Review of Slow Cook-off Rate for Insensitive Munitions Testing

By Dr. Brian E. Fuchs, U.S. Army
Picatinny Arsenal, New Jersey

Insensitive Munitions (IM) minimize the probability of inadvertent initiation and the severity of subsequent damage as a result of unplanned external stimuli, which may be the result of accident, combat, or terrorist actions. IM is mandated by federal law, USC Title 10, Chapter 141, Section 2389, December 2001: “The Secretary of Defense shall ensure, to the extent practicable, that insensitive munitions under development or procurement are safe throughout development and fielding when subjected to unplanned stimuli.”

IM programs were started by the US Navy after several disastrous shipboard events, such as the USS Forrestal aircraft fire during the Vietnam conflict. The IM program has since been embraced by all—U.S. defense services and is characterized by joint interservice efforts to reduce the threat from all countries’ munitions to the warfighter, manufacturers, and the general public.

The Department of Defense has defined six standardized threats and testing for each, in order to evaluate the compliance of munitions with IM law. The defined threats to munitions include fast cook-off, slow cook-off, bullet impact, fragment impact, sympathetic detonation, and shaped charge jet impact.

The DoD has expended significant funding to find solutions to each of these threats, through various programs such as the Joint Services Insensitive Munitions Technical Program, the Army’s Program Executive Office Ammunition IM thrust program, the Navy’s IM Advanced Development, and funding spent by many programs on systems in the design and development phases. The improvements gained so far have not been universally applied to all munitions, and many of the new systems being fielded are not immune to all of the defined threats. However, a number of notable non-events have been reported from IM improved munitions. Two recent examples from the U.S. Army involve fires at a production plant and on the battlefield. A fire at a production plant of the Modular Artillery Charge System left the fire-damaged steel structure still standing after the event. An MRAP armored vehicle in Afghanistan was hit with an improvised explosive device; in the ensuing fire, the 60-mm mortars burned but did not detonate or explode, averting a greater disaster.

In order to develop solutions to the threats that exist for munitions,

(continued on page 4)
CPIAC’s Technical/Bibliographic Inquiry Service

CPIAC offers a variety of services to its subscribers, including responses to technical/bibliographic inquiries. Answers are usually provided within three working days and take the form of telephoned, faxed, electronic, or written technical summaries. Customers are provided with copies of JANNAF papers, excerpts from technical reports, bibliographies of pertinent literature, names of recognized experts, propellant/ingredient data sheets, computer programs and/or theoretical performance calculations. The CPIAC staff responds to nearly 800 inquiries per year from over 180 customer organizations. CPIAC invites inquiries via telephone, fax, e-mail, or letter. For further information, please contact Ron Fry by e-mail to rs_fry@jhu.edu. Representative recent inquiries include:

**TECHNICAL INQUIRIES**
- Recent SRM Systems 25-in to 32-in Dia (Req. 27187)
- Integrated Propulsion Assessment Tool (Req. 27202)
- Data Sources for Propulsion and Exo-atmospheric Applications (Req. 27197)
- Explosive Dispersal of Liquids (Req. 27204)
- Minuteman III Motor Stack Information (Req. 27227)
- AP and AN Moisture Effects (Req. 27233)

**BIBLIOGRAPHIC INQUIRIES**
- In-situ Monitoring of Gaseous Decomposition Products (Req. 27269)
- Castor I / TX-33 Bibliographic Search (Req. 7350)
- Temperature Sensitivity of Reduced Smoke and Minimum Smoke Propellants (Req. 27377)
- Hydantoin Bonding Agent (Req. 27380)
- Throttleable Nozzles for SRMs (Req. 24771)
- Slag Accumulation in SRMs (Req. 27139)
- HAN-based Monopropellants (Req. 27162)

**Recent CPIAC Products and Publications**

**JPM CD-10, 58th JANNAF Propulsion Meeting, April 2011.**

**In Memorium**

**Thomas Lee Kinsel**, age 78, of Golden Hills, CA passed away on June 7, 2011. Kinsel was born April 24, 1933, in Fremont, Ohio. He attended college at Kent State University and served his country in the United States Marine Corps. He continued to serve afterward as an Aeronautical Civil Engineer for the National Aeronautics & Space Administration. Kinsel was a long-term member of the Solids Group at the Air Force Research Lab, Edwards Air Force Base and was also known for his horsemanship, even taking his horse to Vandenburg for a post-launch search in the brush for key elements needed to conduct a thorough investigation.

