



# **JANNAF** INTERAGENCY PROPULSION COMMITTEE JOINT ARMY-NAVY-NASA-AIR FORCE

66th JANNAF Propulsion Meeting  
Programmatic and Industrial Base Meeting  
49th Combustion (CS)  
37th Airbreathing Propulsion (APS)  
37th Exhaust Plume and Signatures (EPSS)  
31st Propulsion Systems Hazards (PSHS)  
JOINT SUBCOMMITTEE MEETING  
**3 - 7 June 2019**  
**Dayton, Ohio**

**Abstract  
Deadline**  
**3 December  
2018**

## Announcement and Call For Papers



The June 2019 meeting of the Joint Army-Navy-NASA-Air Force (JANNAF) will consist of the Joint Meeting of the 49th Combustion / 37th Airbreathing Propulsion / 37th Exhaust Plume and Signatures / 31st Propulsion Systems Hazards Subcommittees; as well as the 66th JANNAF Propulsion Meeting (JPM) and the Programmatic and Industrial Base (PIB) meeting. Dr. David R. Gonzalez with Naval Surface Warfare Center-IHEODTD, Indian Head, MD, is the meeting chair. This meeting will be held **Monday through Friday, 3 - 7 June 2019**, at the **Dayton Convention Center and Wright-Patterson Air Force Base in Dayton, Ohio**. Please refer to page 4 for hotel and area information.

## ATTENDANCE REQUIREMENTS

The overall security level of the meeting is **Secret**. Unclassified sessions will be held at the Dayton Convention Center in downtown Dayton, OH; classified sessions will be hosted by the Air Force Research Laboratory at Wright-Patterson AFB, located approximately 15 minutes by car from the Convention Center and hotel. Attendance, applicable to presenters as well, is restricted to invited U.S. citizens qualified to receive unclassified, limited-distribution information. *No foreign nationals are permitted to attend.*

**ALL non-government attendees** (which includes contractors, consultants and universities) attending this meeting **must**:

1. Be working on a current government contract or certified by a Sponsoring Government Official
2. Provide their organization's DD 2345 Certification Number for receipt of militarily-critical technical data

**DD 2345:** For additional information, contact the Joint Certification Program Office (JCP) at 1-800-352-3572 or visit their Web site at <http://www.dla.mil/HQ/InformationOperations/Offers/Products/LogisticsApplications/JCP.aspx>

**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.

**ALL Attendees:** 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. *All presenters are required to register and pay the registration fee.*

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](mailto:mtg@jhu.edu).

## PURPOSE

The JANNAF Interagency Propulsion Committee focuses on the technology, development, and production capabilities for all types of propulsion systems and energetics for tactical, strategic and missile defense rockets and missiles, for space

boost and orbit transfer, for in-space propulsion, and for gun systems. JANNAF provides a forum for discussion of propulsion issues, challenges, and opportunities across the Military Departments, Defense Agencies and NASA. JANNAF subcommittees focus their resources on technical issues of interest to the JANNAF agencies.

Work in all areas of DoD and NASA is solicited as defined below:

### 6.1 Basic Research:

Systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products.

### 6.2 Applied Research:

Systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.

### 6.3 Development:

Systematic application of knowledge toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

JANNAF accepts papers that are unclassified/unlimited and unclassified/limited for all meetings; and up to classified Secret as announced in the specific meeting's announcement and call for papers.

## SCOPE

The standing JANNAF subcommittees for Combustion, Airbreathing Propulsion, Exhaust Plume and Signatures, and

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## Table of Contents

Attendance Requirements .....	2
Meeting Purpose and Scope .....	2 - 3
Author Timeline .....	3
Abstract Submittal Instructions .....	4
Hotel and Area Information .....	4 - 5
Subcommittee / Mission Area Chart .....	5
JANNAF Propulsion Meeting Mission Areas .....	6 - 10
Combustion Subcommittee Mission Areas .....	11 - 14
Airbreathing Propulsion Subcommittee Mission Areas .....	15 - 17
Exhaust Plume and Signatures Mission Areas .....	17 - 18
Propulsion Systems Hazards Mission Areas .....	19 - 20
Workshops / Specialist Sessions .....	21
JANNAF Awards Program / Nominations .....	21 - 22
Upcoming JANNAF Meetings .....	22

Propulsion Systems Hazards will also hold their biennial meeting (held every 18 months). To learn more about the scope of the standing JANNAF subcommittee meetings, please review the information provided on pages 2-3 and on pages 6-20.

### JANNAF Propulsion Meeting

The JANNAF Propulsion Meeting (JPM) encompasses research and applications at the systems level. The JPM is held each year in conjunction with standing JANNAF subcommittee meetings on a rotating basis. The scope of the 66th JPM in 2019 spans nine mission areas.

### Programmatic and Industrial Base

The JANNAF Programmatic and Industrial Base (PIB) Committee was created with the approval of the updated JANNAF Charter by the Department of Defense and the National Aeronautics and Space Administration in 2014. This Charter states, “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.”

### Combustion Subcommittee

The Combustion Subcommittee (CS) covers analytical modeling and experimental research on chemical combustion phenomena for solid, liquid, hybrid, and airbreathing missile, space, underwater, and gun propulsion systems.

### Airbreathing Propulsion Subcommittee

The Airbreathing Propulsion Subcommittee (APS) addresses technical problems and issues associated with turbojet, ramjet, scramjet, and combined- or mixed-cycle engines.

### Exhaust Plume and Signatures Subcommittee

The Exhaust Plume and Signatures Subcommittee (EPSS) addresses the phenomena associated with the exhaust from rockets, ramjets, space, gun propulsion systems, and Electro-Optical/Infrared (EO/IR) signature community.

### Propulsion Systems Hazards Subcommittee

The Propulsion Systems Hazards Subcommittee (PSHS) examines potential hazards associated with missile, space, and gun propulsion systems.

## JPM / PIB / CS / APS / EPSS / PSHS AUTHOR TIMELINE

Date	Weeks before Meeting	Action
3 Dec 2018	26	Deadline for receipt of <a href="#">Abstract Submittal Forms</a> .
4 Feb 2019	17	Acceptance/rejection letters sent to authors.
25 Feb 2019	14	Deadline for changes to Meeting Invitation and Preliminary Program
11 March 2019	12	Invitation, Preliminary Program, and registration materials forwarded to propulsion community.
1 April 2019	9	Deadline for <a href="#">award nominations</a> .
22 April 2019	6	Deadline for submission of changes to the Final Program.
6 May 2019	4	Deadline for receipt of manuscripts and paper/presentation clearance forms. <b>Papers not received by this date may be removed from the program.</b>
13 May 2019	3	Anticipated deadline for reservations at host hotel.
20 May 2019	2	Deadline for receipt of presentations and personal security clearance forms.
31 May 2019	1	Deadline for completion of online Registration Form. Deadline for reduced registration fee.
3 June 2019	0	Start date for JPM/PIB/CS/APS/EPSS/PSHS Joint Subcommittee Meeting

**For detailed Abstract Submittal instructions, please turn to page 4.**

## ABSTRACT SUBMITTAL INSTRUCTIONS

- The technical areas to be addressed are defined in this announcement. Individuals who wish to submit an abstract should carefully review the topic areas listed on pages 6-20.
- The submission of an abstract represents an agreement to **submit a final paper for publication by 6 May 2019**, attend the meeting, and deliver a 30-minute presentation. Your presentation will be heard by all qualified individuals within industry, government, and university organizations. *If your paper cannot be presented to all qualified attendees, it cannot be presented in this program without specific approval from members of the JANNAF Technical Executive Committee.*
- Submit only unclassified abstracts. **Abstracts will not be published** and will only be used by the program committee members for paper selection purposes.
- Limit the abstract to 250-300 words and exclude tables and figures. State the objective of the work. Describe the scope, method of approach, and any new advances in the state of the art. Highlight important conclusions, and include a brief summary of the data used to substantiate them.
- Please submit using the [Abstract Submittal Form](#), which can be downloaded from the [June meeting website](#).
- Indicate confirmation of management support on the [Abstract Submittal Form](#) to ensure availability of resources for your participation in the meeting. This is NOT related to security review/approval to submit the abstract or submit/present the paper.
- **Many organizations require abstracts to be processed through an approval system prior to submission.** This process takes additional time, so authors should **plan accordingly and begin the process early in an effort to meet the abstract deadline date.**
- Remember, ***you must be an invited and qualified U.S. Citizen to attend and present at this meeting.*** No foreign nationals are permitted to attend.
- The **deadline** date for submission of completed [Abstract Submittal Forms](#) to ERG is **3 December 2018**.

JHU WSE ERG accepts only **electronic submission** of abstracts and papers. **Abstracts must be submitted on the Abstract Submittal Form:**

- Via email to: [scohen@erg.jhu.edu](mailto:scohen@erg.jhu.edu) (*Distribution A only*); **OR**
- Uploaded to the ERG secure server as follows:
  1. Go to <https://webdatabase.cpia.jhu.edu/docorg/program/cgi-bin/Login.pl>
  2. **Choose Infobase:** JANNAF Mtg Abstract Uploads
  3. **Type in User Name:** Abstract

4. **Type in Password** [contact ERG at (410) 992-7300 or 7302 for current password, changed daily].
5. Click the “Login” button.
6. Click on “June 2019 JANNAF Meeting”; choose “Add Document” (to the left of the screen)
7. Complete the “Add Document” form, being sure to Title your Document, select “Upload from Client”, click the “Browse” button and navigate to where you have saved your completed Abstract Submittal Form on your computer. Select the file and click “Open”. Choose the appropriate file format (MS Word or PDF) under Document Type, and click on “Apply”.
8. Email [scohen@erg.jhu.edu](mailto:scohen@erg.jhu.edu) to notify that the file has been successfully uploaded.

