

2008 JANNAF Propulsion Meeting and Joint CS/APS/EPTS/PSHS/SPIRITS User Group Meeting Held in Boston

The 55th Joint Army-Navy-NASA-Air Force (JANNAF) Propulsion Meeting (JPM) and 42nd Combustion Subcommittee (CS), 30th Airbreathing Propulsion Subcommittee (APS), 30th Exhaust Plume Technology Subcommittee (EPTS), 24th Propulsion Systems Hazards Subcommittee (PSHS), and 12th Spectral and In-band Radiometric Imaging of Targets and Scenes (SPIRITS) User Group Joint Meeting were held during the week of May 12-16, 2008, at the Boston Marriott Newton and Hanscom AFB in Newton, Massachusetts. It was one of the largest JANNAF Propulsion and Joint Subcommittee Meetings to be held in years. The Meeting provided a full program with a wide variety of complementary technical topics and continued the current efforts of the JANNAF Executive Committee (EC) to create a different technical interchange and flavor for each JPM by having it meet successively, every 12 months, with a different group of JANNAF Technical Subcommittees. Mr. John B. Moore of the Naval Air Warfare Center Weapons Division in China Lake, Calif., served as the Joint Technical Meeting Chairman for this year's event. Nearly 600 scientists, engineers, and managers attended the joint meeting, with over 325 papers presented in nearly 60 technical sessions, representing a significant attendance growth from previous JANNAF Meetings. All attendees received a complimentary copy of the inaugural issue of the *JANNAF Journal of Propulsion and Energetics*.

Program highlights included an interesting keynote address by Dr. Steven H. Walker, Deputy Director of the Tactical Technology Office of the Defense Advanced Research Projects Agency (DARPA). Dr. Walker oversees the critical mission areas of Air/Space/Land/Sea Platforms, Precision Strike, Laser Systems, Unmanned Systems, and Space Operations. In his keynote entitled "Air-Breathing Hypersonic Flight – Closer Than We Have Ever Been," Dr. Walker highlighted the U.S.-sponsored programs and hypersonic flight test activities that can contribute in a crucial way toward establishing airbreathing hypersonic propulsion for vastly improved capabilities for high-speed missile and space-launch system applications.

Technical Program ceremonies included the honoring of various individuals for their outstanding contributions to the JANNAF Propulsion Community. The Executive Committee recognized Lifetime Achievement Award recipients Dr. Merrill W. Beckstead of Brigham Young University and Mr. David Booth of Aerojet Culpeper. Mr. Parker L. Buckley, U.S. Air Force Research Laboratory (AFRL) (retired) received a Special Service Award from the EC along with a recognition award for service in the EC. Mr. James (Steve) Richards, NASA Marshall Space Flight Center (retired), also received a recognition award for service in the EC.

The Combustion Subcommittee presented awards for Outstanding Sustained Contribution to Dr. William M. Chew, U.S. Army Research, Development and Engineering Command (REDCOM); Mr. Ronald S. Fry, The Johns Hopkins University, Chemical Propulsion Information Analysis Center, and Dr. Gerald L. Pellet, NASA Langley Research Center (LaRC). The Airbreathing Propulsion Subcommittee presented awards for Outstanding Sustained Contribution to Mr. Parker L. Buckley, AFRL (retired) now with Universal Technology Corporation, and Dr. Thomas A. Jackson, AFRL, Wright-Patterson AFB, Ohio. The Propulsion Systems Hazards Subcommittee award for Outstanding Sustained Contribution was presented posthumously to Dr. Robert Bennett, ATK Launch Systems, who died in a biking accident in 2007. Mr. Hank Dovey of ATK Thiokol accepted the award and will present it to Dr. Bennett's widow in Utah.

55th JPM Technical Program

The JPM program included the presentation of 49 papers in nine sessions. Almost half of this technical program was focused upon Propulsion Systems for Space Access (22 papers), followed in interest by Tactical Propulsion (11), Propulsion and Energetics (11), Missile Defense/Strategic (8), and Guns and Gun-Launched Propulsion (3). Joint JPM/CS technical sessions were also

conducted on interior ballistics and propellant combustion (3), gun propellants and ingredients (4), and gun systems and charge design (3).

42nd CS Technical Program

The CS program included presentation of 124 technical papers in 16 technical sessions, four panel meetings and four town meetings in solid, liquid, guns and airbreathing combustion. Additionally eight papers and supporting discussions were held in two sessions on Ambient Atmosphere Solid Propellant Combustion that were cosponsored with the PSHS. These numbers represent approximately a 25% increase over the 2006 Meeting in San Diego, Calif.

