

JANNAF

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



NEWS

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JANNAF Will Meet Virtually in June 2021

Due to the ongoing global Covid-19 pandemic, the June 2021 JANNAF Meeting will take place in a virtual format from 7-17 June 2021. The featured keynote speaker at the meeting is Lakiesha Hawkins, the Deputy Manager for NASA’s Human Landing System (HLS) Program Office at the NASA Marshall Space Flight Center (MSFC), Huntsville, Ala. The Defense Information Systems Agency’s Defense Collaboration Services (DCS) online platform will host all sessions of the meeting, which will feature a joint gathering of the 68th JANNAF Propulsion Meeting (JPM), a meeting of the Programmatic and Industrial Base, and the 15th Modeling and Simulation (MSS), 12th Liquid Propulsion (LPS), and 11th Spacecraft Propulsion (SPS) joint subcommittee meeting. James L. Cannon of the NASA MSFC will chair the meeting.

Ms. Hawkins keynote speech, entitled “Human Landing System Program: Overview and Status,” will be held on 8 June 2021. She will provide an overview of NASA’s Artemis lunar exploration program



James L. Cannon of the NASA Marshall Space Flight Center, Huntsville, Ala., will chair the JANNAF Meeting.

and discuss the current status of the HLS program. On 26 March 2019, NASA was charged with landing the first woman and the next man on the South Pole of the Moon by 2024, followed by a sustained presence on and around the Moon by 2028. NASA’s HLS

(See June 2021 Virtual Meeting on page 3)

»December
Virtual JANNAF
Meeting Review

Page 6

»Virtual Meeting
Planning

Page 10

»Remembering
Al McDonald

Page 12

»ERG Leadership
Profile

Page 14

»American Rocketry
in WWII

Page 16



Editor: Benjamin S.M. Schwantes
410-992-7300, ext. 227
bschwantes@erg.jhu.edu

ERG Director: Peter E. Zeender
The Johns Hopkins University WSE ERG
10630 Little Patuxent Parkway, Suite 202
Columbia, Maryland 21044-3286
<https://www.erg.jhu.edu>
Fax: 410-730-4969

The JHU WSE Energetics Research Group (ERG) is the technical support contractor of the Joint Army-Navy-NASA-Air Force (JANNAF) Interagency Propulsion Committee. The purpose of JANNAF is to solve propulsion problems, affect coordination of technical programs, and promote an exchange of technical information in the areas of missile, space, and gun propulsion technology.

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Recent ERG Publications

- Abstract Number: 2020-0001
JANNAF Journal of Propulsion and Energetics, Volume 11
Dec 2020
- Abstract Number: 2020-0002
Meeting Proceedings of the 67th JANNAF Propulsion Meeting (JPM) / Programmatic and Industrial Base (PIB) / 46th Structures and Mechanical Behavior, 42nd Propellant Explosives Development and Characterization, 33rd Rocket Nozzle Technology (RNTS), 31st Safety and Environmental Protection (SEPS), and 14th Modeling and Simulation Joint Subcommittee Meeting
Sep 2020
- Abstract Number: 2020-0006
Meeting Proceedings of the 50th Combustion (CS), 38th Airbreathing Propulsion (APS), 38th Exhaust Plume and Signatures (EPSS), 32nd Energetic Systems Hazards (ESHS) Joint Subcommittee Meeting / Programmatic and Industrial Base Meeting
Dec 2020

ERG's Technical/Bibliographic Inquiry Service

ERG offers a variety of services to its subscribers, including responses to technical/bibliographic inquiries. Answers are usually provided within three working days, in the form of telephoned, faxed, electronic, or written technical summaries. Customers are provided with copies of JANNAF papers, excerpts from technical reports, bibliographies of pertinent literature, names of recognized experts, propellant/ingredient data sheets, computer programs, and/or theoretical performance calculations. The ERG staff responds to numerous inquiries each year, from over 150 customer organizations. For further information, please contact Nicholas Keim by email at nkeim@erg.jhu.edu.

ERG Subscriptions

ERG recently forwarded GFY 2021 subscription renewal packets to its customer base for continued products and services. We would like to take this opportunity to inform the community that a minimum yearly subscription of \$1,775 entitles subscribers to one complimentary suite of JANNAF databases; one complimentary *JANNAF Journal*; and six hours (prepaid) of technical/bibliographic inquiry hours. For information concerning a yearly ERG subscription and/or products and services, please contact Tricia Frey at 410-992-7300, ext. 222, or email tfrey@erg.jhu.edu. You may also visit <https://www.erg.jhu.edu/subscriptions>.

JANNAF News is seeking short (Dist A) technical articles for future editions. If you are interested in submitting an article or have any questions, please contact Managing Editor Benjamin Schwantes at bschwantes@erg.jhu.edu.

June 2021 Virtual Meeting... *continued from page 1*

program is responsible for deep space transportation to carry humans to and from the surface of the Moon as part of NASA's Artemis lunar exploration program.

Prior to becoming the HLS Deputy Manager, Lakiesha Hawkins served as Manager of the HLS Program Office's Program Planning and Control Office where she was responsible for leadership of the budget, risk, schedule, governance, cyber security, and audit aspects of lander development efforts. From 2018 to 2019, she served as Deputy Manager of the Habitation Systems Development Office, providing program and project leadership for the Gateway Habitation Element. In 2017, she served as Chief of the Avionics Systems Integration Branch, where she managed systems engineers leading avionics software and hardware integration for the Space Launch System. Hawkins holds a B.S. in mechanical engineering from Florida Agricultural and Mechanical University in Tallahassee and an M.S. in engineering management from the University of South Florida in Tampa. She received a NASA Outstanding Leadership Medal in 2017 and was honored as a Distinguished Alumni by the Florida A&M University-Florida State University College of Engineering Department of Mechanical Engineering in 2018.

For complete details on all the papers and topics at the June 2021 JANNAF Meeting, please see the meeting program, which is avail-



Lakiesha V. Hawkins, Deputy Manager for NASA's Human Landing System Program Office at the NASA Marshall Space Flight Center, Huntsville, Ala., will be the keynote speaker at the virtual JANNAF Meeting.

able through the JANNAF Portal at <https://www.jannaf.org/mtgs/2021June/pages/index.html>.