## RECOMMENDATIONS FOR WORKSHOPS OR SPECIALIST SESSIONS

Recommendations for workshops or specialist sessions are solicited at this time. Individuals interested in organizing and chairing a workshop or specialist session should contact the JHU WSE ERG Technical Staff member in their respective subcommittee with suggestions for topics by **3 December 2018**. See pages 20-21 for additional information and requirements.

## AWARDS

Nominations for JANNAF Technical Executive Committee (TEC), PIB Executive Committee (PEC), CS, APS, EPSS, and PSHS recognition awards are being solicited. Individuals interested in nominating an award recipient should follow the guidelines and instructions on pages 21 and 22.

## HOTEL AND AREA INFORMATION

Discounted sleeping rooms will be arranged with the Crowne Plaza Dayton in downtown Dayton, Ohio. All unclassified sessions will be held at the Dayton Convention Center, across the street from the hotel. Several restaurants, shops and entertainment establishments are located within walking distance of the hotel and Convention Center, particularly in the Oregon Historic District. The hotel is also just 15 minutes by car from Wright-Patterson Air Force Base where classified sessions will be held.

### Hotel

The JANNAF room block at the Crowne Plaza Dayton is not yet open for reservations. When reservations open in mid-March, the room rate per night for all attendees will be \$103 plus applicable state and local taxes (currently 13.5%), for single or double occupancy. This rate is equivalent to the GSA FY 2019 per diem rate. More details will be posted on the June meeting website when the Meeting Invitation and Preliminary Program have been posted online, and registration has been opened in mid-March.



## Transportation

Three airports serve the area: Fly to the Dayton International Airport, just a 14 mile ride to the hotel and Convention Center. Or fly into either the Cincinnati/Northern Kentucky International or Columbus International airports; each of these airports is just over an hour drive from downtown Dayton. The Crowne Plaza Hotel offers a complimentary airport shuttle

from the Dayton airport. Rental cars are available at each area airport. **If planning to attend classified sessions at Wright-Patterson AFB, a rental car or personal vehicle will be needed for your transportation to that facility.** Carpooling is encouraged.

## SUBCOMMITTEES / MISSION AREAS AT THIS MEETING

Click on the Mission Area of interest in the chart below to jump to that section in this Call for Papers.

Mission Area	JPM	CS	APS	EPSS	PSHS
I	Tactical Propulsion	Ignition and Combustion of Gun Propellants	Conventional Ramjet Propulsion	Plume/Wake/Hypersonic Flow Field Analysis	Thermal Decomposition and Cookoff
II	Missile Defense / Strategic Propulsion	Solid Propellants and Combustion	Scramjet Propulsion	Plume/Wake/Hypersonic Radiation and Signatures	Shock / Impact-Induced Reactions
III	Propulsion Systems for Space Access	Explosive Performance / Enhanced Blast	Scramjet Propulsion / Structures	Exhaust Plume Effects	Insensitive Munitions Technology
IV	Gun and Gun-Launched Propulsion	Airbreathing Combustion	Scramjet Component / Engine Testing	Other Plume/Wake/Hypersonic Related Problems	Gun Propellant Vulnerability
V	Propulsion and Energetics Test Facilities	Combustion Diagnostics	Combined / Advanced Cycle Propulsion	Composite Scene Signatures of Plume/Wake/Hypersonic Flowfield and Hardbody Configurations	Propulsion Systems Safety and Hazard Classification
VI	Sensors for Propulsion Measurement Applications	Liquid, Hybrid, and Novel Propellants Combustion	Small / Expendable Turbopropulsion		Energetic Liquid Hazards
VII	System-wide Application of Additive Manufacturing for Propulsion Applications		Fuel Technology		
VIII	Digital Engineering		Component Modeling Simulation		
IX	Simulation Credibility: Uncertainty, Verification, Validation and Risk		Advanced Combustion Control		

## JPM MISSION AREAS

The 66th JPM sessions will cover systems development within the nine mission areas described below. Questions concerning these areas or the topics being solicited should be directed to the respective Area Chair.

### Mission Area I: Tactical Propulsion

**Co-Chairs:** Dr. Jeremy R. Rice, AMRDEC / Redstone Arsenal, AL

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Dr. David R. Gonzalez, NSWC-IHEODTD / Indian Head, MD

Telephone: (301) 744-1513

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This area encompasses all tactical propulsion systems including those applicable to air-to-air; air-to-surface, surface launched and underwater missions. Typical systems include tactical missile boosters or sustainers, kinetic energy missiles, free-flight rockets, anti-radiation, anti-ship, anti-armor, anti-personnel/materiel missiles, ramjets, scramjets, and combined cycle propulsion. System studies that evaluate advanced propulsion concepts and demonstrations that incorporate one or more component technologies applicable to tactical propulsion are of interest. Examples of component technologies include propellants and fuels, fuel management systems, cases and combustors, inlets, nozzles, thrust vector control systems, thrust management systems, and advanced materials applications. Life cycle cost and demilitarization are also topics of interest.

#### **Manufacturing technologies and fabrication techniques:**

Papers are requested that emphasize manufacturing technologies and fabrication techniques. Papers need not be associated with a particular system but should be applicable to materials associated with such vehicles and their corresponding flight environment. Abstracts are especially sought on the following topics:

- Airbreathing propulsion systems
- Hybrid propulsion systems
- Solid propellant rocket propulsion systems
- Demilitarization
- Hypersonic propulsion systems
- Improved missile kinematics
- Insensitive munitions (from a systems perspective)
- Propulsion system product improvement
- Manufacturing technologies and fabrication techniques

**Airframe Structures and Materials:** Materials development and characterization, and structural concepts, design, test, and validation for Airframe applications and components exposed to extreme environments as found in atmospheric high speed or reentry conditions. Topics of interest include: TPS and hot structures, materials, structures and related technology for leading edges, exterior acreage surfaces, control surfaces, hot structures, and seals (penetrations). Further topics include hot and integrated structures; acreage thermal protection systems, including ceramic matrix composites, tiles, blankets, ablaters, and metallics; fuel tanks, including cryogenic and hydrocarbon, composite and metallic; leading edges, including active, passive, and heat-pipe-cooled; design and analysis methods; and seals. Papers are encouraged on structures and materials that have recently flown, or are planned for flight on flight vehicles.

### Mission Area II: Missile Defense / Strategic Propulsion

**Chair:** Dr. Robert J. Jensen, Sierra Lobo, Incorporated / Edwards AFB, CA

Telephone: (661) 275-5468

Email: [robert.jensen.12.ctr@us.af.mil](mailto:robert.jensen.12.ctr@us.af.mil)

This area includes technology applicable to ballistic missiles, trans-atmospheric vehicles, and missile defense. Emphasis should be on system-level papers discussing propulsion technology for new vehicle systems, upgrades, modernization and sustainment; failure investigations; and economic considerations that include evolving business practices, life cycle cost estimation, and approaches that reduce development and operations costs and schedules. Papers are requested that emphasize sustainable manufacturing technologies and fabrication techniques. Papers need not be associated with a particular system but should be applicable to materials associated with such vehicles and their corresponding flight environment. Abstracts are especially sought in the areas of:

- Ground-based and sea-based strategic systems
- Ground-based, aircraft-based and sea-based missile defense
- Anti-satellite systems
- Advanced (including low or non-toxic) propellants
- Advanced (including light weight and/or high temperature) materials
- Insensitive munitions technologies
- Energy management approaches
- Dual mode systems (airbreathing/rocket)
- Unconventional propulsion
- Divert propulsion/attitude control propulsion
- Post boost control system propulsion
- Innovative propellant tank and valve technologies (including hot gas valves/pintles)

- Aging and Surveillance of propulsion systems
- Manufacturing technologies and fabrication techniques including the use of 3D printing for strategic and missile defense propulsion system components
- US-sourced sustainable materials
- Demilitarization or alternative applications of heritage propulsion systems

### Mission Area III: Propulsion Systems for Space Access

**Chair:** Mr. Bruce R. Askins, NASA MSFC / Huntsville, AL  
**Telephone:** (256) 544-1096  
**Email:** [bruce.askins@nasa.gov](mailto:bruce.askins@nasa.gov)

This area focuses on existing or potential primary and auxiliary government, commercial or foreign propulsion systems for earth-to-orbit vehicles. Emphasis should be on system-level papers discussing propulsion technologies for new vehicle systems, upgrades and modernization, failure investigations, and evolving business practices that reduce development and operations costs while increasing mission reliability. Papers should address future access to space missions, future exploration missions and needs, vehicle system architectures, and the identification of critical propulsion requirements technologies that must be enabled to support these new system requirements.

