citizens qualified to receive unclassified, limited-distribution information. No foreign nationals will be permitted to attend.**

Questions concerning attendance eligibility should be directed to the JHU WSE ERG Facility Security Officer, Mary Gannaway, at (410) 992-7304, ext. 211 or mtg@jhu.edu.

Registration

Registration is now open. Register by Monday, 28 November to take advantage of the lowest fee.

To register, you must have a JANNAF Secure Portal account. Please visit the [Registration Page](#) of the meeting website for additional information and important links.

Registration for this JANNAF meeting is a **two-part process**; to complete this process:

1. Register for the meeting via the **JANNAF Secure Portal**.
2. Pay the registration fee (Portal account not required).

Additional information and important links for completing your meeting registration can be found at <https://www.jannaf.org/mtgs/2016Dec/pages/registration.html>.

JANNAF Meeting Invitation - December 2016

Registration Fee

For details of what the registration fee includes, please go to the [Registration Page](#) of the meeting website. Please reference the registration fee chart below to determine the amount applicable to your registration. **The dates noted below are based on payment being received.**

Payment Received	Regular Attendee	Student*
<i>on or before 11/28/16</i>	\$1,150.00	\$250.00
<i>11/29/16 or later</i>	\$1,300.00	\$250.00

* A discounted registration fee is offered for **full time** students, interns, and cooperative education students. Students must meet the security/attendance requirements noted above and present current student identification upon registration on-site.

Registration payment will be accepted via check payable to JHU WSE Energetics Research Group, purchase order (government only), or by credit card (VISA, MasterCard, American Express) using the Registration Payment site available online. Go to the [Registration Page](#) of the meeting website, and click on “Pay Registration Fee.”

Attendees are encouraged to complete step one of the registration process via the JANNAF Secure Portal, and submit payment, on or before Monday, 28 November 2016 to ensure prompt registration upon arrival at the meeting. Credit card payments made electronically via the Web will be charged immediately; a receipt will be sent to you via email.

Cancellation Policy

Please note our cancellation policy— Written (email) cancellations submitted on or before 28 November 2016 will receive a full refund minus an administrative fee of \$50.00. Cancellations made after 28 November 2016 **will not be refunded**. Substitutes are welcome as long as the request for substitution is from the original attendee; attendance eligibility is appropriately met by the substitute; and the original and substitute attendee are from the same organization to facilitate transfer of registration funds. Please contact Shelley Cohen via email to scohen@erg.jhu.edu to transfer or cancel your registration.

On-Site Registration / Check-in

The JANNAF Registration desk will be located on the second floor of the Hyatt Regency Phoenix. Photo identification is required upon registration or check-in. The desk will be open Monday, 5 December from 10:00 a.m. - 5:00 p.m., and Tuesday, 6 December through Thursday, 8 December from 7:00 a.m. - 5:00 p.m.

Attention DoD

An approval package to certify the December 2016 JANNAF Meeting as a “government approved” conference has been submitted by Mr. Frank Tse, member of the JANNAF Executive Committee from the Naval Surface Warfare Center in Indian Head, MD.

DoD approval of conferences takes several months and judging from past meetings, may not be received until just prior to the start of the December meeting. **Interested DoD attendees are strongly encouraged to obtain a JANNAF Secure Portal account now and register for the meeting (step 1).** This step does not require travel or training office authorization as it does not include a financial commitment. Payment of the registration fee may be completed as soon as permitted.

Attire

There is no official dress code for JANNAF conferences; however, most attendees wear business or business casual attire. When packing, keep in mind that it can be difficult to regulate the temperature in meeting rooms to everyone’s liking, and any changes may not be noticeable quickly, so it is best to bring a sweater or jacket and dress in layers.

Dining

Approximately one and one-half hours for lunch has been built into the program each day. Restaurants in the hotel include Terrace Cafe (breakfast), Einstein Bros. Cafe (breakfast and lunch), Networks Bar & Grill (lunch, dinner, and late night), and Compass Arizona Grill and Lounge (dinner and late night). Additionally, the hotel is located in downtown Phoenix with many dining options within a short walk.

Networking Room

The Atrium on the 2nd floor of the hotel will serve as the JANNAF networking area; a light continental breakfast and mid-morning coffee break along with mid-afternoon refreshments will be served at the times stated in the program. This area will be open Monday from 10:00 a.m. - 5:00 p.m., and Tuesday - Thursday from 7:00 a.m. - 5:00 p.m. Please note that scheduled breaks are included in session agendas where time permits.

JANNAF Meeting Invitation - December 2016

Networking Night

Come enjoy an evening with fellow JANNAF attendees on Wednesday, 7 December 2016, from 6:30-8:00 p.m., in Regency Ballroom Salons C & D at the Hyatt Regency Phoenix. A complimentary meal is included. There is no charge for meeting attendees; however, guest tickets may be purchased on the Registration Payment site for \$40 (admission is free for children five and under). Be sure to wear your JANNAF badge to attend the event.