47th SMBS / 43rd PEDCS / 34th RNTS / 32nd SEPS / PIB December 6-16, 2021 Virtual Meeting

Questions

Technical questions may be addressed to the following ERG technical representatives:

- SMBS – Bryan DeHoff (bryan.dehoff@aerospacetechnic.com / 513-378-7071)
- PEDCS – William Bagley (wbagley@erg.jhu.edu / 443-718-5009)
- RNTS – Bryan DeHoff (bryan.dehoff@aerospacetechnic.com / 513-378-7071)
- SEPS – William Bagley (wbagley@erg.jhu.edu / 443-718-5009)
- PIB – Kirk Sharp (ksharp@erg.jhu.edu / 228-234-5423)

For all other meeting-related matters, please contact Shelley Cohen (scohen@erg.jhu.edu / 410-992-7302).

June 2021 Meeting Subcommittee Highlights

JPM

The 68th JANNAF Propulsion Meeting (JPM) will hold four sessions at the June 2021 virtual meeting: High-Speed Propulsion Technologies, Future Space Access, Tactical Solid Rocket Motor Developments, and Gun and Gun-Launched Propulsion. The JPM sessions will complement the subcommittee sessions with content on novel and cutting edge technologies, research, and systems.

MSS

The JANNAF 15th Modeling and Simulation Subcommittee meeting will have sessions on the following subjects:

- Simulation credibility,
- Investigations into reactive flow and thermal systems
- A specialist session on Primer for Uncertainty Quantification using the Probability Box Approach
- Code demonstrations on the Generalized Fluid System Simulation Program (GFSSP)
- Fluid analysis of supersonic and space system components

The updated MSS meeting rotation will allow the subcommittee to return to meeting with the Liquid Propulsion (LPS) and Spacecraft Propulsion (SPS) subcommittees this year. Many of the MSS sessions will overlap with these two subcommittees' areas of interest, including the GFSSP code demonstration, and analyses of supersonic space system components.

MSS will also be holding a plenary with invited speaker Venkateswaran Sankaran, Ph.D., former Chief Scientist of the Air Force Office of Scientific Research (AFOSR). Dr. Sankaran will be offering insights regarding the modeling and simulation (M&S) community and action plan, with a focus spanning all aspects of modeling and simulation.

MSS will be holding its usual code demonstrations at the JANNAF Meeting. This year, members

will demonstrate NASA's GFSSP. The demonstration will provide participants with general examples of how to use the program, as well as offer them tips and tricks to highlight the software's ease of use.

LPS

The JANNAF 12th Liquid Propulsion Subcommittee (LPS) meeting will cover a variety of overarching topics including liquid engine systems' analysis, combustion subsystems and components, propellant feed and pressurization systems, as well as advanced materials research and development within these applications. Specific topics of interest covered in the virtual LPS sessions will include propellant characterization and performance, use of additive manufacturing in rocket engine systems, and research into rotating detonation rocket engines (RDREs).

For those interested in greater involvement in the liquid propulsion community, LPS panel meetings will offer opportunities to participate in more in-depth discussions of specific topics. The following panels will have meetings to discuss their ongoing tasks and progress: Combustion Stability, Advanced Materials, and Turbomachinery.

A new panel dedicated to the emerging field of RDREs will meet for the first time after a full session of RDRE papers on Thursday, 10 June. The RDRE Panel will address technology development requirements for RDRE design, manufacturing, modeling, and experimental testing. One of its initial focal points will be the establishment of a minimum set of JANNAF accepted test and performance prediction metrics and figures of merit for RDREs.

The LPS Combustion Stability Panel is also pleased to announce that the update to the CPIA-655 Combustion Stability Guidelines document is nearing completion. The panel commissioned an external review of the guidelines by experts with broad subject matter knowledge. Reviewers included engineers in various capacities: systems-level, combustion device, stability, technical advisors, management, and

“greybeards” with years of experience. The document is currently in the disposition stage, after which it will be submitted for electronic publication by the Johns Hopkins University Energetics Research Group on the JANNAF Digital Online Collection (JDOC).

SPS

The JANNAF 11th Spacecraft Propulsion Subcommittee meeting will have sessions on the following subjects:

- A workshop on the industrial base status of hydrazine and monomethylhydrazine (MMH).
- A workshop investigating a joint approach for identifying and selecting advanced spacecraft propulsion concepts with transformative impacts
- A session on electric propulsion activities, including the fifth instalment of the Electric Propulsion Operation in the Space Environment and Facility Interactions (EPOSE) workshop.
- A session on cube/nano satellite propulsion
- Two full sessions on nuclear propulsion

Multiple workshops will be held during this virtual meeting. The workshop on the status of hydrazine and MMH will focus primarily on the impact of green monopropellants on the procurement and quality of hydrazine and MMH. The workshop will examine the industrial base through NASA, the Air Force, and Defense Logistics Agency perspectives.

SPS will hold its fifth EPOSE workshop in which papers will continue to expand on the testing of electric propulsion in space and examine facility interactions with ground testing.

Nuclear propulsion, both thermal and electric, will have a strong presence in this upcoming meeting. Two full sessions on current technology advancements will be held. Immediately following the sessions, a workshop discussing ground testing for nuclear thermal and electric propulsion will be held.

SEPS Leadership Change

Drs. Karen L. Mummy and Jeanne L. Hartzel have recently taken over the leadership of the Safety and Environmental Protection Subcommittee (SEPS) as Chair and Deputy Chair, respectively. The JANNAF community welcomes them to their significant new leadership role within the subcommittee.

Mummy serves as the Director of the Environmental Health Effects Research Directorate of the Naval Medical Research Unit Dayton, Wright-Patterson AFB, Ohio, and holds a Ph.D. in microbiology from Miami University, Oxford, Ohio. She joined the unit in 2010 after holding various research positions with Massachusetts General Hospital and the Harvard Medical School following the completion of her doctorate in 2004.