#### **Manufacturing technologies and fabrication techniques:**

Papers are requested that emphasize manufacturing technologies and fabrication techniques. Papers need not be associated with a particular system but should be applicable to materials associated with such vehicles and their corresponding flight environment. Abstracts are especially sought in the following areas:

- Methods for development of design reference missions and vehicle systems architecture
- Description of vehicle systems analysis models and assumptions
- Details of architecture studies and descriptions of promising vehicle architectures
- Uncertainty evaluation of vehicle systems analysis
- Results of sensitivity analysis of key parameters on vehicle dry mass fraction margin, gross take-off weight, cost, reliability, and safety, with emphasis on propulsion
- Methods for identification and prioritization of critical enabling propulsion technologies
- Approaches for utilizing higher fidelity propulsion analyses in the overall systems architecture model(s)
- Methods to standardize model assumptions and fidelity in order to make relevant comparisons between vehicle architectures and various propulsion system options
- Description of promising new propulsion systems

- Description and status of the access to space propulsion system technology or development activities
- Small launch vehicle mission analysis
- System analysis for responsive space access
- Manufacturing technologies and fabrication techniques
- Manufacturing use of 3D printing for propulsion hardware

### Mission Area IV: Gun and Gun-Launched Propulsion

**Chair:** Mr. Paul L. Henderson, ARDEC / Picatinny Arsenal, NJ  
**Telephone:** (973) 724-5518  
**Email:** [paul.l.henderson19.civ@mail.mil](mailto:paul.l.henderson19.civ@mail.mil)

This area embraces technologies applicable to small-, intermediate-, or large-caliber guns, as well as gun-launched rocket propulsion, for air, sea, or ground/mobile weapons systems. Typical rocket assisted systems include kinetic energy missiles and extended range projectiles, both guided and unguided. Abstracts are especially sought in the following areas:

- Conventional gun propulsion concepts to include solids and liquids
- Unconventional gun propulsion concepts
- System-level gun propulsion studies (gun tube wear and erosion, blast/flash mitigation, improved system survivability)
- Concepts to enable rocket systems to achieve high operating pressures (gun barrel and motor case)
- Assisted projectiles
- Assisted guided munitions
- Insensitive munitions

### Mission Area V: Propulsion and Energetics Test Facilities

**Co-Chairs:** Mr. Michael D. Owen, NASA WSTF / Las Cruces, NM  
**Telephone:** (575) 524-5403  
**Email:** [michael.d.owen@nasa.gov](mailto:michael.d.owen@nasa.gov)  
 Ms. Julie A. Carlile, AFRL / Edwards AFB, CA  
**Telephone:** (661) 275-5098  
**Email:** [julie.carlile@us.af.mil](mailto:julie.carlile@us.af.mil)

This area targets issues, technologies and achievements relevant to the operation and use of rocket propulsion test facilities for demonstration, development, characterization, and qualification of rocket, spacecraft, and gun propulsion systems, energetics, and materials for propulsion applications. Eligible test facilities include static test facilities for liquid rocket engines, solid rocket motors, electric and in-space propulsion systems, hypersonic test facilities, gel motors, hybrid propulsion systems, explosives, insensitive munitions, wind tunnels, altitude/vacuum chambers, and other rocket

propulsion technologies; laboratory test facilities for energetics and materials science characterization; and test ranges for missiles, guns and rocket sleds. Abstracts are specifically solicited on the following topics:

- Best practices and testing standards
- Integrating instrumentation, controls and data acquisition systems
- Static thrust measurement systems
- Propellant and materials handling and safety
- Accident and incident lessons learned
- Test facility modeling

Abstracts on improvements in base infrastructure, updates and upgrades of test stand capabilities, new propellant inventories, or other general advertisements of capabilities or assets will not be considered for this area.

### Mission Area VI: Sensors for Propulsion Measurement Applications

**Chair:** Dr. Gary W. Hunter, NASA GRC / Cleveland, OH

**Telephone:** (216) 433-6459

**Email:** [gary.w.hunter@nasa.gov](mailto:gary.w.hunter@nasa.gov)

This area captures technologies and advancements in sensors and measurement devices for rocket and gun propulsion applications. Emphasis should be on development, application, modeling and integration of sensors for use in various propulsion applications. Abstracts are specifically sought on systems and sensors for:

- Storage, tanking and cryogenic systems, including true cryogenic mass flow, cryogenic temperature measurement, mass and level measurement in micro and zero gravity, pump and turbomachinery induced pressure fluctuations, leak and tank integrity monitoring, and other propellant feed and storage measurements
- High-temperature systems and hostile environments, including: extreme high-temperature measurements, real-time nozzle erosions and fuel regression, material ablation, flame propagation, high temperature electronics, packaging, and communications, and measurement and analysis of thermal effects on pressure transducers
- In-chamber diagnostics, including development of methods to make measurements of velocity, temperature, pressure, and/or other flow quantities inside of firing combustion chambers
- Plume measurement technology, including methods to utilize plume measurements to understand chamber operating conditions and spacecraft contamination issues
- Systems health monitoring and non-destructive evaluation (NDE) and repair, including: test stand characterization and control, structure and sense line frequency characterization, micro and nanotechnologies, systems

for conversion of sensor data into actionable knowledge, technologies for intelligent health management systems, integrated fiber optics, electromagnetic NDE technologies, NDE data processing and analysis, life cycle monitoring of solid rocket motors, and monitoring of aeroshells and ballutes during reentry

- Smart sensing technology, including the development of sensors capable of automatic calibration and fault detection; intelligent sensors that are calibrated in situ and provide dynamic compensation for environmental changes (temperature, humidity, etc.); fault detection also including any fault that would cause a sensor to provide inaccurate information such as sensor damage, lead wire damage or disconnection, and the disbonding or detorquing of the sensor; smart and distributed sensor system approaches, systems architectures, and applications
- Chemical sensors suitable for solid rocket motor environments and applications (sensors of interest include those for measuring the chemical state or composition of a solid, including gaseous diffusion, liquid diffusion, changes in free volume, direct measurement of changes in molecular weight or molecular weight per crosslink due to chain scission or the reaction products which result from chain scission); and development and applications of sensors that do not alter the chemical equilibrium of the solid solution are of particular interest
- Sensor modeling and simulation including modeling and simulation methods for sensor selection and data validation approaches; and recent advances in micro/nano technology, embedded sensor systems, optical diagnostics, and multiparameter measurement technologies

### Mission Area VII: System-wide Application of Additive Manufacturing for Propulsion Applications

**Chair:** Mr. James L. Cannon, NASA MSFC / Huntsville, AL

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This area focuses on the use of Additive Manufacturing (AM) as an enabling technology from both an organizational and a systems perspective. Additive manufacturing is critical for reducing manufacturing time and cost to produce specific components for propulsion systems, and multiple JANNAF Subcommittees are addressing the specific application challenges within their areas. Affordability is a critical element for both government and commercial systems. New and innovative manufacturing techniques are working their way into mainstream manufacturing. Before additive manufacturing is widely accepted for general use, it is necessary to understand the technology well enough to proceed with a high level of confidence. This Mission Area emphasizes how the various JANNAF organizations are



planning to address the challenges of integrating AM into propulsion systems. What are the synergies between the JANNAF organizations' AM plans and the AM centers of excellence such as America Makes (as well as others)? How are the JANNAF organizations addressing the integration of AM hardware into existing or new systems? Other areas to consider are overall cost considerations and ROI when incorporating AM hardware into new systems.

Papers should address AM technology roadmaps (government, industry, AM centers), AM integration challenges, strategies for incorporating AM hardware into new or existing systems, and economic considerations.

Additive Manufacturing Technology:

- Government AM Technology Road Maps/Plans
- AM Centers of Excellence Technology Road Maps/Plans
- Industry AM Technology Road Maps
- Synergy between roadmaps, what is missing?
- Challenges for incorporating AM hardware into systems
- Economic considerations of incorporating AM hardware into new systems
- Are we investing enough into AM?
- Are we investing in the right areas?

## Mission Ares VIII: Digital Engineering [Joint Mission Area with MSS]

**Chair:** Dr. Michael D. Watson, NASA MSFC / Huntsville, AL

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Digital Engineering (DE) is an integrated digital approach that uses authoritative sources of system data and models as a continuum across disciplines to support lifecycle activities from concept through disposal. DE focuses on the application and integration of models and simulations to improve the development and support of systems. DE encompasses several areas within the propulsion, hypersonic, and munitions communities including: Model Based Engineering (MBE); Integrated Health Management (IHM); and Modeling and Simulation of System Autonomy. The JANNAF Propulsion Meeting is providing an opportunity for modeling and simulation advancements in support of the DE strategy be shared across the military services, NASA, and the industrial base. Papers are sought in DE initiatives in general and the DE initiatives in the following areas:

- 1) Model-Based Engineering (MBE) encompasses the development of methodologies, codes, and model simulations to quantitatively evaluate and optimize propulsion, hypersonic, and munitions technologies across component, subsystem, and vehicle system levels.

MBE includes Model Based Systems Engineering (MBSE), Computational Fluid Dynamics (CFD), Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Finite Element Modeling (FEM), Optical Design, and other modeling and simulation used in Digital Engineering. The integrated set of these models constitutes the system Digital Twin. The use of models complements traditional experiments during technology development with a goal of reducing technology development time and schedule, as well as use physics-based models to explore domains and behaviors that are particularly difficult or impossible to examine experimentally.