Reading Room

All papers presented in the technical sessions and received in time will be available to read via JANNAF touch-screen tablets. The reading room, located in the Borein Room, will be open Monday from 1:30 p.m. - 4:30 p.m., and Tuesday through Thursday from 8:00 a.m. - 4:30 p.m. Reproduction of reading room papers is not permitted.

Side Meetings

A limited number of meeting rooms of varying sizes, located on the 2nd and 3rd floors of the hotel, are available for JANNAF-related side meetings. Audiovisual equipment will not be provided. Please contact Shelley Cohen at scohen@erg.jhu.edu to reserve a room as soon as possible. Requests may also be made on-site during the meeting. Rooms will be assigned first-come, first-served.

Program Changes

Meeting programs will be distributed to attendees upon registration/check-in on-site. Note that **Final Programs are Distribution Statement C and should be secured when not in your possession.** Changes to the Final Program will be posted on touch screen monitors located in the Atrium. Attendees should periodically check for program updates and administrative announcements and note these updates in their copy of the Final Program.

Meeting Proceedings

Proceedings from this meeting will be published by the JHU WSE Energetics Research Group. Papers, and in limited cases, presentations will be provided complimentary to attendees of this meeting who have paid the full registration fee (early or regular). These attendees will have access to these materials beginning approximately 12 weeks following the meeting via the JANNAF Digital Online Collection (JDOC) Database accessible through your account on the JANNAF Secure Portal. This benefit is not available for student attendees.

Questions

Questions concerning this meeting and/or payment of the registration fee should be directed to Shelley Cohen at (410) 992-7302, ext. 215 or email: scohen@erg.jhu.edu.

Questions pertaining to registering via the JANNAF Secure Portal should be directed to:

Mary Gannaway: Call (410) 992-7304, ext. 211 or email mtg@jhu.edu

OR

Tricia Reider: Call (410) 992-7300, ext. 222 or email treider@erg.jhu.edu

Upcoming JANNAF Meetings

Programmatic and Industrial Base Meeting
11th Modeling and Simulation

9th Liquid Propulsion

8th Spacecraft Propulsion

Joint Subcommittee Meeting

5-9 December 2016

Hyatt Regency Phoenix

Phoenix, Arizona

64th JANNAF Propulsion Meeting

Programmatic and Industrial Base Meeting

44th Structures and Mechanical Behavior

40th Propellant and Explosives Development and Characterization

31st Rocket Nozzle Technology

29th Safety and Environmental Protection

Spring 2017

Location TBA

JANNAF Meeting Invitation - December 2016

Program Committee Members

PROGRAM CHAIR

Dr. Michael D. Watson
NASA Marshall Space Flight Center
Huntsville, AL

PROGRAMMATIC AND INDUSTRIAL BASE

PIB Executive Committee Co-Chair

Dr. Christine M. Michienzi
OUSD(AT&L)/DASD, MIBP / Alexandria, VA

PIB Executive Committee Co-Chair

Dr. Rajiv Doreswamy
NASA Marshall Space Flight Center / Huntsville, AL

JHU WSE ERG Technical Representative

Kirk V. Sharp
JHU WSE Energetics Research Group
Columbia, MD

MODELING AND SIMULATION SUBCOMMITTEE

Technical Steering Group Chair

Dr. Michael D. Watson
NASA Marshall Space Flight Center / Huntsville, AL

Technical Steering Group Deputy Chair

Mr. Gary C. Prybyla
Naval Surface Warfare Center / Indian Head, MD

JANNAF Executive Committee Liaison

Dr. Dhannireddy R. Reddy
NASA Glenn Research Center / Cleveland, OH

JHU WSE ERG Technical Representatives

Mr. Nicholas S. Keim
JHU WSE Energetics Research Group / Columbia, MD

Mission Area I: Modeling and Simulation of Systems

Mr. Eric J. Paulson
Air Force Research Laboratory / Edwards AFB, CA

Mr. Joseph C. Boyle
Naval Air Warfare Center Weapons Division / China Lake, CA

Mission Area II: Virtual Engineering

Mr. Gary C. Prybyla
Naval Surface Warfare Center / Indian Head, MD

Mission Area III: Integrated Health Management

Mr R. Scott Hyde
Orbital ATK / Brigham City, UT

Mr. David K. Hogan
Army Aviation and Missile Research, Development and
Engineering Center / Redstone Arsenal, AL

Mission Area IV: Space and Launch Vehicle Cost Estimation

Dr. Michael D. Watson
NASA Marshall Space Flight Center / Huntsville, AL

Mission Area V: Simulation Credibility

Dr. Unmeel B. Mehta
NASA Ames Research Center / Moffett Field, CA
Dr. Dean R. Eklund
Air Force Research Laboratory / Wright-Patterson AFB, OH