Hartzel serves as a Physical Scientist for the Naval Ordnance Safety and Security Activity (NOSSA), Ordnance Environmental Support Office, Indian Head, Md., and holds a Ph.D. in environmental science and policy from George Mason University, Fairfax, Va. She joined NOSSA in 2018 after more than two decades of work as an environmental research scientist and program manager for private industry and the Navy and Marine Corps.

Please keep an eye on this space in the future for insights from JANNAF Technical Executive Committee or Programmatic and Industrial Base Executive Committee Members

JANNAF Meets Virtually for December 2020 Meeting

The JANNAF community met in December for its second virtual meeting of 2020. Due to the Covid-19 pandemic, participants in the 50th Combustion (CS), 38th Airbreathing Propulsion (APS), 38th Exhaust Plume and Signatures (EPSS), and 32nd Energetic Systems Hazards (ESHS) subcommittees, as well as the Programmatic and Industrial Base, gathered online using the Defense Information Systems Agency's Defense Collaboration Services (DCS) online platform for all sessions and panel meetings. Kevin D. Kennedy, Ph.D., of the U.S. Army DEVCOM Aviation & Missile Center in Redstone Arsenal, Ala., chaired the two-week meeting. Michael E. White, Principal Director for Hypersonics in the Office of the Under Secretary of Defense for Research and Engineering, Washington, D.C., gave a keynote speech focusing on the role of hypersonic systems in future U.S. military warfighting strategies.

White addressed current Department of Defense (DoD) efforts related to hypersonics. He noted that the U.S. has significant experience with hypersonic research dating back to the 1950s and 1960s. However, unlike some other near-peer nations, the U.S. did not make the leap from scientific research to the development of fielded weapons systems over the past couple of decades. White argued that the U.S. must make up for lost time and even the playing field with potential adversaries. However, he cautioned that the U.S. should not simply try to match the capabilities of potential opponents' hypersonic weapons. Instead, the U.S. must develop hypersonic capabilities that complement current and anticipated DoD warfighting needs and leverage the key advantages offered by hypersonic systems,



Keynote speaker Michael E. White, Principal Director for Hypersonics in the Office of the Under Secretary of Defense for Research and Engineering, Washington, D.C.

namely range, survivability, compressed timescale from launch to target, and lethality.

White touched on three cornerstones of the DoD's current hypersonic strategy: offensive warfighting capabilities; defense against potential adversary hypersonic weapons; and reusable systems for strike and space access. He noted that the DoD's priority involved offensive hypersonic systems development, but argued that offensive and defensive systems go hand in hand, since the best defense involves offensive actions to knock out adversary hypersonic systems prior to launch. He termed this "comprehensive layered defeat" and argued that advances in ballistic missile and traditional air defense capabilities against hypersonic cruise missiles and boost-glide strike vehicles would complement strike capabilities supported by global persistent surveillance of potential adversary launch sites.

In order to advance warfighter access to hypersonic capabilities, White discussed the four-phase development plan being pursued by the DoD in order to deploy hypersonic weapons systems by the mid-2020s. Phase

one, already in progress, involved research and development efforts involving cruise missile and boost-glide demonstrators. He highlighted efforts by the Defense Advanced Research Projects Agency (DARPA) and Strategic Capabilities Office (SCO) to develop such technologies. Next, phase two will see the development of specific weapons systems by the armed services for ground, sea, and air launch. These systems will be fielded under phase three and will be available to warfighters for tactical deployment if needed. Finally, phase four will involve a mass rollout of hypersonic weapons systems plus a robust upgrade strategy.

White concluded his remarks by noting the need for additional investments in hypersonic ground- and air-test facilities and capabilities. He also argued that the DoD needs to draw on domestic academic research efforts and support workforce development within the industrial base in order to ensure the rapid and smooth development and fielding of hypersonic systems in the near term. At the end of his presentation, White addressed audience questions regarding specific technologies needed for hypersonic systems development and other related topics.

Following White's keynote address, Kevin Kennedy introduced JANNAF Technical Executive Committee (TEC) Chair Drew DeGeorge of the Air Force Research Laboratory (AFRL), Edwards Air Force Base, Calif., who thanked JANNAF Meeting participants on behalf of the TEC and Programmatic and Industrial Base Executive Committee for their willingness to assemble online and join the meeting remotely. He expressed hope that all attendees would find the meeting valuable and would continue to contribute to JANNAF in various ways until in-person meetings resumed.

**JANNAF is pleased to announce the
Best Student Paper from the
December 2020
JANNAF Meeting**

Student/Primary Author:

Andy H. Huynh

Authors:

Andy H. Huynh

Joseph Kalman, Ph.D.

**JANNAF is pleased to announce the
following awards from the
Airbreathing Propulsion Subcommittee**

Sustained Contribution Award

Lawrence Huebner

NASA Langley Research Center, Hampton, Va.

*For service as Chair of the
APS Technical Steering Group*

Lifetime Achievement Award

Aaron Auslender, Ph.D.

NASA Langley Research Center, Hampton, Va.

*For contributions to
hypersonic airbreathing propulsion*

Lifetime Achievement Award

Robert Mercier

AFRL, Wright-Patterson Air Force Base, Ohio

*For exemplary service to the
Air Force and JANNAF in the field of
high-speed systems development*

Best Paper Award

2019 JANNAF Meeting, Dayton, Ohio

**Eric Blades, Ph.D., and Azariah Cornish,
ATA Engineering, Inc., Huntsville, Ala.;**
**Patrick O'Hara, Ph.D., Mark Hagenmaier,
Ph.D., and Dean Eklund, Ph.D., AFRL,
Wright-Patterson Air Force Base, Ohio;**
**Bryan Kubitschek, Analytical Services and
Materials, Inc., Hampton, Va.; Andrew
Williams and Jacques Cuneo, Southern
Research Institute, Birmingham, Ala.;**
**Wallace Vaughn, Ph.D., David Glass, Ph.D.,
and Matthew Mahlin of NASA Langley
Research Center, Hampton, Va.**

Congratulations to all award recipients!