- 2) Integrated Health Management (IHM) promotes advancement and development of technologies that support both Simulation Credibility and Digital Engineering efforts that are being pursued across many of the JANNAF Subcommittees. IHM technologies are focused on propulsion, hypersonic, and munitions systems within a "system of systems" environment that reduces maintenance and logistics costs, and increases reliability of these systems. IHM includes methods and tools for: data management and mining; integrated communications, command and control; diagnostics; prognostics, and integrated sensors and sensing systems. These Digital Engineering tools enable making redline and contingency decisions using knowledge-based expert systems, model-based diagnostic and reasoning, fault models, neural networks, fuzzy logic, genetic and evolutionary algorithms, and life-cycle analysis.
- 3) Modeling and Simulation of System Autonomy encompasses the development of methodologies, codes, models, and simulations to evaluate, analyze, and optimize autonomous system capabilities. Autonomous systems include aircraft, ground vehicles, hypersonic vehicles, launch vehicles, spacecraft, submarines, and sea surface ships. Modeling and Simulation of System Autonomy addresses the modeling and simulation of artificial intelligence (AI) algorithms, the integration of AI algorithms, simulation environments including the interaction of algorithms with system hardware, verification and validation of non-deterministic algorithms, and determination of operational bounds of autonomous systems. The use of modeling and simulations of autonomous systems to determine their responses and operational bounds is also a crucial Digital Engineering technology area.

## Mission Area IX: Simulation Credibility: Uncertainty, Verification, Validation and Risk [Joint Mission Area with MSS]

**Co-Chairs:** Dr. Robert A. Baurle, NASA LaRC / Hampton, VA

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Dr. Dean R. Eklund, AFRL / Wright-Patterson AFB, OH

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Digital Engineering is based on having credible models and simulations of the system. The credibility of digital simulations is a major issue for incorporating simulation tools and data into a technology-development program, for conducting simulation-based acquisition, for assessing system reliability to assure human safety and/or mission success, and for identifying and assessing risks in complex, technological systems. Simulation credibility includes assessment and quantification of simulation uncertainty, sensitivity-uncertainty analysis, experimental uncertainty, physical model validation, simulation verification and validation, and risk assessment. Papers are solicited on efforts and guidance on simulation credibility for unit, benchmark, subsystem, and system problems related to the following topics:

- Uncertainty sources and sensitivity analysis
- Propagation, quantification, and management of uncertainty
- Simulation verification
- Model validation
- Simulation credibility assessment
- Risk assessment and management
- Best practices, guidelines, and procedures for establishing simulation credibility.

## JHU WSE ERG Technical Representative

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## CS MISSION AREAS

The JANNAF 49th Combustion Subcommittee meeting will include sessions on chemical combustion phenomena occurring within the interior of guns and combustors of solid, liquid, and airbreathing (including small or expendable turbojets) missile and space propulsion systems. Papers are solicited that will aid in developing design criteria to build efficient and stable combustion systems. Papers are also invited that will aid in synthesizing, interpreting, and validating current knowledge to make research and development results more useful to design engineers. Specific areas of interest are listed below:

### Mission Area I: Ignition and Combustion of Gun Propellants

**Co-Chairs:** Dr. Michael J. Nusca, ARL / Aberdeen Proving Ground, MD

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Dr. Eugene Rozumov, ARDEC / Picatinny Arsenal, NJ

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Mr. Michael A. Bonanno, NSWC-IHEODTD / Indian Head, MD

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Experimental and modeling studies of ignition, flame spreading, and combustion of solid propellants in guns, mortars and novel gas generators are considered. These studies include the investigation of combustion temperature sensitivity, transient combustion (pressure waves), and gun barrel erosion under gun chamber conditions. Burn rate measurements and techniques, novel gun propelling charge concepts, interior ballistics of grain/stick/disk/consolidated and traveling charges are also considered. Innovative ignition systems, novel chemical igniter and propellant formulations, experimental and analytical techniques to support the production of gun propellants and igniter materials, muzzle flash and blast, mechanical behavior and integrity of propellants in dynamic pressure wave environments, combustion behavior of thermally and mechanically damaged propellant, modeling and studies of deterred propellants, improved gun erosion and ballistic efficiencies through propellant chemical formulations and additive manufacturing are among the many topics included in this mission area. Papers on gun propellant ignition and combustion and propellant vulnerability will be considered for joint CS/PSHS sessions.

## Specialist Sessions

*CHEETAH Users Group:* As a follow-up to the CHEETAH workshop held at the 48th JANNAF CS Meeting in December 2017, the mission area chairs are soliciting technical presentations (paper optional) that highlight applications of the CHEETAH model, observations and/or shortcomings of the model as documented by researchers, and extensions made or suggested to be made to the model for particular applications as performed by individual researchers. The organization of a CHEETAH specialist session will be based on the number of presentations received.

*Extended Range Munitions:* A majority of the services are proposing extended range munitions that will provide battlefield overreach for lethality (range) and terminal effects (velocity). Soliciting technical presentations (paper optional) that highlight requirements for extended range munitions, mission objectives, gun muzzle blast and signature effects, gun propulsion options and post-launch propulsion (rocket motors and ramjets) options. The organization of an Extended Range Munitions specialist session will be based on the number of presentations received.

## Workshop

*Nitrocellulose (NC):* A workshop to explore current advances and challenges in dealing with nitrocellulose based propellants with an emphasis on nitrocellulose's role in those materials. Presentations (papers optional) will focus on recent developments/challenges of processing, sensitivity, aging effects, and batch to batch variability of NC based materials. Also of interest will be current advances in physical, thermal, and structural characterization of nitrocellulose and nitrocellulose based materials.

### Mission Area II: Solid Propellants and Combustion

**Co-Chairs:** Dr. Ephraim B. Washburn, NAWCWD / China Lake, CA

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- *Decomposition, Ignition, Kinetics, Combustion, and Extinguishment of Ingredients and Solid Rocket Propellants:* Decomposition of ingredients and propellants (including kinetics, mechanisms, microstructure, and thermochemistry of thermal decomposition); ignition of ingredients and propellants (including ignition mechanisms, ignition transients, igniter designs, especially smokeless igniters, and new problems associated with ignition); combustion of ingredients and propellants (including burn rate, pressure exponent and temperature sensitivity, understanding the microstructural combustion zone structure, chemistry, and heat release, effect of motor environment, including spin on combustion, transient burning, combustion of fuel rich propellants, analytical modeling including detailed

kinetics studies); hazard initiation of propellants (including inadvertent ignition and effects of high burn rate); methods of extinguishing propellants and implementing thrust termination are considered. Of special interest is how these processes are related to new energetic ingredients and how this knowledge may be used to design new propellants that meet more demanding performance, insensitive munitions, and life cycle requirements. (Papers on thermal decomposition ignition and combustion will be considered for joint CS/PSHS sessions.)

- *Failure Analysis of Solid Rocket Motors:* Combustion analyses including ignition, flame propagation, burning in cracks and defects, burnback, and flow behavior in support of accident investigations and failure analyses of solid rocket motors are considered. (Papers in this area will be considered for joint CS/PSHS sessions.)
- *Solid Rocket Propellant Combustion Instability:* Development, laboratory, and analytical advancements are considered. Specific topics of interest include: combustion response of low smoke propellants; velocity coupled instability; nonlinear instability; instability at high pressures; motor pulsing; mean flow and acoustics interactions;  $L^*$  instability; high frequency instability in low smoke motors; combustion response function measurement techniques; and analytical methods for predicting propellant response functions and motor stability.
- *Metal Combustion:* Behavior of metallic ingredients with special emphasis on nano-particle metals in solid rocket motors is sought. Individual areas of interest include: ignition and burning rate of metal particles or droplets; metal combustion in high density propellants; effects of metal combustion on motor stability and performance; particle phase and size change phenomena; surface melt, agglomeration, and filigree formation; metal combustion in fuel-rich propellants and metal combustion in propellants without ammonium perchlorate; and methods for obtaining in situ particle size measurements.
- *Combustion, Prediction, Performance, and Other Topics in Solid Rocket Motor Behavior:* Combustion related motor behavior and the application of analytical models, experimental research, and subscale testing to their solution are considered. Areas of interest include: methodology for standardizing experimental measurements, measurement uncertainties, analytical prediction, computer code verification, correlation, extrapolation, and flight confirmation of performance of solid and liquid rocket, missile and space propulsion systems. Papers on grain design and ballistic modeling are also sought. Behavior in conventional ballistic, tactical, low smoke, controllable, spin-stabilized, ducted, nozzleless motors and gas generators are appropriate subjects for presentation, as are methods for calculating combustion chamber flowfields and their interaction with the motor structural components.

- *Solid Rocket RP-21 Combustion Technologies:* Advancements in the understanding of state-of-the-art in combustion technology in solid rocket motors, modeling, and analysis techniques, funded by RP-21 and/or IR&D programs are sought. Advancements in solid propellant combustion are of interest and its impact on selection of case, nozzle, and insulation materials or propellant ingredients. Papers on new or improved methods of thermal, structural, and fluid analysis and improved motor performance prediction and evaluation as related to combustion technology are also solicited.