LIQUID PROPULSION SUBCOMMITTEE

Technical Steering Group Co-Chair

Dr. Daniel L. Brown
Air Force Research Laboratory / Edwards AFB, CA

Technical Steering Group Co-Chair

Mr. James L. Cannon
NASA Marshall Space Flight Center / Huntsville, AL

JANNAF Executive Committee Liaison

Dr. Thomas M. Brown
NASA Marshall Space Flight Center / Huntsville, AL

JHU WSE ERG Technical Representative

Mr. Peter Zeender
JHU WSE Energetics Research Group / Columbia, MD

Mission Area I: Liquid Engine Systems

Mr. Jason B. Turpin
NASA Marshall Space Flight Center / Huntsville, AL

Mr. Nils M. Sedano
Air Force Research Laboratory / Edwards AFB, CA

JANNAF Meeting Invitation - December 2016

Mission Area II: Liquid Combustion Subsystems and Components

Dr. Christopher S. Protz
NASA Marshall Space Flight Center / Huntsville, AL

Mr. Robert N. Bernstein
Air Force Research Laboratory / Edwards AFB, CA

Mission Area III: Liquid Propellant Feed and Pressurization Systems

Mr. James L. Cannon
NASA Marshall Space Flight Center / Huntsville, AL

Mr. Alan M. Sutton
Air Force Research Laboratory / Edwards AFB, CA

Mission Area IV: Advanced Materials for Liquid Propulsion Applications

Mr. Clyde "Chip" Jones
NASA Marshall Space Flight Center / Huntsville, AL

Mr. Jamie B. Malak
Air Force Research Laboratory / Edwards AFB, CA

SPACECRAFT PROPULSION SUBCOMMITTEE

Technical Steering Group Chair

Mr. David T. Jacobson
NASA Glenn Research Center / Cleveland, OH

Technical Steering Group Deputy Chair

Dr. William A. Hargus, Jr.
Air Force Research Laboratory / Edwards AFB, CA

JANNAF Executive Committee Liaison

Mr. Drew O. DeGeorge
Air Force Research Laboratory / Edwards AFB, CA

JHU WSE ERG Technical Representative

Mr. David Owen
JHU WSE Energetics Research Group / Columbia, MD

Mission Area I: Chemical Propulsion

Mr. A. Paul Zuttarelli
Air Force Research Laboratory / Edwards AFB, CA

Dr. Matthew Deans
NASA Glenn Research Center / Cleveland, OH

Ms. Caitlin A. Bacha
NASA Goddard Space Flight Center / Greenbelt, MD

Mission Area II: Electric Propulsion

Dr. Hani Kamhawi
NASA Glenn Research Center / Cleveland, OH

Dr. Robert B. Lobbia
Jet Propulsion Laboratory / Pasadena, CA

Mission Area III: Cube / Nano Satellite Propulsion

Dr. Juergen Mueller
Jet Propulsion Laboratory / Pasadena, CA

Dr. William A. Hargus, Jr.
Air Force Research Laboratory / Edwards AFB, CA

Mission Area IV: Future Technologies

Dr. Kurt A. Polzin
NASA Marshall Space Flight Center / Huntsville, AL

Mission Area V: Spacecraft Modeling and Simulation

Dr. Justin Koo
Air Force Research Laboratory / Edwards AFB, CA

JANNAF MEETING MANAGER

Shelley S. Cohen
JHU WSE Energetics Research Group / Columbia, MD

JANNAF MEETING PROCEEDINGS EDITOR

Kathleen Rowan
JHU WSE Energetics Research Group / Columbia, MD

SECURITY OFFICER

Mary T. Gannaway
JHU WSE Energetics Research Group / Columbia, MD

JANNAF Meeting Invitation - December 2016

Program Highlights

Keynote Address



Mr. Jeffrey M. Hanley, Principal Director for Human Exploration and Space Flight, NASA and Civil Space Division of The Aerospace Corporation in Houston, Texas, will present the keynote at this year's conference. The title of Mr. Hanley's address is "Crossroads and Opportunities – Human Space Flight Perspectives." In the midst of addressing the "what" and the "how" of human space

flight in NASA's "capability driven" exploration strategy, a new administration will soon once again be facing the "where" and "why" of US space policy to come. Mr. Hanley will discuss the challenges and forces at play shaping the future now and in the months and years ahead as the 50th anniversary of Apollo 11 approaches during the first term of the next US President.

Mr. Hanley has more than 33 years' experience in human spaceflight, technical management, operations, and program management. He joined The Aerospace Corporation in 2015 where he is responsible for all civil human space flight and transportation systems such as the ISS, and future NASA programs including the Orion/MPCV, Space Launch System (SLS), and Commercial Crew Programs.

Prior to joining Aerospace, Mr. Hanley served as Director of the Extravehicular Activity (EVA) Management Office at NASA's Johnson Space Center, where he was responsible for managing the development, production, logistics, and sustaining engineering of all flight hardware used to support the agency's EVA capability within the Human Exploration and Operations Directorate (HEOMD).