Kinsel is survived by his wife, daughter, son-in-law, grandson, and two stepsons.
Various propulsion-related meetings are listed below. If you know of an event that may be of interest to the propulsion community, please forward the details to bulletin@cpiac.jhu.edu. Additional industry meetings are posted on the CPIAC Web site, Meetings & Symposia: http://www.cpie.jhu.edu/templates/cpiacTemplate/meetings/1. The Calendar of JANNAF Meetings appears on the back page.

### Upcoming Meetings and Events

**4th European Conference for Aerospace Sciences (EUCASS)**  
4-8 July 2011  
St. Petersburg, Russia  

**7th International Conference on Chemical Kinetics**  
10-14 July 2011  
Cambridge, Massachusetts  

**RAM Energetics Conference 2011**  
14-15 July 2011  
Butte, Montana  
POC: Jill.Thornton@resodynmixers.com

**International Colloquium on the Dynamics of Explosions and Reactive Systems (ICDERS)**  
24-29 July 2011  
Irvine, California  

**47th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit**  
1-3 August 2011  
San Diego, California  
POC: [http://www.aiaa.org/content.cfm?pageid=230&lumeeetingid=2424](http://www.aiaa.org/content.cfm?pageid=230&lumeeetingid=2424)

**32nd International Electric Propulsion Conference (IEPC)**  
11-15 September 2011  
Wiesbaden, Germany  

**6th Ankara International Aerospace Conference (AIAC'2011)**  
14-16 September 2011  
Ankara, Turkey  
POC: [http://aiaac.ac.metu.edu.tr](http://aiaac.ac.metu.edu.tr)

**6th EFEE World Conference**  
18-20 September 2011  
Lisbon, Portugal  
POC: [http://web.efee.eu/default.aspx](http://web.efee.eu/default.aspx)

**2011 International Autumn Seminar**  
20-23 September 2011  
Nanjing, China  

**First Conference on Space Access**  
21-23 September 2011  
Paris, France  
POC: [http://space-access2011.com/call-for-papers](http://space-access2011.com/call-for-papers)

**AIAA SPACE 2011 Conference & Exposition**  
27-29 September 2011  
Long Beach, California  

**62nd International Astronautical Conference**  
3-7 October 2011  
Cape Town, South Africa  

**High Energy Materials 2011**  
3-4 October 2011  
La Rochelle, France  

**ATV-177/RSY-027: Munition and Propellant Disposal and its Impact on the Environment**  
17-20 October 2011  
Edinburgh, United Kingdom  
these threats must be defined properly. These definitions are standardized for all services, although additional threats and testing can be specified by each individual service. Standardized threats include the type of bullets and fragments and their velocity, the fuels used for fires, etc. These threats must be periodically reviewed in order to assure their applicability. For this reason, the JANNAF April 2011 meeting in Crystal City, VA held a workshop for the “Review of Slow Cook-off Rate for Insensitive Munitions”.

The slow cook-off threat is one where the munitions are heated by a fire, but not directly in it. Examples include a shipboard fire in a compartment next to a storage magazine or a fire outside a magazine. Slow cook-off events are characterized by the munition being heated to a high temperature before the chemical reaction begins. The high temperature of the energetic materials frequently causes the results to be more catastrophic than a munition that is placed directly into a fire. For a slow cook-off test, the results and technical solutions can change depending upon the heating rate selected. Complicating the problem is the fact that real-world events are unpredictable and cannot be simulated by a single test condition. Additionally, some of the proposed solutions, such as pre-igniting the munitions at a lower temperature where reactions are less violent, have their own safety-related concerns. The determination of a heating rate that best exemplifies the threats and improves munitions design to improve safety is required.

The JANNAF-sponsored workshop was co-chaired by Dr. Kerry A. Clark of the Naval Ordnance Safety and Security Activity at Indian Head, MD and Dr. Brian E. Fuchs of the Army Armament Research, Development and Engineering Center at Picatinny Arsenal, NJ. The meeting was attended by 70 people representing all services, the DoD Explosives Safety Board, the Department of Energy, and commercial munition developers and manufacturers. The stated purpose of the meeting was to review the current standard heating rate for the slow cook-off (SCO) test, which is currently 6°F per hour; a heating rate known to be slower than in real world situations. The review was prompted by concerns that munition developers are designing rounds specifically to pass this test instead of improving munitions for all slow heating rates. The objectives of this workshop were to consider what the proper heating rate (or rates) for SCO testing should be, to develop methods to improve data collection in order to better analyze the SCO response of munitions, and to organize the community toward development of a joint consensus. Presentations given at the workshop examined the current science and understanding of slow cook-off events, as well as historical accounts of slow cook-off accidents.