### Workshop

*Propellant Burning Rate Measurement Techniques:* Solid propellant propulsion is a vital propulsion method for US DoD weapons systems. The objective of this workshop is to survey techniques used to measure solid propellant burning rate, determine possible sources for variations in reported burning rate values, and assess the accuracy and consistency of data reporting. The burning rate as a function of pressure and temperature is one of the main propellant properties that determine missile performance. There are various burning rate measurement methods including strand burner, window bomb, ultrasound, in situ motor, etc. There are variations in the compared measured burning rate between different measurement methods and variations in the measured burning rate between different experimental setups at different organizations even with the same method. This causes challenges with comparisons in the literature and with understanding the fundamental burning rate itself. In this workshop, organizations will report on the different test methods to measure the burning rate of solid propellants at their facility. A detailed description of their measurement technique will be given including sample preparation such as use of burn rate inhibitors, size/configuration of propellant samples, source of propellants, and thermal conditioning; experimental techniques such as ignition methods, pressure/temperature measurements, and burning surface tracking; and data analysis approaches applied to the reported burning rate including error analysis, measurement precision and bias, and resolution between differences in reported burn rates. As the preceding list may not be fully exhaustive, discussion on other topics in support of the workshop objectives is also welcome. Technical papers are required and will be submitted in addition to the presentations.



### Mission Area III: Explosive Performance / Enhanced Blast

**Co-Chairs:** Dr. Barrie E. Homan, ARL / Aberdeen Proving Ground, MD

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Dr. Eric J. Welle, AFRL / Eglin AFB, FL

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Investigations related to detonation and blast performance are sought. Topics ranging from detonation propagation, chemical species formed from the detonation, and combustion processes following the detonation are appropriate for this area. Experimental, theoretical, and computational studies are encouraged that address diverse subjects including; detonation properties, metal driving, enhanced blast, Chem/Bio defeat, target response, underwater blast, and blast protection.

Papers elucidating how new or existing energetic materials and/or novel munitions designs can be exploited are of interest. New experimental techniques, advanced diagnostics and new modeling capabilities that are applicable to the dynamic conditions inherent in detonation events are of interest to this community. Reports of propellant technologies that are applicable to explosive performance are also encouraged.

Of particular interest to this mission area are enhanced blast technologies. Investigations of combustion of detonation products, added fuels, and reactive material dispersal for enhancing blast effects in open-air and various confined structures are sought. Targets of interest include tunnels, caves, multi-room structures, and blast chambers. Papers reporting experimental, theoretical, and computational efforts specifically geared toward understanding the non-ideal, post-detonation energy release phenomena are requested. Papers concerning enhanced blast technologies that exploit novel explosive formulations, non-detonative energetic materials, and munitions designs are of interest.

### Mission Area IV: Airbreathing Combustion

**Chair:** Dr. Mark R. Gruber, AFRL / WPAFB, OH

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*Airbreathing Combustion:* Theoretical and experimental investigations of subsonic, supersonic, and hypersonic combustion phenomena for airbreathing systems (including small or expendable turbojet engines) are considered. Specific topics of interest include: analytical and experimental (including CFD) determination of combustor flowfield characteristics; connected-pipe testing, freejet testing, and scaling analyses to free-flight conditions; experiments and analyses relating

to ignition, mixing and combustion in liquid-fuel, gel/slurry-fuel, and solid-fuel ramjets, gas generator (ducted rocket) combustors, scramjets, and combined cycle engines; the use of ignition and combustion enhancement techniques; studies of liquid and gel/slurry fuel injection, spray formation, vaporization, and combustion processes; the measurement and analysis of combustion instability phenomena; investigation of the formulation, properties, and combustion of high energy-density single- and multi-phase fuels, including boron and other metal-burning slurries and gels; fundamental investigations of airbreathing combustion. (Papers in this area will be considered for joint CS/APS sessions.)

### Mission Area V: Combustion Diagnostics

**Chair:** Dr. Jeffrey S. West, NASA MSFC / Huntsville, AL

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This area seeks to bring together the non-intrusive flow field diagnostics and computational fluid dynamics (CFD) communities to create an interaction beneficial to both. Papers are sought from the flow field diagnostics community on the development and implementation of new or existing instrumentation relevant to any combustion problem. Emphasis is placed on methods producing data required for code verification. Similar papers are sought from the computational community emphasizing measurement needs and uncertainties required for verification of existing CFD codes. This interaction is expected to result in development of new instrumentation for combustion research, methods designed specifically for high confidence measurements of critical CFD parameters, and new approaches for creating computational models.

### Mission Area VI: Liquid, Hybrid and Novel Propellants Combustion

**Co-Chairs:** Mr. Joel W. Robinson, NASA MSFC / Huntsville, AL

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This topic area solicits summaries of work planned, underway, or completed to support state of the art and emerging propellant formulation development for evolving, non-traditional mission applications as well as traditional applications. Primary applications of interest are in aerospace propulsion but would also include primary or auxiliary power system application developments reliant upon rapid gas generation.

- *Combustion Dynamics of Liquid and Gaseous Rocket Propellants*: Theoretical and experimental studies of steady and unsteady combustion phenomena in propulsion systems using liquid or gaseous propellants are considered. Areas of interest include: transient system or process analysis; characterization of the physical and chemical processes involved in combustion; performance, heat transfer, and cooling prediction methods for subcomponents, components, and assemblies including CFD approaches; stability prediction models; development and application of new instrumentation techniques applicable to spray characterization and measurement of species characteristics such as type, distribution, temperature, droplet velocity and evolution to vapor, etc.; subsystem effects on stability; feedback control, or other adaptive methods of stabilizing liquid engines; stability rating techniques; and validity of subscale stability studies.
- *Combustion Dynamics of Monopropellant, Bipropellant, and Hybrid Propulsion Systems*: Theoretical and experimental studies of steady, unsteady, transition from transient to steady state, and multi-phase combustion phenomena in propulsion systems using liquid monopropellants and bipropellants, liquid oxidizers and solid fuels are considered. Areas of interest include injection, mixing, analytical models of fuel regression rate, chemical kinetics of combustion, ignition system design, and simulation of combustor flows.
- *Combustion Dynamics of Hydrogen Peroxide (HP)*: Theoretical and experimental studies of combustion phenomena in propulsion systems using HP are considered. Areas of interest include: effect of stabilizers and additives on longevity and reactivity of HP; development of advanced catalysts and catalytic devices for HP decomposition; chemical kinetics of catalysis; direct energy conversion including fuel cells, thermionics, and thermoelectrics; containment strategies mitigating decomposition over time using advanced materials; manufacture and chemical enrichment of HP; and historical usage of HP in propulsion applications.
- *Combustion for Underwater Propulsion*: Theoretical and experimental studies, numerical modeling, and simulation of steady and unsteady combustion phenomena in propulsion systems for underwater vehicles are considered. Topics of interest include but are not limited to: experimental determination and numerical simulation of combustor flows; underexpanded reacting jets and their mixing, entrainment, and transport characteristics; transients in combustion processes (e.g., kinetics, ignition, quenching, acoustic oscillations in jets, reverse shocks, coherent turbulent structures in fuel-product baths); experimental studies of non- or slowly-reacting similarity systems; combustion similitude, model development, and verification; radiation and other heat transfer effects; behavior of multiphase and multiple, immiscible liquid-phase constituents in combustors; shock, turbulent mixing, and chemical kinetics interactions; and diagnostic measurements, simulation, and combustion instrumentation for underwater propulsion systems.
- *Areas of specific community interest*: Based upon the Combustion Town Hall Meeting held during the December 2017 JANNAF Conference, this Mission Area anticipates papers on the following topics: green monopropellant ignition and thruster scaling; MON25 thruster performance and stability; MON30/hybrid performance and stability; density-specific impulse increase of green monopropellants; results from the Air Force Research Laboratory Broad Agency Announcement for green monopropellant thrusters; green hypergolic performance & stability; and multi-mode applications.

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## APS MISSION AREAS

The JANNAF 37th Airbreathing Propulsion Subcommittee sessions will discuss technical problems and issues associated with airbreathing propulsion systems for application to missiles, launch vehicles, aerospace planes, and remotely piloted vehicles. These include technology, components, and engines within the turbojet, ramjet, scramjet, and combined cycle families. Session topics may include characterization of system performance, engine cycle analysis and testing, engine design, engine/airframe integration, thermal management, fluid and structural mechanics, advanced engine structures and materials, fuel control systems, and characterization of advanced airbreathing fuels.

### Mission Area I: Conventional Ramjet Propulsion

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- *Ramjets:* Welcome are papers describing either experimental or theoretical studies related to solid, liquid, and gaseous (aka ducted rocket) fueled ramjet systems or the constituents thereof. By example, topics at the component level include techniques for mixing enhancement, active and passive control, plume signature reduction, instability and fuel development studies. Authors are welcome to submit papers addressing ramjet and ducted rocket technologies at the component, section, or system level.
- *Mode Transition:* Papers that address mode transition either to or from that of conventional ramjet operation, e.g., boost to conventional ramjet or subsonic to supersonic combustion are welcome. Papers should emphasize the technology that assists in this transition.
- *Technologies with a Ramjet Application:* Authors are encouraged to submit papers that address technologies applicable to ramjet systems, e.g., manufacturing technologies and fabrication techniques, etcetera. Papers need not be associated with a particular system but should be applicable to materials associated with such vehicles and their corresponding flight environment.