At NASA, Mr. Hanley previously served as Director of the Human Exploration Development Support Office. He also served as Deputy Project Manager for Verification on the James Webb Space Telescope (JWST) Project at NASA Goddard; Manager of the Constellation Program; and was a NASA Flight Director for a number of Shuttle and International Space Station missions.

Mr. Hanley earned his B.S. in Electrical Engineering, and his M.S. in Natural and Applied Sciences, from the University of Houston.

All attendees are invited to participate. **The Keynote Address begins at 8:00 a.m. on Tuesday, 6 December, in Salons C & D of the Regency Ballroom** on the first floor of the hotel.

Subcommittee Plenary Presentations

Each subcommittee will hold a Plenary presentation or panel discussion during the December meeting.

Modeling and Simulation

Dr. Ephraim B. Washburn, head of the Combustion Sciences and Propulsion Research branch, Naval Air Warfare Center Weapons Division, will discuss "**Bringing Increased Fidelity to System Level Calculations,**" on Tuesday afternoon at the start of session 2Q (1:30 p.m.). Dr. Washburn's presentation will use the modeling and simulation of the combustion of energetic materials to show the ability to utilize information from the detailed high-fidelity calculations at the system level.

Ephraim Washburn received his B.S. and Ph.D. in chemical engineering from Brigham Young University. In 2004 he joined the Energetics Research Division of the Naval Air Warfare Center Weapons Division (NAWCWD). Dr. Washburn's

research deals with modeling and simulation of various forms of combustion. His work has included simulation of solid propellant combustion, metal combustion, and hydrocarbon combustion. Current applications of his work include rocket propulsion, explosives, and internal combustion engines. He is also involved in improving insensitive munitions technology and reestablishing air-breathing propulsion technology development at NAWCWD. He has published in and is an active reviewer for Combustion publications.

JANNAF Meeting Invitation - December 2016

Subcommittee Plenary Presentations - continued

Liquid Propulsion

Mr. N. Wayne Hale, Jr., Director of Human Spaceflight, Special Aerospace Services, LLC, and former NASA Space Shuttle Program Manager, will moderate a panel discussion entitled, “**Future of Liquid Rocket Engine (LRE) in the US,**” at the start of session 3B (8:00 a.m.) on Wednesday morning. Panel Members will be representatives from Industry and Government.

Since the early 2000’s the US Liquid Rocket Engine (LRE) sector has evolved from having multiple LRE propulsion suppliers to Launch Service Providers (LSP) who are vertically integrated and develop their own propulsion systems. Dynamics in the LRE market is the result of emerging companies entering the market with disruptive business models, which have reshaped the traditional role of government in the development of LRE’s and Launch Vehicles (LV). As a result of this trend, the US has one remaining LRE supplier. The shift toward vertically integrated LSPs has also shaped how the government invests in LRE technology and development. Potential discussion topics:

- Transitioning of LRE development to industry.
- Evolution/revolution of the LRE and LV industry in the next decade.
- Challenges in establishing/developing engineering guidelines, processes, and capabilities for LRE development.
- Key observations on the different approaches to developing LRE’s in support of LSP’s.
- US government role in developing LRE’s going forward.

Spacecraft Propulsion

On Thursday morning, at the start of session 4G (8:00 a.m.), Mr. Carl Engelbrecht, Johns Hopkins University Applied Physics Laboratory, will discuss “**Some Lessons I Learned in 30 Years of Interplanetary Propulsion,**” sharing anecdotes with resulting technical and non-technical lessons learned from the design, development, integration and test of several propulsion systems.

Mr. Engelbrecht is the lead propulsion engineer for the Europa Clipper spacecraft. He has over 30 years of experience at JPL, Aerojet (Redmond, WA), DASA (Germany) and JHU/APL working on a wide range of types of space propulsion components and systems. Mr. Engelbrecht received his BS and MS in Aeronautics and Astronautics from the University of Washington and was the chairman of the AIAA’s Liquid Propulsion Technical Committee from 2007-2009.

Additional Highlights

JANNAF PIB Specialist Sessions: Modern technology and the next generation workforce are changing the way the propulsion industrial base is designing and producing rocket propulsion systems. For instance, Additive Manufacturing (AM) has the potential to revolutionize the way rocket propulsion systems are designed - allowing for more intricate designs and quicker turnaround time between design and testing work. But AM also comes with its own set of challenges, risks and questions. The younger generation workforce also brings different ways of doing things to the industrial base, but also brings challenges - especially when integrating with the existing legacy workforce, techniques and ideas. The JANNAF PIB will have 3 Specialist Sessions (3A, 3M, and 4F) highlighting these topics and is still accepting presentations. All are welcome to attend.