December 2020 Virtual Meeting Subcommittee Review

CS

The Combustion Subcommittee (CS) met virtually for its 50th anniversary this past December 2020. Attendance and support for the CS sessions was strong. Topics addressed ranged from hypersonic combustion (injection, fuels, and system design) and associated processes and modeling, interior combustion ballistics, as well as fundamental combustion research, novel green propellant chemistry, and metal combustion studies. Some highlights from the program sessions and panel meeting are detailed below.

Collaboration between CS and EPSS Subcommittees: Combustion Kinetics Panel

The CS and Exhaust Plume and Signatures (EPSS) subcommittees conducted a joint tutorial on chemical kinetics featuring four presentations. This topic is of keen interest to the EPSS community since the chemical kinetics that occurs in rocket engine/motor combustion chambers determine the observable signature of the consequent exhaust plume. The briefings addressed measurement and computational techniques used to discern and formulate kinetic mechanisms; recent video and constituent measurements of two interacting, combusting streams of liquid propellant; development of a corresponding kinetic mechanism; and the development of solid propellant mechanisms. After the tutorial, the Combustion Kinetics Panel held a meeting during which the discussion revealed the high value of continued joint interactions between the CS and EPSS. As a result, it was decided to hold an off-cycle meeting of the Kinetics Panel before the next JANNAF Meeting in June 2021.

Contributed by Milton "Ed" Vaughn, Ph.D., Army DEV-COM Aviation & Missile Center, Redstone Arsenal, Ala.

Enhancing Synergy between Flowfield Diagnostics and Computational Modeling Specialist Session

Four strong presentations provided different examples of the working interaction between experimental and computational research efforts. In one instance, separate groups conducted the measurement and computational activities independently while in periodic

communication. In a second report, researchers conducted measurements and computations in tandem to enable bootstrapping progress. A third report addressed the use of computation to inform a measurement strategy. The fourth covered the development of computational models to reflect previously completed measurements. The breadth of work presented enabled a rich discussion afterwards concerning the validation of computational models, the need for system-level modeling and measurements, and the robust presentation of uncertainty estimates for both measurement and computational results. It was recommended that the next session include papers covering the difficulty of "marrying" measurements and modeling results for two-phase flow environments and the introduction of Bayesian techniques in addressing modeling uncertainty.

Contributed by Michael S. Brown, Ph.D., AFRL, Wright-Patterson AFB, Ohio

Reactive Materials Panel Meeting Highlights 2020 Highlights:

Panel participants presented on efforts at the Navy, Air Force, Army, Defense Threat Reduction Agency (DTRA), and Defense Advanced Research Projects Agency (DARPA) including work underway in industry supporting these efforts. The presentations described each service's and agency's approach to reactive materials and highlighted a resurgence in both basic and applied research efforts to better understand the structure/property relationships for these various classes and types of reactive materials. A significant increase in advanced diagnostics to link the chemistry and physics of fracture and breakup of reactive materials (RM) and their subsequent reaction is critically important. High fidelity modeling efforts focused on the linkage between mechanical properties and energy release phenomenology has grown significantly. These efforts are fundamental to improving our fast-running lethality and effectiveness models. The meeting wrapped up with a lengthy discussion about how the U.S. technical community should move forward with a Technical Cooperation Program (TTCP) effort to look at L&E prediction capabilities for RM weapon systems across the "Five-Eyes" nations. Several compositions were offered as model compositions to use

for comparative predictions. An area of growing interest for the services is incorporating thermal and incendiary effects into L&E codes for RM weapon systems. This is a challenging problem and the work is on-going.

Contributed by Heather F. Hayden, Ph.D., NSWC-Indian Head, Md.

APS

The Airbreathing Propulsion Subcommittee (APS) gathered virtually in December 2020 for its 38th meeting. Subcommittee sessions were well attended and attendees participated actively. The main topics discussed included hypersonic vehicles, ramjets, scramjets, high-speed flow modeling, high-speed fuels, and rotating detonation engines/pressure gain combustion. A four-day session on NASA's Aether hypersonic model vehicle also took place.

Overview sessions on current U.S. hypersonics programs were well attended. The sessions addressed the Air Force's and NASA's current activities in the hypersonic field, as well as offering an overview of future plans and the status of other hypersonic vehicle projects.

Joint sessions with the Combustion Subcommittee (CS) on ignition, combustion, flameholding, alternate fuels, and analysis tools for scramjets also took place. The Medium Scale Critical Component (MSCC) program was addressed and discussions took place between the technical community and program managers on future goals for technical progress in the airbreathing propulsion field.

EPSS

The Exhaust Plume and Signatures Subcommittee (EPSS) gathered for the 38th time at the December 2020 virtual JANNAF Meeting. The technologies of concern to EPSS involve phenomena associated with exhaust plumes from rockets, ramjets, space, and gun propulsion systems, as well as wakes and hypersonic flows. 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/missile signature community from both government and industry.

Kevin Kennedy, Ph.D., Deputy Chair of the EPSS served as the overall chair for December's joint subcommittee meeting and presided over a very full schedule of events for EPSS. The subcommittee hosted two tutorials – the first on chemical kinetics, held jointly with the Combustion Subcommittee (CS), was followed by the CS Kinetics Panel meeting. A lively discussion on potential areas of collaboration between EPSS and CS, particularly in the areas of liquid hypergol kinetics, soot formation, and hypersonic relevant problems, took place. The second tutorial involved a deep-dive into the features of the new SPIRITS Model AC3. Finally, EPSS hosted the inter-agency collaboration forum, which first began at the June 2019 Dayton JANNAF Meeting, to facilitate the identification of challenges and solutions of mutual interest across the DoD and NASA, an activity that is a critical and foundational component of JANNAF.