The workshop was successful in opening dialog and increasing the communities’ understanding of the problem, although it did not come to a final conclusion as to the proper heating rate. The next workshop, in May 2012, will present information being gathered by the community from real life scenarios, updated modeling, firefighters’ perspectives, and current research on the issue.

**CALL FOR PAPERS**

**JANNAF Journal of Propulsion and Energetics, Vol. 5**

**Deadline: 1 August 2011**

For more information, Contact Ashley Hajnos at 410-992-7303, ext. 227 or by e-mail to ahajnos@cpiac.jhu.edu.
Joint Community Discusses Business of Demilitarization at Annual Symposium

Jaime Thompson, U.S. Army Defense Ammunition Center (DAC)
McAlester, Oklahoma

The 19th annual Joint Ordnance Commanders Group Global Demilitarization Symposium & Exhibition was held in Denver, CO, 17–19 May 2011. Over 400 personnel from 17 countries were in attendance.

The agenda for the symposium focused on ongoing demilitarization/disposal, resource recovery, recycling and reuse operations and programs, sale of recovered demilitarization materials, demilitarization R&D efforts, transitioning technologies and environmental, safety, and policy issues that affect the demilitarization business.

Brig. Gen. Gustave F. Perna and Brig. Gen. Jonathan A. Maddux delivered keynote addresses. “My number one POM (Program Objective Memorandum) priority is demilitarization authorization for funds,” stated Perna. “We have one-third of our total storage capability being used for items that need to be destroyed.” He challenged the group to reduce demilitarization stocks by 10% for fiscal year 2012. “Work as a demilitarization team to execute our goal,” explained Perna.

In Maddux’s role as the Single Conventional Manager for Ammunition, he stresses the importance of a concentrated effort among the services.

“Doing the right thing, at the right place, at the right time, with the right R&D effort is critical,” stated Maddux. “We must understand and embrace our demilitarization initiatives – make sure we are getting the best value for our collective tax dollars.”

Perna and Maddux jointly presented the distinguished John L. Byrd, Jr. Excellence in Munitions Demilitarization Award to Tyrone Nordquist. Nordquist has been employed with the federal government for thirty-one years, with twenty of those years with DAC. Nordquist has actively served as the Chairperson for the Joint Ordnance Commanders Group, Munitions Demilitarization/Disposal Subgroup since 2008 and has been deployed to Southwest Asia in support of Operation Desert Storm and Operation Iraqi Freedom.

Larry Gibbs, Product Manager for Demilitarization, provided closing remarks for the event.

JANNAF Best Paper Awards
25th Safety and Environmental Protection Subcommittee Meeting, December 2010

The Awards Committees of the various JANNAF subcommittees select the best papers presented at their meetings in order to increase public recognition of the exceptional work accomplished by JANNAF participants. Specific titles of papers are not published, due to possible sensitivity.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Authors of Best-in-Session Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Hygiene and Safety</td>
<td>(1) E. Santiago-Maldonado and J.E. Captain; (2) J. Houseman and E. Wallis</td>
</tr>
<tr>
<td>Environmental Protection</td>
<td>N. Lieb, C. Wong, and W.H. Ruppert</td>
</tr>
<tr>
<td>Hydrazine Neutralization</td>
<td>E. Santiago-Maldonado, R.W. Devor, and J.K. Parkerson</td>
</tr>
<tr>
<td>Demilitarization</td>
<td>R. J. Cramer</td>
</tr>
</tbody>
</table>

**Best Overall Paper:** E. Santiago-Maldonado and J.E. Captain (Industrial Hygiene and Safety)
Texas Students Fly to Great Heights and Take First Place in TARC Finals

A team of students from Rockwall-Heath High School in Heath, Tex. were named national champions after earning the top score at the ninth annual Team America Rocketry Challenge (TARC) Final Fly-off. The event, held in The Plains, Va. on May 14, was a thrilling culmination to a nine month-long journey that challenged students to design rockets and conduct simulated flights and test launches.