The CS technical sessions covered reactive materials; ignition and combustion of solid propellants; ambient combustion of solid propellants; modeling and data for combustion simulation; enhanced blast; solid propellant burn rate augmentation and combustion; interior ballistics and propellant combustion modeling; solid propellant combustion modeling and combustion instability; combustion diagnostics; aluminum combustion and combustion efficiency; modeling engine flowfields in test facilities; analysis and modeling of gun propellant and igniter ingredients; ballistic studies of small and medium caliber guns; and, novel liquid rocket propellants and combustion.

CS Panels

All four CS technical panels held meetings during the week; many were in conjunction with CS Town Meetings in the same technical areas. The ***Reactive Materials Panel***, a joint panel with the PEDCS, is seeking more intelligent use of the power contained within an energetic material. The panel conducted a successful workshop in February 2008 on “Reactive Material Technology for Enhanced Lethality,” and presented a paper at this meeting summarizing this workshop. Additionally, they organized three technical sessions that are serving to guide the panel’s future activities. The ***Liquid Fuel Kinetics and Properties Panel*** is successfully working jointly with the APS and Liquid Propulsion Subcommittee (LPS) panels on hydrocarbon fuel issues. Members of the hydrocarbon fuels community, many of whom are engaged in the American Institute of Aeronautics and Astronautics (AIAA) and The Combustion Institute, as well as JANNAF, need to assess how the public release work that is being conducted will mesh with what is being pursued within JANNAF. The ***Kinetics and Related Aspects of Propellant Combustion Panel*** has been focused on developing a report on recommendations on the R&D required to implement new energetic ingredients in munitions. A workshop report was completed documenting findings developed over a year’s efforts that are anticipated to contribute greatly toward defining such recommendations. The ***Flowfield Diagnostics Panel*** is continuing to foster better collaboration between the computational and experimental communities. During the meeting this panel organized technical sessions on “Combustion Diagnostics.” Participation has grown four-fold, which will enhance membership resources and raise awareness of needs and concerns. The panel is identifying solution approaches to selected diagnostic problems of concern.

30th APS Technical Program

The APS program included presentation of 68 technical papers in 11 technical sessions, five panel meetings, an airbreathing Town Meeting and a workshop. The paper and session numbers represent a slight increase from the 2006 San Diego Meeting. The technical sessions covered conventional ramjet propulsion; hypersonic technology overviews; scramjet component engine testing; scramjet test facilities and flight tests; axisymmetric scramjet engine technology (ASET); scramjet propulsion structures; component modeling and simulation; ground test of X-51A SED flight development engine SJX61-1; rocket-based combined cycle (RBCC) and pulse detonation engine (PDE) technology; scramjet propulsion; and turbine-based combined cycle (TBCC) and inlet technology.

The APS technical program also included an RBCC Technology Assessment Workshop, which was cochaired by 2nd Lt Katherine Andrews and Mr. Glenn Liston of the Air Force Research Laboratory, and Mr. Jeff Pearce of Universal Technology Corporation (UTC). The purpose of this evening workshop was to introduce a new Air Force program to assess the current state of technology for RBCC propulsion systems and to solicit the participation of the community in a comprehensive review team. This program will include assessment of Technology Readiness Levels (TRLs), definition of technology gaps, completion of a comprehensive risk assessment, and the definition of risk mitigation activities. Ultimately, the Air Force plans to use the results of this assessment as a tool for planning future RBCC technology development activities. During the workshop, attendees were welcomed, introduced and then presented with an overview of the program's plan. Following the presentation, the floor was opened for comments and there was a spirited interchange, with Mr. Liston responding to most of the questions. Participation in the workshop was excellent with more than 50 attendees, indicating that the technical community has a keen interest in this topic. The workshop attendees were asked to participate in the study both by providing inputs on RBCC system concepts, current TRLs, and perceived technology gaps, and also by periodically reviewing the results of the assessment. A general willingness to participate in the study was indicated by the workshop attendees. There are tentative plans to hold a follow-up workshop at the next JANNAF APS meeting.