On Wednesday, the Modeling and Simulation Subcommittee will present an all-day Specialist Session on **Simulation Credibility: Advances in Verification, Validation, and Uncertainty Quantification**, scheduled in sessions 3G and 3S. Simulation verification, simulation validation, and uncertainty propagation and quantification validation are the key processes used to quantify numerical, model, and input credibility, respectively. The Simulation Credibility (SC) Panel of the Modeling and Simulation Subcommittee, initiated a voluntary endeavor to develop a simulation credibility guide to describe and demonstrate these state-of-the-art processes, resulting in a joint NASA and JANNAF Interagency Propulsion Committee publication titled, “Simulation Credibility in Continuum Physics: Advances in Verification, Validation, and Uncertainty Propagation and Quantification.” This publication presents a compilation of some key advances in these processes over the last 10 years. Creators of continuum physics simulations will find the detailed processes and illustrated examples in this volume very useful to guide and assist them in conveying the credibility of their simulations to decision makers for many years to come. The contributing authors will present the publication during this session. Refer to pages 27 and 30 in the Preliminary Program to review the draft agenda for this all-day specialist session.

continued on page 10

JANNAF Meeting Invitation - December 2016

Additional Highlights - continued

The Spacecraft Propulsion Subcommittee will present an all-day workshop on Thursday entitled, **Electric Propulsion Operation in the Space Environment and Facility Interactions II (EPOSE II)**, in sessions 4E and 4Q. The Electric Propulsion Operation in Space Environment (EPOSE II) will continue the discussions initiated in EPOSE I. The workshop will provide an overview of the EPOSE I workshop findings. Additionally, this workshop will also present an overview of recent EP system flight data, overview of NASA Asteroid Retrieval Mission (ARM) plasma diagnostics package, results from recent experiments on ground facility effects, updates on modeling and simulation progress, and an update on the JANNAF data repository. See pages 33 and 36 for the draft agenda for this all-day workshop.

Several sessions throughout the program have been scheduled with a focus on **Additive Manufacturing**. These sessions include:

- Advanced Materials and Additive Manufacturing for Liquid Propulsion Systems (2M - Liquid Propulsion Subcommittee).
- Specialist Session: How is Additive Manufacturing Changing the Way We Do Business? I (Industry Briefs) and II (Government Briefs) (3A / 3M - Programmatic and Industrial Base).
- Advanced Materials and Processes for Combustion Devices (4A - Liquid Propulsion Subcommittee).
- Advanced Materials and Processes for Propulsion Systems (4M - Liquid Propulsion Subcommittee).

Technical Program

This year's technical program currently consists of 37 technical sessions with more than 200 presentations, plus 7 specialist sessions, 4 workshops, 11 panel meetings, 2 subcommittee plenary presentations and a panel discussion. A detailed daily schedule of all sessions, workshops, meetings and networking activities is provided below and continues through page 13. Detailed agendas of the technical sessions, specialist sessions, and workshops are listed in the Program Section of the Preliminary Program beginning on page 14.

A Schedule Color Key has been provided on pages 11 and 13.

SCHEDULE - Monday, 5 December					
10:00 a.m. - 5:00 p.m.	On-Site Check-In and Registration Desk Open				
10:00 a.m. - 5:00 p.m.	I.T. Office Open (for Presenters and Session Chairs needing technical assistance)			Cowboy Artists	Open
10:00 a.m. - 11:00 a.m.	Networking Area Refreshments			Atrium	Open
12:45 p.m. - 1:00 p.m.	Session Chair Meeting (Monday Sessions)			Borein	Closed
1:30 p.m. - 4:30 p.m.	Reading Room			Borein	Open
1:30 p.m. - 6:05 p.m.	Monday Afternoon Technical Sessions and Panel Meetings				
1:30 p.m. - 3:05 p.m.	IM	SPS	Overviews / Propellant Summaries – I (Green)	Phoenix Ballroom East	Open
3:05 p.m. - 4:05 p.m.	IM	SPS	PANEL MEETING: Chemical Propulsion	Phoenix Ballroom East	Open
1:30 p.m. - 6:05 p.m.	IN	LPS	Liquid Rocket Engine Research and Development	Phoenix Ballroom West	Open
1:30 p.m. - 3:35 p.m.	IO	LPS	Combustion Stability and Dynamics	Remington A-C	Open
1:30 p.m. - 5:35 p.m.	IP	MSS	Munitions Modeling, Simulation, and Test	Russell A-C	Open
5:35 p.m. - 6:05 p.m.	IP	MSS	PANEL MEETING: Virtual Engineering	Russell A-C	Open
1:30 p.m. - 5:05 p.m.	IR	SPS	EP Plume Modeling	Ellis Room West	Open
1:30 p.m. - 2:35 p.m.	IS	SPS	Ionic Fluids Research and Development	Ellis Room East	Open
3:05 p.m. - 4:05 p.m.	Networking Area Refreshments			Atrium	Open
3:45 p.m. - 4:30 p.m.		LPS	PANEL MEETING: Test Practices and Standards	Meeting Suite 314	Open