### Mission Area II: Scramjet Propulsion

**Chair:** Dr. Aaron H. Auslender, NASA LaRC / Hampton, VA  
**Telephone:** (757) 864-6545  
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- *Fundamental (CS) and Applied Technology:* Fundamental and applied supersonic and hypersonic airbreathing propulsion technology and systems, particularly as related to existing technology development and demonstration programs. Development of scramjet propulsion

technologies, whether or not related to a particular program or system, will also be of interest. (Papers in this area will be considered for joint APS/CS sessions.)

### Specialist Session

*Hypersonic R&D Overview:* Abstracts are requested for an overview session reviewing current activities in hypersonic R&D. Technical papers are not required but may be submitted in addition to the presentations. Please indicate your interest in being included in this Specialist Session when completing the [Abstract Submittal Form](#).

### Mission Area III: Scramjet Propulsion / Structures

**Chair:** Mr. Jonathan Boston, AFRL / WPAFB, OH  
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**Chair:** Dr. Patrick J. O'Hara, AFRL / WPAFB, OH  
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- *Propulsion Structures and Materials:* Structures and materials technologies for enhancing and enabling current and future airbreathing propulsion concepts and systems. Topics of interest include: cooled and uncooled propulsion related structures and materials such as engine and nozzle flowpaths, combustion chambers, rotating components, combustor liners, hot ducts, insulation concepts, injectors and nozzles and attachment and joining techniques. Papers on structures and materials that have recently flown, or are planned for flight, on flight vehicles are encouraged.
- *Manufacturing Technologies and Fabrication Techniques:* Papers are requested that emphasize manufacturing technologies and fabrication techniques. Papers need not be associated with a particular system but should be applicable to materials associated with such vehicles and their corresponding flight environment. Papers on additive manufacturing applicable to scramjets are also encouraged.
- *Airframe Structures and Materials:* Materials development and characterization, and structural concepts, design, test, and validation for airframe applications and components exposed to extreme environments as found in atmospheric high speed or reentry conditions. Topics of interest include: TPS and Hot Structures, materials and structures and related technology for leading edges, exterior acreage surfaces, control surfaces, hot structures, and seals (penetrations). Further topics include: hot and integrated structures; acreage thermal protection systems, including ceramic matrix composites, tiles, blankets, ablators, and metallics; fuel tanks, including cryogenic and hydrocarbon, composite and metallic; leading edges, including active, passive, and heat-

pipe-cooled; design and analysis methods; and seals. Papers are also encouraged on structures and materials for flight vehicles, either those that have flown or are planning to fly.

#### Mission Area IV: Scramjet Component / Engine Testing

**Chair:** Dr. G. Douglas Garrard, National Aerospace Solutions / Arnold AFB, TN

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Papers are solicited for all topics related to both ground and flight testing of scramjet systems. Topics may include, but are not limited to:

- Ground test facility and flight test range upgrades
- Characterization and calibration of ground test facility flow fields
- Effects of vitiated test medium on scramjet system performance and operability
- Ground and flight test program results and lessons learned
- Integration and homogenization of ground and flight test data
- Engine and component test and evaluation techniques for large scale systems for which existing ground test facilities may not exist
- Instrumentation strategies for performance, operability, thermal management, and durability in ground and flight tests and comparisons between the two
- Test techniques for transient flight events in ground test facilities
- Uncertainty assessments including techniques to reduce uncertainty by coupling both experiments and analytical computations

#### Mission Area V: Combined / Advanced Cycle Propulsion

**Co-Chairs:** Dr. Charles J. Trefny, NASA GRC / Cleveland, OH

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Mr. Glenn W. Liston, AFRL / Arnold AFB, TN

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*Fundamental and Applied Technology:* Combined, combination, and advanced cycle airbreathing propulsion technology and systems. Of particular interest are analytical, numerical, and experimental research regarding: 1) integration of multiple propulsive cycles and mode transitions; 2) methods of broadening the flight Mach number range of gas turbine, ramjet and scramjet cycles; 3) exploration of airbreathing propulsive cycles other than the Brayton cycle; and 4) system-level evaluations and payoff assessments. (Papers in this area will be considered for joint APS/CS sessions.)

#### Mission Area VI: Small / Expendable Turbopropulsion

**Chair:** Mr. Gregory B. Bruening, AFRL / WPAFB, OH

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*Basic Technology and System Applications:* Small, expendable, and limited-life turbopropulsion technology and vehicle systems related to missiles, drones, and UAVs. Areas of interest include both subsonic and supersonic mission applications. (Papers in this area will be considered for joint APS/CS sessions.)

#### Mission Area VII: Fuel Technology

**Chair:** Dr. Donald K. Phelps, AFRL / WPAFB, OH

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*Fundamental and Applied Technology:* Fuels, propellants and fuel-system catalysts R&D for conventional and advanced cycle airbreathing propulsion, as applied to missiles, launch vehicles, and advanced aircraft for global reach applications. Conventional non-expendable turbine-powered aircraft are excluded from this call. (Papers in this area will be considered for joint APS/CS sessions.)

#### Mission Area VIII: Component Modeling Simulation

**Co-Chairs:** Dr. Mark A. Hagenmaier, AFRL / WPAFB, OH

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- *Data for Propulsion Simulation Code Validation:* Papers summarizing data for airbreathing propulsion code validation are requested which summarize new data and/or existing collections of data. The validation data may represent fundamental physics, propulsion system component operation, propulsion system unit problems, or system data. The physical phenomena investigated may include shock boundary layer interactions, multi-phase flow, turbulent flow, combustion, electromagnetic flow interactions or thermal protection systems. Fundamental thermodynamic data on physical properties of fluids including ionized gasses to supercritical fluids are also of interest. (Papers in this area will be considered for joint APS/CS sessions.)
- *Methods for Propulsion Component Analysis:* Methods suitable for propulsion system design, analysis, optimization and uncertainty quantification are solicited. These methods may be new methods or evaluations of



existing methods. The methods may range from CFD simulation methods to integral cycle codes. Methods for efficient and/or accurate modeling of turbulent flow, combustion systems, ionized flow interactions, or multi-phase flow in the subsonic to hypersonic speed range are desired. Another issue of importance is methods for the integration of component models into a larger system simulation. (Papers in this area will be considered for joint APS/CS sessions.)

- Application of design, analysis, optimization and uncertainty quantification methods and tools to propulsion system components and integrated components. This also includes validation studies for models, methods and tools.

### Mission Area IX: Advanced Combustion Control

**Chair:** Dr. Aaron H. Auslender, NASA LaRC / Hampton, VA

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*Fundamental and Applied Technology:* Papers are requested to advance active combustion control technology for airbreathing propulsion engines. Combustion control includes issues such as NO<sub>x</sub> control, pattern factor control, blowoff control, combustion dynamics control, and mode transition in combined-cycle, launch-vehicle propulsion systems, and combustion control on flight systems. Three main areas of particular interest are: the need for CFD codes to incorporate time accurate transient solutions to model actively controlling combustion; the need for sensors and actuators that are robust, responsive, inexpensive, and light enough to be used in flight for active combustion control; and the need to catalogue sources of suitably characterized sensors and actuators to actively control combustion in air breathing propulsion applications.

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## EPSS MISSION AREAS

The 37th JANNAF Exhaust Plume and Signatures Subcommittee meeting will include sessions on phenomena associated with exhaust plumes from rockets, ramjets, space, and gun propulsion systems, as well as wakes and hypersonic flows. These phenomena can be divided into three technical areas: plume/wake/hypersonic flowfields, plume/wake/hypersonic signatures (to include electro-optical [EO], infrared [IR], and radio frequency [RF] radiation), and a broad area incorporating other plume/wake/hypersonic effects.

In addition, the EPSS Signatures panel (formerly the Spectral and In-band Radiometric Imaging of Targets and Scenes (SPIRITS) Users Group) promotes technical interchange among members of the Electro-Optical/Infrared (EO/IR) aircraft signature community from both government and industry.

### Mission Area I: Plume/Wake/Hypersonic Flow Field Analysis

**Chair:** Dr. Kevin D. Kennedy, AMRDEC / Redstone Arsenal, AL

Telephone: (256) 876-7278

Email: [kevin.d.kennedy14.civ@mail.mil](mailto:kevin.d.kennedy14.civ@mail.mil)

Papers submitted should be concerned with basic definitions of nozzle and exhaust plume flow fields, as well as wake and hypersonic flows. Solid propellant, liquid rocket, and ramjet exhaust plumes will be considered. In addition, plume/wake/hypersonic flow fields at all altitudes will be addressed. Some typical problem areas relating to low/mid-altitude exhaust plumes include external aerodynamic-plume interaction, combustion, turbulent mixing and afterburning, two-phase flow, multi-engine base flow, radiant heating, and oxidizer/fuel gradients. Typical high altitude vacuum plume problems include non-continuum flow, nozzle boundary layer expansion, and condensation. Wake and hypersonic flow problems of interest include ablation mechanisms, flow field modifications caused by outer mold line shape changes due to ablation, and aerothermal heating.