APS Panels

All five active APS technical panels held meetings during the week, many following directly after related technical sessions. The *Engine Test and Validation Panel* is continuing to develop standards for scramjet engine testing, drawn from the 2nd Edition of CPIA Publication 710, Scramjet Propulsion Testing Standards, Recommended Practices and Guidelines, released in December 2005, and they are working on improvements and additions for a 3rd Edition of Publication 710. In addition, this panel is continuing to examine test medium effects in scramjet testing by focusing their analysis activities on a facility and flowpath engaged in active testing. The *Advanced Engine Cycle Panel* has pursued multiple areas of interest. JANNAF workshops have contributed to characterizing PDE technology and engine performance. Workshop findings are to be summarized in a planned CD publication. A follow-on PDE workshop has been recommended. There is continued interest in having multiple independent analysts examine a standard set of hypersonic test data for comparison of methods and results. Use of public release HYCAUSE data was suggested as a candidate topic for a workshop. The panel has identified recent interest in two new tasks: 1) comparing analysis anticipated high quality 3-D inward-turning inlet data with analysis results; and, 2) refining the assumptions and analysis basis for the classic Isp versus Engine Mach number curves used by so many over the years. The *Component Level and Physical Modeling Panel* continues its activities in two areas: 1) turbulent mixing, Schmidt number modeling and data collection; and, 2) isolator CFD modeling. Panel members have developed an outline of best practices for isolator modeling, and they continue to validate the need for databases containing data that can be used for CFD validation for component analysis. The *Structures and Materials Panel* was organized to foster productive interchange between propulsion and airframe specialists and structures and materials specialists in such areas as the SOA in non-metallic high temperature materials, identifying a technology roadmap for needed developments and identifying existing and needed test facilities. The panel adopted a unique solution by encouraging JANNAF and CPIAC to cosponsor, for the first time, JANNAF specialist sessions on "Hypersonic Thermal Protection Systems (TPS) and Hot Structures" at a non-JANNAF meeting. These sessions were held at the 32nd Annual Conference on Composites, Materials and Structures (CMS) in January 2008 in Daytona Beach, Florida. The CMS Conference was sponsored by the Ceramic, Metal and Carbon Composites Committee (CMC3) of the Advanced Composites Working Group (ACWG), and held in cooperation with the U.S. Air Force, U.S. Army, U.S. Navy, U.S. Department of Energy, National Aeronautics and Space Administration (NASA) and DARPA. The JANNAF sessions were organized in order to improve the archiving of ITAR information on advanced materials technologies for possible U.S.

hypersonic applications. The field of TPS and Hot Structures addressed here encompasses multiple technologies for both rocket- and airbreathing-based systems. Future such sessions are being planned. The proceedings of these JANNAF Specialist Sessions consist of 14 technical papers.

CPIAC subscribers and other organizations registered with the Defense Technical Information Center (DTIC) and the Defense Logistics Information Service (DLIS) may request copies of this CD-ROM or individual papers. The **Fuels Panel** is engaged in joint activities with CS and LPS involving the kinetics of liquid hydrocarbon fuels. REFPROF data modules are being worked upon for a number of high profile hydrocarbon fuels.

30th EPTS and 12th SPIRITS Technical Program

This program included 50 technical papers presented in 10 sessions. Sessions covered technical areas such as plume signatures, code development, applications, and flowfield data and modeling. Dr. Kevin Kennedy of the U.S. Army AMRDEC, Redstone Arsenal, served as the EPTS Meeting Chair and Ms. Robin Miller of Naval Air Warfare Center Weapons Division, Point Mugu, served as the SPIRITS Meeting Chair. Papers presented included plume radiation transfer, vehicle induced glows, helicopter modeling, plume model validation, infrared (IR) sensor performance, flowfield simulations, model-data comparisons, plume signature measurements, plume signature prediction studies, signature anomalies/phenomenology, signature identification, new data collections, data analysis, hard body signatures, afterburner plumes, and code development and enhancements. Dr. Kennedy and Ms. Miller will continue their roles as chairpersons for the next EPTS and SPIRITS meeting. Mr. Nick Keim will replace Mr. Peter Zeender as the CPIAC technical representative for EPTS.

A SPIRITS training course conducted by Aerodyne Research, Inc. was held in conjunction with the meeting. There were a total of eight participants in the four-day course, which provided an introduction to SPIRITS and its usage. The course was taught by Mr. John Conant, the industry coordinator for SPIRITS.

24th PSHS Technical Program

The PSHS program consisted of 40 technical papers in seven sessions, four panel meetings, and one workshop. The papers covered general insensitive munitions technology, thermal decomposition leading to cookoff, impact/shock-induced reactions, propulsion system safety/hazard classification, and gun propellant vulnerability. Two joint PSHS/CS sessions were also conducted. They comprised 14 papers on ambient atmosphere solid propellant combustion.