JANNAF Meeting Invitation - December 2016

SCHEDULE - Tuesday, 6 December

7:00 a.m. - 5:00 p.m.	On-Site Check-In and Registration Desk Open				
7:00 a.m. - 5:00 p.m.	I.T. Office Open (for Presenters and Session Chairs needing technical assistance)			Cowboy Artists	Open
7:00 a.m. - 8:00 a.m.	Networking Area Refreshments			Atrium	Open
7:15 a.m. - 7:30 a.m.	Session Chair Meeting (Tuesday Sessions)			Borein	Closed
8:00 a.m. - 10:00 a.m.	KEYNOTE ADDRESS: "Crossroads and Opportunities – Human Space Flight Perspectives" - Mr. Jeffrey M. Hanley <i>Awards and Announcements</i>			Regency Ballroom C-D	Open
8:00 a.m. - 4:30 p.m.	Reading Room			Borein	Open
9:30 a.m. - 10:00 a.m.	Networking Area Refreshments			Atrium	Open
10:00 a.m. - 6:00 p.m.	JANNAF Technical Executive Committee Meeting			Meeting Suite 316	Closed
10:00 a.m. - 12:05 p.m.	Tuesday Morning Technical Sessions and Panel Meetings				
10:00 a.m. - 12:05 p.m.	2A	LPS	Liquid Rocket Engine Model and System Studies	Phoenix Ballroom East	Open
10:00 a.m. - 12:05 p.m.	2B	LPS	Hydrocarbon Fuels Properties and Performance Characterization - I	Phoenix Ballroom West	Open
10:00 a.m. - 12:00 p.m.		LPS	PANEL MEETING: Combustion Stability	Remington A-C	Open
10:00 a.m. - 12:05 p.m.	2D	SPS	Overviews / Propellant Summaries - II (Bipropellants)	Russell A-C	Open
10:00 a.m. - 11:35 a.m.	2E	SPS	Electric Propulsion Flight Projects	Curtis A-B	Open
10:00 a.m. - 12:05 p.m.	2F	LPS	Liquid Propulsion Component Test and Development	Ellis Room West	Open
10:00 a.m. - 12:05 p.m.	2G	LPS	Propellant Feed System Development	Ellis Room East	Open
10:00 a.m. - 1:30 p.m.	PIB Large Liquid Propulsion Working Group Meeting			Boardroom	Closed
12:00 p.m. - 1:30 p.m.	Lunch Break - <i>On Your Own</i>				
1:30 p.m. - 6:05 p.m.	Tuesday Afternoon Technical Sessions, Panel, and Working Group Meetings				
1:30 p.m. - 4:35 p.m.	2M	LPS	Advanced Materials and Additive Manufacturing for Liquid Propulsion Systems	Phoenix Ballroom East	Open
4:35 p.m. - 5:35 p.m.	2M	LPS	PANEL MEETING: Advanced Materials	Phoenix Ballroom East	Open
1:30 p.m. - 5:05 p.m.	2N	SPS	MicroPropulsion Systems and Development	Phoenix Ballroom West	Open
5:05 p.m. - 6:05 p.m.	2N	SPS	PANEL MEETING: Micro-thrust Propulsion	Phoenix Ballroom West	Open
1:30 p.m. - 5:35 p.m.	2O	LPS	Hydrocarbon Boost Subscale Preburner Testing	Remington A-C	Open
2:30 p.m. - 5:35 p.m.	2P	MSS/SPS	Integrated Health Management Modeling and Sensing - I	Russell A-C	Open
5:35 p.m. - 6:05 p.m.	2P	MSS	PANEL MEETING: Integrated Health Management	Russell A-C	Open
1:30 p.m. - 2:30 p.m.	2Q	MSS	PLENARY: Bringing Increased Fidelity to System Level Calculations	Curtis A-B	Open
2:30 p.m. - 6:05 p.m.	2Q	MSS	Propellant SLOSH Physics, Modeling, Verification and Validation	Curtis A-B	Open
1:30 p.m. - 3:05 p.m.	2R	LPS	Turbomachinery Design and Development	Ellis Room West	Open
3:35 p.m. - 5:35 p.m.	2R	LPS	PANEL MEETING: Turbomachinery	Ellis Room West	Open
1:30 p.m. - 5:10 p.m.	2S	SPS	HERMeS Hall Thruster Development / High Power Electric Propulsion Development	Ellis Room East	Open
1:30 p.m. - 4:30 p.m.	PIB Test and Evaluation Working Group Meeting			Meeting Suite 314	Closed
2:00 p.m. - 5:00 p.m.	CSTD Technical Interchange Meeting (TIM) 7			Boardroom	Closed
3:05 p.m. - 4:10 p.m.	Networking Area Refreshments			Atrium	Open