ESHS

The 32nd Energetic Systems Hazards Subcommittee (ESHS), formerly the Propulsion System Hazards Subcommittee, convened virtually at the December 2020 JANNAF Meeting for six technical sessions, including three joint sessions with the Combustion Subcommittee (CS), to address hazards associated with missile, space, and gun propulsion systems. Seventy-five attendees noted ESHS was their primary reason for participating in the online event. Seventeen presentations explored topics including slow and fast cook-off, sensitivity of green propellants, as well as ongoing research supporting the development of insensitive propellants and explosives. ESHS held three panel meetings to share current research and advances in cook-off, shock and impact-induced reactions, and insensitive munitions. In addition, ESHS held a Department of Defense-only session addressing reactive material and fragmentation testing.

“A Huge Team Effort” ERG’s Pivot to Virtual JANNAF Meetings in 2020

The Covid-19 pandemic disrupted a multitude of planned activities in the spring of 2020. In the case of the JANNAF community, state and local lockdowns and employer restrictions on work travel jeopardized the May 2020 gathering of the 67th JANNAF Propulsion Meeting; Programmatic and Industrial Base; and 46th Structures and Mechanical Behavior, 42nd Propellant and Explosives Development, 33rd Rocket Nozzle Technology, 31st Safety and Environmental Protection, and 14th Modeling and Simulation Joint Subcommittee Meeting scheduled to convene in Pittsburgh, Pa. Beginning in March 2020, as the scale of the pandemic in the U.S. began to make itself felt, the Johns Hopkins University Energetics Research Group (ERG) and JANNAF leadership began discussing how to respond to the new restrictions and the potential health risks posed by in-person meetings. ERG leadership and the JANNAF Technical Executive Committee (TEC) faced three options at their initial teleconference: postpone the in-person JANNAF Meeting until the fall of 2020; postpone it until the spring of 2021; or continue moving forward with the scheduled meeting with a significant anticipated drop in attendance. Ultimately, both sides agreed to pause planning activities and postpone the meeting while the Air Force Contracting Office (AFCO) staff at the Air Force Research Laboratory, Edwards Air Force Base, Calif., investigated modifications to ERG’s JANNAF support contract.

Two anxious months passed before meeting planning resumed in May 2020 after the AFCO approved contract modifications and cleared ERG and the JANNAF TEC to move forward with defining a path for the delayed May 2020 JANNAF Meeting. Subsequent teleconferences determined that the JANNAF Meeting would not be held face to face and would need to be pushed back to the fall in order to provide sufficient time for funding questions and meeting planning considerations to be resolved. By mid-summer, the path ahead was finally beginning to come into focus. Working in collaboration

with the AFCO, ERG leadership and the JANNAF TEC determined that the JANNAF Meeting would take place through a virtual format using the Defense Information Support Agency’s (DISA’s) secure Defense Collaboration Services (DCS) platform rather than a commercial virtual conferencing platform. While these commercial platforms offered some additional functionality over DCS, they could not be used to disseminate the ITAR and limited-distribution content presented at a JANNAF Meeting. Based on these decisions, ERG and the JANNAF TEC agreed to hold the meeting in late September 2020. In order to ensure that participants from all four U.S. time zones could join the meeting, the program was restructured by the JANNAF technical and meeting planning staffs with just one set of sessions per day, beginning at 11:00 a.m. Eastern time. To meet this goal and still accommodate all of the sessions that had already been planned for May, four additional days were added to the meeting, bringing the total to nine.

As these key decisions were being made, ERG’s Meeting Virtualization Team had begun moving forward with initial meeting planning activities. The team, which included ERG leadership, security, administration, information technology (IT), and meeting planning staff, initially met to evaluate various virtual meeting platforms and consider the logistics of a virtual meeting. The ERG security staff began developing procedures to ensure only authorized persons were permitted in virtual sessions. IT staff generated baseline IT requirements for the virtual meetings. The Meeting Virtualization Team also began the process of formulating best practices for the meeting, a process that JANNAF Meeting Planner Shelley Cohen and Assistant Meeting Planner Gabrielle Delisle-Ballard would later expand on as specific planning for the September meeting commenced.

Once ERG leadership and the JANNAF TEC made the decision to move forward with a September JANNAF Meeting using the DCS platform, Cohen and Delisle-Ballard sprang into action. They surveyed

authors whose papers had been accepted for the May meeting to see if they would be able to present online during the new meeting dates. They also surveyed workshop and specialist session chairs to determine if these sessions could be conducted virtually via DCS. With the exception of the Modeling and Simulation Subcommittee Plenary and Tools Demonstrations, the other workshops and specialist sessions were removed from the program until they could be held in person. Cohen noted that the meeting was ultimately planned three times, since the original schedule for May was later adapted for an anticipated week-long, in-person fall meeting and eventually reformatted into the expanded two-week virtual meeting hosted via DCS.

Putting Down Track

Developing and refining policies and procedures for the first all-virtual JANNAF Meeting occupied much of Cohen's and Delisle-Ballard's time between July and September. A virtual workshop for the Energetic Systems Hazards (ESHS) and Combustion (CS) Subcommittees in July offered Delisle-Ballard and members of the ERG security, IT, and technical staffs an initial opportunity to test out the DCS system. Two simultaneous technical interchange meetings (TIMs) for In-Space Chemical Propulsion and Additive Manufacturing for Propulsion Applications in mid-September also provided Delisle-Ballard with a chance to test out many of the online meeting procedures that would be employed successfully a couple of weeks later during the September/October JANNAF Meeting since they were well attended and include concurrent sessions.

"The whole process felt like we were putting down the [train] track as we were traveling along," Delisle-Ballard reflected.

Instructions, guidelines, and communications developed and tailored over many years for in-person JANNAF Meetings had to be modified for the new virtual meeting format. Paco Wong of the ERG IT staff quickly developed a Virtual Reading Room so all attendees could remotely access papers. A Small Team page on the JANNAF website was also utilized for hosting pre-

sentations, a feature of critical importance for phone-only participants who could not view presentations via their computers. Similarly, new methods for providing attendees with access to meeting schedule information and program updates had to be established and tested.