PSHS Panels

The four PSHS panel meetings included discussions of topics of current interest to members and possible future activities. The **Cookoff Hazards Panel** meeting discussions included the May 16 workshop (more on this workshop below) and the need to improve the accessibility of insensitive munitions (IM) data. At the **Impact/Shock-Induced Reactions Panel** meeting, topics of discussion were definition of parameters of the bullet-impact threat spectrum, quantification of real-world shock/impact threats, relations between IM performance and weapon platform survivability, effects of improvised explosive device (IED) attacks on insensitive munitions, energetic material characteristics required to mitigate shaped charge jet attacks, and shock desensitization of energetic materials. The panel decided to study shock desensitization of energetic materials as a new task. Discussions at the **Insensitive Munitions Technology Panel** meeting included a possible tutorial on insensitive munitions at a future PEDCS meeting and the status of a continuing panel task to generate a historical compilation of IM data. Several members volunteered to provide additional input for that task. The panel also agreed to support a CPIAC state-of-the-art report on prediction of IM performance from subscale and laboratory tests, as a new panel task. At the **Safety and Hazard Classification Panel** meeting, topics of discussion were revised energetic materials safety standards and requirements, transportation

issues with munitions shipped overseas and then modified, UN Series 7 hazard classification, hazard classification by analogy, safety standards for hypergolic liquid propellants, suitability of card gap tests for classification of Extremely Insensitive Detonating Substances, and ambiguity within the divisions of Hazard Class 1.2.

PSHS Workshop: “Scaling Approaches for Hazards Assessment of Cookoff”

During this May 16 workshop, participants cooperated in establishing a best estimate of the current state of knowledge regarding the use of small-scale tests and modeling to predict the outcome of a specific accident scenario, namely a collision and subsequent fire involving a truck carrying a rocket motor. The workshop utilized a process known as PIRT (Phenomena Identification and Ranking Tables). Participants first identified every phenomenon that could conceivably affect the violence of the rocket motor’s reaction to the accident, as exhibited by energy of thrown fragments. It was assumed that violent reaction would be initiated by the fire rather than by the impact, although the impact could conceivably affect the severity of the violent reaction. Participants then ranked the importance of each phenomenon by a voting procedure. For selected phenomena, participants ranked the adequacy of available data, adequacy of available models, validation of available models, and confidence in scaling of predictions, by the same kind of voting procedure. This process showed how areas of technology where more work is needed can be identified and prioritized.

Drs. Unmeel Mehta (NASA Ames) and Dean Eklund (AFRL WPAFB), representatives from the Uncertainty Panel of the Modeling and Simulation Subcommittee (MSS), briefed all members of the CS, APS, EPTS and PSHS Technical Steering Groups (TSGs) on their efforts to develop a JANNAF publication, “*Guide for Uncertainty Quantification for Credible Propulsion and Energetic Simulations.*”

The guide has two main objectives: 1) to describe procedures and processes for uncertainty quantification, including those for verification, validation, model conditioning, and predictions; and, 2) to serve as a useful tool for all members of the Technical Subcommittees of the JANNAF propulsion community for generating credible simulations for making simulation-based critical decisions. The guide is aimed at fostering a strong dialog between simulation model developers and simulation users. The briefings to the TSGs were made in an effort to identify people who would have interest in contributing toward the development of the proposed guide and identify representative case studies of worked problems in propulsion and energetics applications, both for a public release publication, and restricted distribution publication (limited/export controlled). Significant progress was made toward both objectives.

Overall, the 55th JPM, 42nd CS, 30th APS, 30th EPTS, 24th PSHS and 12th SPIRITS Joint Meeting met with much success. JANNAF continues to be effective in addressing problems of mutual interest to the Government, industry and academia, as evidenced by the collaboratively fruitful meetings of current CS, APS, EPTS and PSHS Technical Steering Groups that were held throughout the week and will contribute to the future direction of technical activities. We at CPIAC wish to thank all who responded to our follow-up meeting survey. Many fine suggestions were made that will certainly be useful in enhancing the technical program content for the next meeting. The next JPM is scheduled for May 2009 and will be held in conjunction with the Rocket Nozzle Technology Subcommittee, Nondestructive Evaluation Subcommittee, Structures and Mechanical Behavior Subcommittee, Propellant and Explosives Development and Characterization Subcommittee and the Safety and Environmental Protection Subcommittee. The location has not yet been determined.

Finally, we hope that you have had a chance to read through your complimentary copy of the new *JANNAF Journal*. The Editorial Staff of the Journal recently distributed a survey to solicit your feedback. Your opinion and perception of this new JANNAF effort is very important as we move forward with plans for the second issue, which is scheduled for release at the next JPM.

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