Schedule Color Key

Meeting Services	Concurrent Sessions or Panel Meetings
Networking Opportunities	Session Details
Closed Meetings	Panel, Town Hall, & Working Group Meetings

JANNAF Meeting Invitation - December 2016

SCHEDULE - Wednesday, 7 December

7:00 a.m. - 5:00 p.m.	On-Site Check-In and Registration Desk Open				
7:00 a.m. - 5:00 p.m.	I.T. Office Open (for Presenters and Session Chairs needing technical assistance)			Cowboy Artists	Open
7:00 a.m. - 8:00 a.m.	Networking Area Refreshments			Atrium	Open
7:15 a.m. - 7:30 a.m.	Session Chair Meeting (Wednesday Sessions)			Borein	Closed
8:00 a.m. - 4:30 p.m.	Reading Room			Borein	Open
8:00 a.m. - 12:35 p.m.	Wednesday Morning Technical Sessions, Specialist Sessions and Panel Meetings				
8:00 a.m. - 12:00 p.m.	3A	PIB	<i>SPECIALIST SESSION: How is Additive Manufacturing Changing the Way We Do Business? - I (Industry Briefs)</i>	Phoenix Ballroom East	Open
8:00 a.m. - 10:00 a.m.	3B	LPS	<i>PANEL DISCUSSION: Future of Liquid Rocket Engine (LRE) in the US</i>	Phoenix Ballroom West	Open
10:30 a.m. - 12:05 p.m.	3B	LPS	Hydrocarbon Boost Full Scale Components - I	Phoenix Ballroom West	Open
8:00 a.m. - 11:35 a.m.	3C	SPS	Green Propellants	Remington A-C	Open
8:00 a.m. - 11:35 a.m.	3D	MSS	Motor A&S Technology Embedded Sensors Design Placement and Analysis	Russell A-C	Open
10:00 a.m. - 12:05 p.m.	3E	LPS	<i>SPECIALIST SESSION: The Combustion Stability Tool Development (CSTD) Project and the Stable COmbustion in Rocket Engines (SCORE) Stability Assessment Tool Suite - I</i>	Curtis A-B	Open
8:00 a.m. - 11:05 a.m.	3F	SPS	Ground Facility Effects on Hall Thruster Operation	Cassidy	Open
11:05 a.m. - 12:35 p.m.	3F	SPS	<i>PANEL MEETING: Electric Propulsion</i>	Casdidy	Open
8:00 a.m. - 12:30 p.m.	3G	MSS	<i>SPECIALIST SESSION: Simulation Credibility: Advances in Verification, Validation, and Uncertainty Quantification - I</i>	Ellis Room East-West	Open
10:00 a.m. - 10:35 a.m.	Networking Area Refreshments			Atrium	Open
12:00 p.m. - 1:30 p.m.	Lunch Break - <i>On Your Own</i>				
12:10 p.m. - 1:20 p.m.	SPS Technical Steering Group Meeting			Boardroom	Closed
1:30 p.m. - 4:30 p.m.	PIB Science and Technology Working Group			Meeting Suite 314	Closed
1:30 p.m. - 5:35 p.m.	Wednesday Afternoon Technical Sessions and Specialist Sessions				
1:30 p.m. - 5:35 p.m.	3M	PIB	<i>SPECIALIST SESSION: How is Additive Manufacturing Changing the Way We Do Business? - II (Government Briefs)</i>	Phoenix Ballroom East	Open
1:30 p.m. - 4:35 p.m.	3N	LPS	Hydrocarbon Boost Full Scale Components - II	Phoenix Ballroom West	Open
1:30 p.m. - 5:05 p.m.	3O	SPS/MSS	Diagnostics and Modeling of Thrusters and Combustors	Remington A-C	Open
1:30 p.m. - 2:35 p.m.	3P	MSS	Integrated Health Management Modeling and Sensing - II	Russell A-C	Open
1:30 p.m. - 5:30 p.m.	3Q	LPS	Part I - <i>SPECIALIST SESSION: The Combustion Stability Tool Development (CSTD) Project and the Stable Combustion in Rocket Engines (SCORE) Stability Assessment Tool Suite - Part II</i> Part 2 - <i>DEMONSTRATION: Stable Combustion in Rocket Engines (SCORE) Stability Assessment Tool Suite</i>	Curtis A-B	Open
1:30 p.m. - 3:35 p.m.	3R	SPS	Hall Thruster Development	Cassidy	Open
1:30 p.m. - 5:30 p.m.	3S	MSS	<i>SPECIALIST SESSION: Simulation Credibility: Advances in Verification, Validation, and Uncertainty Quantification - II</i>	Ellis Room East-West	Open
3:00 p.m. - 4:05 p.m.	Networking Area Refreshments			Atrium	Open
6:00 p.m. - 8:00 p.m.	Networking Night - Dinner and Cash Bar - <i>JANNAF Badge or Guest Ticket required</i>			Regency Ballroom C-D	Open