ERG technical staff were drafted to serve as session moderators in the virtual DCS meeting rooms, and ERG administrative, communication, IT, and meeting staff began training with the DCS platform in order to serve as virtual meeting room administrators responsible for screening and admitting attendees, fielding emails from participants experiencing difficulties accessing the rooms, monitoring participant chat windows in each session, and handling various other tasks as necessary. Test sessions for both ERG staff and attendees were scheduled with the goal of shaking out any remaining bugs in the meeting procedures before the fall JANNAF Meeting commenced. A further source of stress involved a pending update to the DCS system that held the potential to cause new technical problems and confusion as system functionality (notably Adobe Flash support) changed. The update eventually happened a little more than two weeks prior to the beginning of the September meeting and shortly before the first of 12 test sessions. Thus, Cohen and Delisle-Ballard opted to move forward with the new DCS interface and the necessary change that it entailed rather than trying to use the legacy system. Cohen noted that the two-month marathon planning process involved a huge team effort organized through countless hours of virtual staff meetings and email exchanges.

Bandwidth is Everything

As the first set of concurrent virtual sessions commenced on the morning of Tuesday, September 29, Cohen and Delisle-Ballard monitored the DCS system and the virtual meeting rooms closely. Fortunately, the brief window of planning paid off and the sessions went forward with only minor and scattered issues for attendees, mostly involving delays in access to virtual rooms or slow loading presentations. As the JANNAF Meeting continued over the next two weeks, it became apparent that a good Internet connection was critical for both administrators and meeting attendees.

(See ERG Meeting Pivot on page 13)

Remembering Allan McDonald, Advocate for Ethical Decision-Making

Allan James “Al” McDonald, a well-respected member of the JANNAF community and expert on solid rocket propulsion and large motor development, passed away on 6 March 2021, at the age of 83 in Ogden, Utah. According to his family, his death was due to complications from a fall. As a one-time Director of the Space Shuttle Solid Rocket Motor Project, McDonald attained national recognition through his unsuccessful attempt to stop the ill-fated launch of the Space Shuttle Challenger in January of 1986. His determination led him to reveal efforts by NASA and his employer Morton Thiokol to downplay evidence that exposure to cold conditions could cause the O-rings in the Shuttle Solid Rocket Boosters (SRBs) to fail, leading to hot gasses escaping from joints between the booster segments and threatening the structural integrity of the launch vehicle. McDonald’s willingness to speak publicly before the Rogers’ Commission, the presidential committee tasked with investigating the Shuttle disaster, and contradict the testimony of senior Thiokol management, led to a demotion from his employer. When members of Congress learned of the firm’s actions, they threatened to bar Thiokol from future NASA contracts unless company leadership reversed their actions. Ultimately, McDonald was promoted to a corporate vice president position and placed in charge of Shuttle SRB redesign efforts. He remained with the company until his retirement in 2001.

Allan J. McDonald was born in Cody, Wyo., on 9 July 1937, to John and Eva Marie McDonald. He grew up in Billings, Mont., and attended college at Montana State University (MSU) in nearby Bozeman. After earning a B.S. in chemical engineering from MSU in 1957, McDonald sought employment with Thiokol in Utah. There, he worked on large solid rocket motors for the Minuteman intercontinental ballistic missile program, which was in its later stages of development at the time. McDonald later earned an M.S. in engineering administration in 1967 from the University of Utah in



Allan James “Al” McDonald (1937-2021)

Salt Lake City and an honorary Ph.D. in engineering from MSU in 1986.

By 1986, McDonald had been with Thiokol for 29 years and had advanced through the ranks to Director of the Space Shuttle Solid Rocket Motor Project. He led a team responsible for the performance of the massive twin SRBs that provided much of the Space Shuttle’s thrust during the first phase of flight. Freezing conditions on the launch pad at the Kennedy Space Center (KSC) prior to the January 1986 Challenger flight greatly concerned McDonald and his engineering team due to well-documented concerns about the performance of the SRB O-rings in cold conditions. McDonald and his team pushed for a flight delay on the evening before the scheduled launch but Thiokol staff ultimately relented to NASA pressure to approve the flight. They faxed an approval letter to KSC for McDonald’s signature but he refused to sign the document. Instead, a supervisor signed on his behalf. The subsequent destruction of the Challenger orbiter and loss of seven astronauts served as a tragic and sobering confirmation of McDon-

ald's fears about the launch. In the investigation that followed, he and a colleague, Roger Boisjoly, made it clear that the disaster was entirely foreseeable and the result of a broken safety culture at NASA that sought to maintain an aggressive Shuttle launch tempo for political reasons despite concerns expressed by engineers both from within NASA and from its contractors.

McDonald remained with Thiokol for another 15 years before retiring in 2001. After working on the Shuttle SRM redesign, his later projects included investigations of the environmental impact of solid rocket launches and advocacy for the rocket industrial base. He also participated in numerous JANNAF and American Institute of Aeronautics and Astronautics (AIAA) meetings, published more than 70 papers, and gave presentations to various industry, government, and educational organizations detailing his experiences. At the time of his retirement, the staff of the *CPIA Bulletin* (now the *JANNAF News*) described his career as “sto-

ried” and remarked that his “presence and experience in the rocket industry will be sorely missed.”

Retirement offered McDonald new opportunities to share his ideas and values regarding ethical decision-making. He discussed the topic with both engineering students and professional engineers. He also teamed up with Mark Maier, Ph.D., an Associate Professor of Leadership at Chapman University, to hold seminars and training sessions on ethics and leadership for professionals. McDonald co-authored a detailed study of the Challenger disaster, *Truth, Lies, and O-Rings: Inside the Space Shuttle Challenger Disaster* and participated in documentaries on the topic including a recent Netflix project. Through these efforts, he sought to instill a message that engineering decisions should be guided by ethical choices and human life should never be subordinated to arbitrary schedules and political pressures.

Al McDonald leaves behind his wife of 58 years, Linda, three daughters, a son, and nine grandchildren.

ERG's Virtual Meeting Pivot... *continued from page 11*

“Bandwidth is everything,” Cohen noted. “Having a robust connection helped to ensure that both presenters and audience members could experience seamless presentations with minimal interruptions. We put together a list of detailed technology requirements to help attendees address, prior to the meeting, several of the potential pain points when using DCS. Bandwidth, as well as using a hard-wired connection, were two major factors we wanted attendees to consider as they prepared for the virtual meetings.”