### Mission Area II: Plume/Wake/Hypersonic Radiation and Signatures

**Chair:** Mr. Jonathan Mautz, NASIC / WPAFB, OH

Telephone: (937) 522-6238

Email: [jonathan.mautz@us.af.mil](mailto:jonathan.mautz@us.af.mil)

Papers are solicited which describe or highlight the following: recent achievements in plume/wake/hypersonic radiation and signatures (to include the EO/IR and RF regimes); plume/wake/hypersonic radiation and signatures related to the generation of vehicle design environments; detection, surveillance, and identification; advancement of theoretical prediction methods; experimental techniques; results of ground and flight

measurements; interpretation and correlation of data; any portion of the radiation spectrum from ultraviolet through longwave infrared; plume/wake/hypersonic radiation interactions with hardbodies in the RF portion of the radiation spectrum; propulsion systems of all types in terms of thrust level, propellant used, and application, as well as operating altitude; the effects of atmospheric species reacting with the exhaust species or absorbed and emitted energy from exhaust plumes, wakes and hypersonic flows; and plumes in a vacuum.

### Mission Area III: Exhaust Plume Effects

**Chair:** Dr. Forrest E. Lumpkin, NASA JSC / Houston, TX  
**Telephone:** (281) 483-2955  
**Email:** [forrest.e.lumpkin@nasa.gov](mailto:forrest.e.lumpkin@nasa.gov)

Theoretical and experimental papers concerning the prediction of plume impingement pressures and heating for low altitude and/or high altitude spacecraft vehicle applications are solicited. Papers treating the generation of plume contaminants and the effects of such contamination on vehicle surface are of interest. Also of interest are papers concerned with high altitude base convective heating resulting from multi-engine plume interactions.

### Mission Area IV: Other Plume/Wake/Hypersonic Related Problems

**Chair:** Dr. Milton E. Vaughn, AMRDEC / Redstone Arsenal, AL  
**Telephone:** (256) 876-3726  
**Email:** [milton.e.vaughn.civ@mail.mil](mailto:milton.e.vaughn.civ@mail.mil)

Other papers dealing with exhaust plume technology not covered by the above areas are invited.

### Mission Area V: Composite Scene Signatures of Plume/Wake/Hypersonic Flowfield and Hardbody Configurations

**Chair:** Ms. Robin L. Miller, NAWCWD / Point Mugu, CA  
**Telephone:** (805) 989-4894  
**Email:** [robin.miller@navy.mil](mailto:robin.miller@navy.mil)

Papers are solicited for the following topics related to Signatures: EO/IR target signature phenomenology; EO/IR atmospheric transmission/radiation phenomenology and modeling; EO/IR signature target measurements; SPIRITS and *other* signature codes development and improvement; validation and calibration of SPIRITS and *other* signature codes and target modules; computational fluid dynamic analysis and modeling for exhaust and related flowfields; exhaust plume radiation; applications of SPIRITS and *other* signature codes data for acquisition programs, signature reduction, and operational warfighting.

**Instructional Tutorial(s) are solicited.** Back by popular demand, these instructional tutorials provide the opportunity for each community member to obtain an advanced technical understanding of the inner mechanics of SPIRITS and *other* signature codes from experts in the field. Each tutorial should be related to a topic listed in paragraph 1. Tutorials should focus on a specific phenomenon or algorithm, provide clear technical instruction, be informative, and carry an academic tone. Tutorials should be limited to two hours or less. Please communicate your interest.

### Exhaust Plume and Signatures Subcommittee Chair

Dr. Milton E. Vaughn, AMRDEC / Redstone Arsenal, AL  
**Telephone:** (256) 876-3726  
**Email:** [milton.e.vaughn.civ@mail.mil](mailto:milton.e.vaughn.civ@mail.mil)

### Exhaust Plume and Signatures Subcommittee Deputy Chair

Dr. Manish Mehta, NASA MSFC / Huntsville, AL  
**Telephone:** (256) 544-0076  
**Email:** [manish.mehta@nasa.gov](mailto:manish.mehta@nasa.gov)

### JHU-WSE ERG Technical Representative

Mr. Nick Keim, JHU WSE Energetics Research Group / Columbia, MD  
**Telephone:** (443) 718-5005  
**Email:** [nkeim@erg.jhu.edu](mailto:nkeim@erg.jhu.edu)

## PSHS MISSION AREAS

The JANNAF 31st Propulsion Systems Hazards Subcommittee meeting will address hazards and related technology areas for strategic missile, tactical missile, gun, and rocket propulsion systems. Papers are invited that (1) address all aspects of vulnerability and survivability, loading and firing hazards of propulsion systems, and weapon systems safety or (2) aid in synthesizing, interpreting, and validating current knowledge to make research and development results more useful to the design engineer. Meeting topics generally fall into two groups: (1) hazards evaluation and (2) hazards mitigation technology.

### Mission Area I: Thermal Decomposition and Cookoff

**Co-Chairs:** Ms. Aubrey D. Farmer, NAWCWD / China Lake, CA

Telephone: (760) 939-7582

Email: [aubrey.farmer@navy.mil](mailto:aubrey.farmer@navy.mil)

Dr. William W. Erikson, SNL / Albuquerque, NM

Telephone: (505) 284-5867

Email: [wweriks@sandia.gov](mailto:wweriks@sandia.gov)

- *Thermal Decomposition, Ignition, and Combustion:* Fundamental experimental and modeling studies of decomposition of ingredients and propellants (including kinetics, mechanisms, microstructure, and thermochemistry); ignition of ingredients and propellants (including ignition mechanisms, ignition transients, and effects of heating rate); combustion of ingredients and propellants (including burn rate, pressure exponent, and temperature sensitivity; understanding of the microstructural combustion zone, chemistry and heat release; burning in cracks, defects, and thermally damaged materials; convective combustion and DDT); characterization of thermally damaged materials; coupled thermal-chemical-mechanical modeling of cookoff. (Papers in this area will be considered for joint PSHS/CS sessions.)
- *Cookoff Hazards Assessment and Mitigation:* Cookoff response of propulsion systems and components; cookoff mitigation technologies; threat/hazards assessment (THA) of cookoff scenarios; relationships between THA and cookoff test procedures; small scale test methodologies for predicting cookoff of full scale systems.
- Hazards from thermal environments produced in operational and accident scenarios. This may include experimental and modeling studies of the environments themselves (e.g. aerothermal heating, fire) and the response of energetic systems (propellants, explosives) to those environments.

### Mission Area II: Shock / Impact-Induced Reactions

**Co-Chairs:** Dr. Joel B. Stewart, ARL / Aberdeen Proving Ground, MD

Telephone: (410) 278-3129

Email: [joel.b.stewart2.civ@mail.mil](mailto:joel.b.stewart2.civ@mail.mil)

Mr. Joshua E. Felts, NSWC-IHEODTD / Indian Head, MD

Telephone: (301) 744-2374

Email: [joshua.felts@navy.mil](mailto:joshua.felts@navy.mil)

- *Coupling in Energetic Materials between Mechanical and Reactive Response:* Modeling and experimental studies on sub-detonative events triggered by impact or low amplitude shock loading; experimental, theoretical, and computational studies on the influence that the damage and fracture of the energetic material has on the initiation and evolution of reaction; development and use of experiments and diagnostics to either (1) identify fundamental mechanisms for the initiation and evolution of reaction (e.g., inter-granular friction vs plastic heating of binder material vs intra-granular fracture); (2) obtain the material response of the individual energetic constituents (e.g., for use in meso-scale modeling); (3) aid in sub-detonative model validation; or (4) better characterize sub-detonative responses in full scale systems.
- *Detonation Phenomena:* Modeling and experimental studies of shock-to-detonation transitions (SDT), deflagration-to-detonation transitions (DDT), unknown-to-detonation transitions (XDT), delayed detonation phenomena (e.g., due to shock desensitization), or other detonation phenomena not mentioned. Experimental and theoretical studies of hot spot initiation and growth. Scaling of fundamental physics to predict full scale events.

### Mission Area III: Insensitive Munitions Technology

**Co-Chairs:** Ms. Jessical L. Vaughn, AMRDEC / Redstone Arsenal, AL

Telephone: (256) 876-1993

Email: [jessica.l.vaughn16.civ@mail.mil](mailto:jessica.l.vaughn16.civ@mail.mil)

Mr. Stephen R. Struck, AFRL / Eglin AFB, FL

Telephone: (850) 882-3911

Email: [stephen.struck@us.af.mil](mailto:stephen.struck@us.af.mil)

Areas of interest include but are not limited to:

- historical reviews of prior IM technology developments and lessons learned from integration into munitions;
- ongoing IM technology development efforts whether general in nature or geared to specific systems/munitions;
- design and functional details on mitigation concepts involving both passive and active features;

- results of IM and Safety testing of components and full up systems;
- evaluation of the relationship between small scale and full scale testing.

#### Mission Area IV: Gun Propellant Vulnerability

**Chair:** Mr. J. Kevin Boyd, ARL / Aberdeen Proving Ground, MD

Telephone: (410) 278-2505

Email: [james.k.boyd.civ@mail.mil](mailto:james.k.boyd.civ@mail.mil)

Any aspects related to the response of gun propellants, ammunition, and ammunition compartments to shaped charge jets, other penetrators, and spall; and new LOVA propellant technologies. (Papers in this area will be considered for joint PSHS/CS sessions.)