JANNAF Meeting Invitation - December 2016

SCHEDULE - Thursday, 8 December

7:00 a.m. - 5:00 p.m.	On-Site Check-In and Registration Desk Open				
7:00 a.m. - 5:00 p.m.	I.T. Office Open (for Presenters and Session Chairs needing technical assistance)			Cowboy Artists	Open
7:00 a.m. - 8:00 a.m.	Networking Area Refreshments			Atrium	Open
7:15 a.m. - 7:30 a.m.	Session Chair Meeting (Thursday Sessions)			Borein	Closed
8:00 a.m. - 4:30 p.m.	Reading Room			Borein	Open
8:00 a.m. - 12:35 p.m.	Thursday Morning Technical Sessions, Workshops, Specialist Session, and Panel Meetings				
8:00 a.m. - 11:35 a.m.	4A	LPS	Advanced Materials and Processes for Combustion Devices	Phoenix Ballroom East	Open
8:00 a.m. - 12:05 p.m.	4B	LPS	Combustion Stability Tool Development at AFRL and MSFC - I	Phoenix Ballroom West	Open
8:00 a.m. - 10:05 a.m.	4C	LPS	Fuel Film Cooling: Measurements and Modeling	Remington A-C	Open
8:00 a.m. - 11:35 a.m.	4D	MSS	Model Validation and Uncertainty Assessment	Russell A-C	Open
11:35 a.m. - 12:05 p.m.	4D	MSS	PANEL MEETING: Simulation Credibility	Russell A-C	Open
9:00 a.m. - 12:15 p.m.	4E	SPS	WORKSHOP: Electric Propulsion Operation in the Space Environment and Facility Interactions II (EPOSE II) - Part I	Curtis A-B	Open
8:00 a.m. - 12:05 p.m.	4F	PIB	SPECIALIST SESSION: Challenges Integrating Multi-generational Technologies and Workforce	Ellis Room West	Open
8:00 a.m. - 9:00 a.m.	4G	SPS	PLENARY: Some Lessons I Learned in 30 Years of Interplanetary Propulsion	Ellis Room East	Open
9:00 a.m. - 12:35 p.m.	4G	SPS	Vehicle Orion / European Service Module	Ellis Room East	Open
8:00 a.m. - 12:00 p.m.	4H	MSS	WORKSHOP: Development of Sensor and Sensing System Standard for Aerospace Propulsion Systems - I	Cassidy	Open
9:35 a.m. - 10:35 a.m.	Networking Area Refreshments			Atrium	Open
12:00 p.m. - 1:00 p.m.	MSS Technical Steering Group Meeting			Boardroom	Closed
12:00 p.m. - 1:15 p.m.	LPS Technical Steering Group Meeting			Meeting Suite 314	Closed
12:00 p.m. - 1:30 p.m.	PIB LLP Working Group Data Analysis Presentation to PIB Working Group Leads			Meeting Suite 312	Closed
12:00 p.m. - 1:30 p.m.	Lunch Break - <i>On Your Own</i>				
1:30 p.m. - 4:30 p.m.	PIB Executive Committee Meeting			Meeting Suite 316	Closed
1:30 p.m. - 6:35 p.m.	Thursday Afternoon Technical Sessions, Workshops, and Panel Meetings				
1:30 p.m. - 4:35 p.m.	4M	LPS	Advanced Materials and Processes for Propulsion Systems	Phoenix Ballroom East	Open
1:30 p.m. - 3:35 p.m.	4N	LPS	Combustion Stability Tool Development at AFRL and MSFC - II	Phoenix Ballroom West	Open
1:30 p.m. - 5:35 p.m.	4O	LPS	Hydrocarbon Fuels Properties and Performance Characterization - II	Remington A-C	Open
5:35 p.m. - 6:35 p.m.	4O	LPS	PANEL MEETING: Hydrocarbon Fuels	Remington A-C	Open
1:30 p.m. - 5:45 p.m.	4Q	SPS	WORKSHOP: Electric Propulsion Operation in the Space Environment and Facility Interactions II (EPOSE II) - Part II	Curtis A-B	Open
1:30 p.m. - 5:05 p.m.	4R	MSS	Modeling and Simulation of Systems	Ellis Room West	Open
1:30 p.m. - 3:35 p.m.	4S	SPS	Vehicle - Other	Ellis Room East	Open
1:30 p.m. - 3:00 p.m.	4T	MSS	WORKSHOP: Development of Sensor and Sensing System Standard for Aerospace Propulsion Systems - II	Cassidy	Open
3:05 p.m. - 4:05 p.m.	Networking Area Refreshments			Atrium	Open

Schedule Color Key

Meeting Services	Concurrent Sessions or Panel Meetings
Networking Opportunities	Session Details
Closed Meetings	Panel, Town Hall, & Working Group Meetings