The experience gained by ERG technical and administrative staff during the September TIMs and the pre-JANNAF Meeting practice sessions also paid off, as staff were able to address minor issues in the background and ensure that presenters could complete their presentations in a timely manner and field questions from the audience in each virtual room.

The Continued Exchange of Technical Information

ERG staff and meeting planners drew on their experiences in the September/October meeting as they prepared for the December 2020 50th Combustion, 38th Airbreathing Propulsion, 38th Exhaust Plume

and Signatures, 32nd Energetic Systems Hazards Joint Subcommittee and Programmatic and Industrial Base meetings.

“Online meetings are different from in-person JANNAF Meetings and require a learning process in order to have a good experience,” Cohen stated.

This applies to both meeting organizers and attendees. For organizers, this means figuring out how to leverage DCS's virtual meeting platform to make online meetings as much like in-person meetings as possible. In the case of attendees, understanding how to access DCS by participating in testing sessions prior to meetings is critically important. When both sides do their part, the meeting experience becomes more positive and meaningful.

“The online JANNAF Meeting format is still providing an important service to the community by facilitating the continued exchange of technical information virtually in the interim until it's safe to meet in person,” Cohen said.

As Cohen, Delisle-Ballard, and the rest of the ERG team prepare for the next virtual JANNAF Meeting in June 2021, they are keeping that goal squarely in mind.

ERG Leadership

The Energetics Research Group (ERG) is comprised of four teams that collectively serve the JANNAF Community - Technical Staff, Administrative Staff, Information Technology, and Communications and Publications. The JANNAF News has featured profiles on each of the teams in previous issues. Below, you can read about the leadership at ERG that runs the teams and ERG as a whole.

Peter Zeender, the Director of the Energetics Research Group, manages several organizations for Johns Hopkins University (JHU) including ERG, JANNAF's



*Director of the Energetics Research Group
Peter Zeender*

technical support contractor, and the Commercial and Government Program Office (CGPO), which serves as a liaison between JHU's Whiting School of Engineering, and members of government and industry with similar research interests. Zeender manages approximately 23 full time staff as well as many part time Subject Matter Experts and freelance staff. After serving as a member of the technical staff for many years, Zeender was promoted to Executive Director of the former Chemical Propulsion Information Analysis Center (CPIAC) in 2013, and has since grown the organization with the opening of the AERo Fuels Lab for testing rocket fuels. He has also increased the scope of ERG's research portfolio to include more areas of chemical propulsion, including several projects involving explosives. At the JANNAF meetings, you can find him at the Executive Committee meetings, in technical sessions, and in the common areas strategizing new partnerships and ventures among JANNAF members.

Nick Keim, the Deputy Director of ERG, oversees all matters related to JANNAF, manages the Technical Staff, and the AERo Fuels Laboratory. The AERo

Fuels Lab was established in 2012 to advance the understanding of hydrocarbon rocket fuel thermal stability. Under Keim's direction,



*Deputy Director of the Energetics Research Group
Nick Keim*

the lab has grown to include several new projects involving cryogenic methane/LNG propellants, additively manufactured LRE component testing, propellant compatibility testing, and hypersonic fuel development and performance quantification. In March of 2020 the AERo Fuels Lab was tasked with the development of an emergency ventilator to support the emerging COVID-19 crisis; a functional ventilator prototype was tested on a patient simulator at the Johns Hopkins Hospital after only six weeks. Keim also serves as the Technical Liaison to the Exhaust Plume and Signatures Subcommittee (EPSS) and the Commodities Panel for JANNAF's Programmatic and Industrial Base (PIB).

Debra Eggleston keeps all the gears turning as the Administrative Manager, but serves more as an operations manager of ERG. She oversees the Financial Team, the Security Staff, and the Meetings Team, which plans all of the JANNAF Interagency Propulsion Committee Meetings and Technical Interchange Meetings. She also serves as the administrator to the JANNAF Technical Executive Committee. Eggleston has been at ERG longer than anyone else on the staff. She has been with ERG and its predecessor

organiza-
tions for 43
years. She
manages a
staff of sev-
en, as well
as assists
with the
financials
for CGPO.



*ERG Administrative Manager
Debra Eggleston*

Her expe-
rience and
institutional
knowledge of
ERG and JAN-
NAF are in-
valuable to
making the
JANNAF meet-
ings and ser-
vices run so
smoothly.

Bruce Dennett, ERG's IT manager, oversees all aspects of the IT requirements at the JANNAF Meetings, both in-person and now virtual, along with the JANNAF website (<https://www.jannaf.org>), which



*ERG IT Manager
Bruce Dennett*

houses the
JANNAF Se-
cure Portal
and all of its
tools to make
networking
across orga-
nizations and
geographi-
cal locations
easier. Den-
nett manages
department
operations,
and over-
sees the IT
infrastructure
for both ERG
and JANNAF,
particularly
the firewall
and Inter-
net connec-
tions. He
manages a
team of four.

Linda McLean is the Communications and Publications Manager, overseeing all communications and publications for ERG and JANNAF, including the *JANNAF Journal* and the *JANNAF News*. McLean also works on content for the various websites that ERG runs including www.jannaf.org and www.erg.jhu.edu; films keynote sessions and technical sessions that session chairs wish to be documented at the JANNAF

Meetings; con-
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*Communications and Publications Manager
Linda McLean*

JANNAF Journal Electronic Prepublication Program is Live!

The *JANNAF Journal of Propulsion and Energetics* is happy to announce that its new electronic prepublication program is now live. This program allows authors and readers to access articles much sooner than when the full volume is published annually. Publication-ready articles will be available electronically via JDOC, the JANNAF Digital Online Collection, as soon as they have been accepted for publication, edited, and approved by the author(s). Articles published electronically will still be available in print in the annual *JANNAF Journal* volume released each December. One electronic prepublication article is currently available and may be accessed via JDOC by searching for Abstract Number 2021-0004A. Future electronic prepublication articles will be announced via the news section on the front page of the JANNAF website.