#### Mission Area V: Propulsion Systems Safety and Hazard Classification

**Chair:** Dr. Josephine Covino, DDESB / Alexandria, VA

Telephone: (571) 372-6685

Email: [josephine.covino.civ@mail.mil](mailto:josephine.covino.civ@mail.mil)

- *Hazard Classification of Large Solid Rocket Motors:* Test methods/procedures, analysis techniques, experimental data and computer simulation results related to the assessment of hazard response of large solid rocket motors for hazard classification purposes. In particular, papers covering three hazard scenarios are of interest, including: (1) detonation/explosive reaction characteristics of various propellant families subjected to explosive shocks, for example critical diameter, shock sensitivity, and the relationship between the two parameters; (2) response of large SRMs in an engulfing fire or fast cookoff scenario; and (3) creation and effects of propellant damage on hazard response of large SRMs in impact and other accident scenarios.
- *Propulsion Systems Safety and Hazard Classification:* Harmonization of Hazard Classification and Insensitive Munitions Testing, Issues identified by the service safety offices, Hazard classification issues, Differences between insensitive munitions and hazard classification and safety testing and standardization, Assessment of response and pass/fail criteria, Alternate test protocols and the role of small scale to full scale testing and hazard classification, and miscellaneous safety issues and programs.

#### Mission Area VI: Energetic Liquid Hazards

**Chair:** Mr. Adam J. Brand, AFRL / Edwards AFB, CA

Telephone: (661) 275-5787

Email: [adam.brand@us.af.mil](mailto:adam.brand@us.af.mil)

- Hazards characterization associated with energetic liquids either as part of bipropellant combinations, monopropellant formulations, or liquid ingredients in solid propellant formulations and their respective propulsion systems.
- Identification and application of meaningful analytical/experimental methods for assessing hazard risk with energetic liquids, and the development and standardization of new test methods for assessing hazards in the different propulsion systems considered.

#### Propulsion Systems Hazards Subcommittee Chair

Mr. Adam J. Brand, AFRL / Edwards AFB, CA

Telephone: (661) 275-5787

Email: [adam.brand@us.af.mil](mailto:adam.brand@us.af.mil)

#### JHU WSE ERG Technical Representative

Mr. William A. Bagley, JHU WSE Energetics Research Group / Columbia, MD

Telephone: (410) 718-5009

Email: [wbagley@erg.jhu.edu](mailto:wbagley@erg.jhu.edu)



## WORKSHOPS/SPECIALIST SESSIONS

Recommendations for workshops or specialist sessions are solicited at this time. **Individuals interested in organizing and chairing a workshop or specialist session should contact the JHU WSE ERG Technical Staff member in their respective subcommittee by 3 December 2018.**

### Workshops

The JANNAF workshop is reserved for bringing the community together to address a specific task or problem, the outcome of which is important and substantial enough to warrant the publication of a final report detailing the discussions, conclusions, and recommendations that resulted from the workshop.

Requirements for JANNAF workshops and established best practices can be found in the [JANNAF Workshop Guide for Chairs](#); this document will guide you through the planning and approval process for workshops held at a JANNAF meeting.

To request a workshop you must submit a [Workshop Request Form](#) to your JHU WSE ERG Technical Liaison or Shelley Cohen [scohen@erg.jhu.edu](mailto:scohen@erg.jhu.edu). This form must be submitted to ERG by **Monday, 3 December 2018**. The agenda and invitation list is due **Monday, 25 February 2019** for inclusion in the Preliminary Program, and must be approved no later than **Monday, 22 April 2019** for inclusion in the Final Program.

### Specialist Sessions

To request a specialist session for this JANNAF meeting, a [Specialist Session Request Form](#) must be submitted to JHU WSE ERG. This form requires a statement of justification for the specialist session as well as a well thought out agenda. Requests will be reviewed by the designated JANNAF subcommittee TSG chair and ERG for approval; this approval is necessary for any specialist sessions to be included in the Final Program.

**The deadline for submission of a specialist session request is 3 December 2018.** If you have any questions about planning a specialist session please contact your ERG Technical Liaison or Shelley Cohen at [scohen@erg.jhu.edu](mailto:scohen@erg.jhu.edu).

## JANNAF AWARDS PROGRAM

In the tradition of recognizing the outstanding achievements by members of the propulsion community, the JANNAF Technical Executive Committee (TEC), PIB Executive Committee (PEC), and the Combustion (CS), Airbreathing Propulsion (APS), Exhaust Plume and Signatures (EPSS), and Propulsion Systems Hazards (PSHS) subcommittees are soliciting nominations for awards to be presented at the meeting. A TEC Award is justified if the achievement or service is in a technical area that is not covered by an existing subcommittee, or is of such scope or magnitude that merits this recognition.

### Special Recognition Awards

The **Special Recognition** awards for **Sustained Contribution** and **Lifetime Achievement** honor individual achievements, either in the last 18 months or for a lifetime of dedicated service. These awards are the most prestigious subcommittee awards and reflect on the awardees' contributions to JANNAF.

Special recognition award winners will be selected by respective subcommittee Awards Committees based on review of the nomination in consideration of the following:

- Technical value of the achievement(s) including level of technical complexity and challenge, quality of results, degree of innovation and timeliness of research.
- Impact of the achievement on the broader propulsion community.
- For individuals nominated for lifetime achievement, demonstrated participation in technical societies as evidenced by positions held and papers published will be considered favorably.

### Outstanding Achievement Award

The **Outstanding Achievement Award** is given for the most outstanding technical achievement in the subcommittee's area by an individual, by a team within an organization, or by a team of organizations. To recognize the varied nature of the JANNAF subcommittees and the accomplishments of their communities, nominations may be solicited and given in the two focus areas of R&D Technology and Operational Systems.

The achievement shall have been accomplished in the previous 18 months. The nominees must have worked for the organization during the same 18-month period of performance.

The award recipients(s) must be able to attend the meeting to receive the award.

### Certificate of Commendation

The **Certificate of Commendation** is given to recognize an individual whose contributions within the last 18 months have been pivotal in ensuring the success of a JANNAF activity.

## Certificate of Appreciation

The **Certificate of Appreciation** is given to recognize individuals for outstanding contributions and dedicated service to JANNAF.

## Nominations

To nominate an individual for one of the above awards please use the [JANNAF TEC/PEC and Subcommittee Award Nomination Form](#). Nomination submissions should include the following:

- A description of the achievement or distinguished service, of no less than 200 and no more than 1000 words. The description must be typed or provided in electronic format (Adobe Acrobat PDF or MS Word) via email.
- Supporting data (if desired) of no more than 10 pages.
- Supporting curriculum vitae, list of publications, and/or professional activities as required to support the nomination.
- Contact information for the nominee(s) and the nominator, including organization affiliation, phone number, and email address.

Nominations should be submitted to the appropriate JHU WSE ERG technical representative no later than **Monday, 1 April 2019**.

## Best Paper Awards

In addition to the nomination awards listed above JANNAF recognizes authors of papers that exhibit excellence and significant merit with the **Best Paper Awards**. Best Paper Awards from this meeting will be given at the next JANNAF Subcommittee meeting.

## Best Student Paper Awards

The **Best Student Paper Award** will be given to undergraduate or graduate students who author papers that exhibit excellence and significant merit. One paper will be selected to receive the Best Student Paper Award. If requested on the Abstract Submittal Form, student-authored works will be included in the initial round of consideration with the submission of an abstract; please be sure to indicate on the Abstract form if you wish to be considered for the Best Student Paper Award.

As a reminder: student authors must conform to the same JANNAF eligibility requirements as other authors, per the policy on non-government attendees at JANNAF meetings given on page 2. Student authors are encouraged to work with

their advisors to ensure they meet these requirements, and should contact JHU WSE ERG at their earliest convenience with questions regarding their eligibility and participation.

Student papers will be reviewed upon submission of their cleared manuscripts. In order to be considered for the student best paper selection, the completed paper must be provided to JHU WSE ERG by **1 April 2019**. The Best Student Paper Award will be presented at the JANNAF meeting at which the paper is given.

## UPCOMING JANNAF MEETINGS

45th Structures and Mechanical Behavior  
41st Propellant and Explosives Development and Characterization

32nd Rocket Nozzle Technology

31st Safety and Environmental Protection

Joint Subcommittee Meeting

Programmatic and Industrial Base Meeting

*10-13 December 2018*

*Vancouver, WA*

[Visit December 2018 meeting website](#)

66th JANNAF Propulsion Meeting

Programmatic and Industrial Base Meeting

49th Combustion

37th Airbreathing Propulsion

37th Exhaust Plume and Signatures

31st Propulsion Systems Hazards

Joint Subcommittee Meeting

*3-7 June 2019*

*Dayton, OH*

[Visit June 2019 meeting website](#)

13th Modeling and Simulation

11th Liquid Propulsion

10th Spacecraft Propulsion

Joint Subcommittee Meeting

Programmatic and Industrial Base Meeting

*December 2019*

*Location and specific dates TBA*