United States Rocket Research and Development During World War II

Over the course of the Second World War, rockets evolved from scientific and technical curiosities into practical weapons with specific battlefield applications. The Allied and Axis powers both pursued rocket research and development programs during the war. British and American rocket scientists and engineers (and their Japanese adversaries) primarily focused their efforts on tactical applications using solid-propellant rockets, while the Germans pursued a variety of strategic and tactical development programs, primarily centered on liquid-propellant rockets. German Army researchers, led by Wernher von Braun, spent much of the war developing the A-4 (more popularly known as the V-2), a sophisticated long-range, liquid-fueled rocket that was employed to bombard London and Rotterdam late in the war. German Air Force investigators developed short-range rocket-powered bomber interceptor aircraft and jet-assisted takeoff (JATO) units for piston-powered attack fighters and bombers. Wartime American rocket research evolved along a number of similar and overlapping research trajectories. Both the U.S. Navy and Army (which included the Army Air Forces) developed rockets for ground bombardment purposes. The services also fielded aerial rockets for use by attack aircraft. The Navy focused on rocket-powered bombs for antisubmarine warfare, while the Army developed the handheld bazooka antitank rocket system. Both services conducted research into JATO units for use with bombers and seaplanes. Throughout the war, however, limited coordination between the armed services and American leaders hampered the country's rocket development efforts and led to duplicated research and competition among production facilities for scarce manpower and resources. Consequently, the war revealed the significant potential of rockets as a revolutionary military technology, but also the shortcomings of the decentralized research and development efforts conducted by the armed services and the federal government during the conflict.

Use the link below to read the full story on the history of rocket research and development during World War II on the JANNAF website (https://www.jannaf.org/sites/default/files/jannaf/WWII_Rocketry_Distro-A.pdf).



Unidentified U.S. Navy LSM(R) (Landing Ship Medium (Rocket)) launching rockets during a drill late in the Second World War. Image courtesy of the U.S. National Archives and Records Administration.

JANNAF Journal Volume 11 Now Available Electronically Via JDOC

The *JANNAF Journal of Propulsion and Energetics* is pleased to announce that Volume 11 of the publication is now available to the JANNAF community. All journal content may be accessed via JDOC by searching for Abstract Numbers 2020-0001 (Table of Contents) and 2020-0001A through 2020-0001K (Articles).

Please consider serving as a reviewer or associate editor for future volumes. Contact Journal Managing Editor Benjamin Schwantes at bschwantes@erg.jhu.edu for more information.

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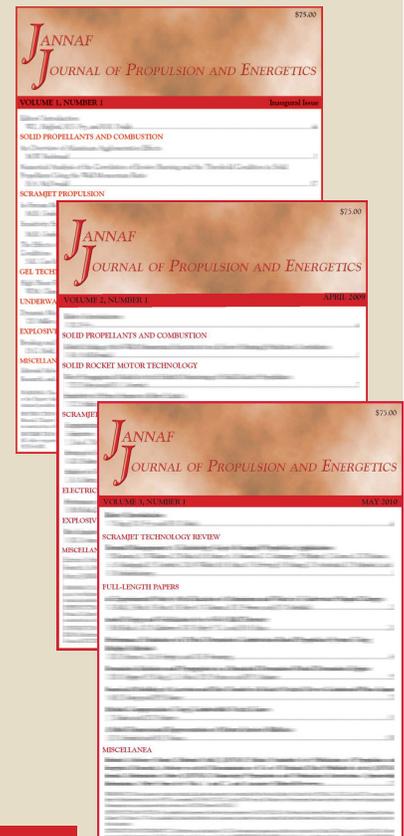
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manuscript style or preparation, figures and graphics,
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Contact Journal Managing Editor
Benjamin Schwantes at
Bschwantes@erg.jhu.edu

For matters related to...
technical topics, special focus areas, research, and data

Contact Technical Advisor Nicholas Keim
at JournalTA@erg.jhu.edu



ERG Directory

DIRECTOR

Peter E. Zeender

pzeender@erg.jhu.edu / 443-718-5001

DEPUTY DIRECTOR

Nicholas Keim

nkeim@erg.jhu.edu / 443-718-5005

CUSTOMER SERVICE

General Inquiries

410-992-7300

Technical Inquiries

410-992-7301

Administrative Staff

Debbie Eggleston

Administrative Manager

dse@jhu.edu / 443-718-5002

Meetings

Shelley Cohen

JANNAF Meeting Manager

scohen@erg.jhu.edu / 410-992-7302

Gabrielle Delisle-Ballard

Assistant Meeting Planner

gdelisle@erg.jhu.edu / 410-992-7300 ext. 208

Security

Mary Gannaway

Facility Security Officer

mtg@jhu.edu / 410-992-7304 ext. 211

Tricia Frey

Assistant Facility Security Officer

tfrey@erg.jhu.edu / 410-992-7300

INFORMATION TECHNOLOGY

Bruce Dennett

IT Manager

bdennett@erg.jhu.edu / 443-718-5003

Paco Wong

Software Engineer

pwong@erg.jhu.edu / 410-992-7307 ext. 213

Rowan Harcourt-Brooke

LAN Administrator

rharcourt-brooke@erg.jhu.edu / 410-992-7304 ext. 203

COMMUNICATIONS AND PUBLICATIONS

Linda McLean

Communications and Publications Group Manager

lmclean@erg.jhu.edu / 410-992-7304 ext. 225

Benjamin Schwantes

JANNAF Journal Managing Editor/*JANNAF News* Editor

bschwantes@erg.jhu.edu / 410-992-7300 ext. 227

TECHNICAL REPRESENTATIVES

William Bagley

wbagley@erg.jhu.edu / 443-718-5009

Alex Bishop

abishop@erg.jhu.edu / 443-718-5008

Bryan DeHoff

bryan.dehoff@aerospacetechnic.com / 513-378-7071

Ben Hill-Lam

bhill-lam@erg.jhu.edu / 443-718-5011

Kirk Sharp

ksharp@erg.jhu.edu / 228-234-5423

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ELECTRIC PROPULSION

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TEST and EVALUATION

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