“It’s a good feeling,” said Rockwall-Heath team president John Easum, a senior at the school.

In September 2010, Easum and his teammates, along with more than 600 other participating teams from across the country, eagerly accepted the challenge of building a model rocket, hoping to earn the opportunity to launch it at the Great Meadow Outdoor Events Center and compete for the TARC national title in the spring. The team was notified in April that they qualified for participation in the Final Fly-off and they made the most of the opportunity, earning the best score of the competition and defeating 99 teams that also made it to the finals.

Each team was tasked to design and build a rocket that lifted off to an altitude of 750 feet while remaining in flight for a 40- to 45-second duration. The payload, a raw egg, had to return to the ground undamaged, using a 15-inch diameter parachute as the sole recovery system.

The Rockwall-Heath students carried out their launch successfully and earned a first place score of 16.0, which was calculated by combining the official duration score and altitude score of two flights. Each point represents a deviation from altitude and length of flight, meaning the lower the score, the higher the rank on the scoreboard.

Easum and his teammates, Michael Gerritsen and Colt McNally, both seniors, and Landon Fisher, a junior, were thrilled with their launch.

“This contest is why I’m going into aerospace,” said Easum, who will be attending Embry-Riddle Aeronautical University in the fall. “It’s hands-on, and you experience a lot of failures, but then you troubleshoot and end up with success,” Easum added.

With their victory, the foursome advanced to an international fly-off on June 24 where they had an opportunity to compete against teams from the United Kingdom and France at the Paris Le Bourget Air Show. They also shared prizes with other top ten teams, including more than $60,000 in cash and scholarships. The top 20 teams will receive an invitation from NASA to participate in its advanced rocketry program, Student Launch Initiative.

The Aerospace Industries Association (AIA) and National Association of Rocketry (NAR) team up each year to sponsor TARC, which is currently the largest rocket contest in the world. AIA and NAR hope the contest inspires students in grades 7-12 to work hard in their studies of science, technology, engineering, and mathematics while also encouraging them to pursue careers in aerospace engineering or other science, technology, engineering, and mathematics (STEM)-related fields.

“We’re delighted with this year’s competition,” said AIA President and CEO Marion C. Blakey. “It’s clear that all the teams put a lot of effort into their rockets. I’m sure that in just a few short years, we’ll be welcoming a number of today’s participants to our industry.”

The TARC event was first held in 2002 and originally planned as a one-time celebration of the Centennial of Flight, which marked the birth of the aviation industry in 1903 when Orville and Wilbur Wright completed the first-ever powered flight. The Wright brothers flew their “Wright Flying Machine” on a 12-second, 120-foot journey on the sands of Kitty Hawk, N.C. and, with their achievement, brought about a new way of life.

With the overwhelming success and enthusiasm that ensued following the first TARC fly-off, AIA and NAR agreed to make the challenge an annual event. More than 50,000 students have entered the competition since 2003.

In a 2010 survey of TARC alumni, four out of five respondents noted the positive impact TARC has had on their course of study and 92% of participants said they would encourage a friend to pursue a STEM-related career. Complete competition results, photos, and additional information about the challenge are available at www.rocketcontest.org.
**3M™ Defense Technology Offerings:**

- Dynamar™ Bonding Agents
- Fluorel™ Fluoropolymer Binders
- Glycidyl Azide Polymers (GAP)
- Perfluoropolyether Diol
- 3M™ Glass Bubbles
- Hypergolic Liquid Fuel
- Radar Attenuation Materials
- Custom Synthesis

These 3M advanced materials, manufactured for quality and consistency under strict ISO controls, are available worldwide.*

*Subject to export licensing guidelines as set forth by the United States government.

**Let Your Defense Technology Needs Reach MACH I**

MACH I Is An Authorized Distributor For These 3M Products.

For more information on these 3M™ defense technology offerings, please contact:

MACH I, Inc. • 340 East Church Road • King of Prussia, PA 19406
Phone: 610-279-2340 • Fax: 610-279-6605 • e-mail: machi@machichemicals.com

This is a paid advertisement. Postings should not be taken as support or endorsement of any kind by CPIAC.
The Technology Directorate, a division within the Defense Ammunition Center (DAC), assisted the Naval Surface Weapons Center (NSWC) in Indian Head, MD in developing an economically feasible demilitarization solution.

The U.S. Navy at NSWC requested that DAC conduct a demilitarization of a Cartridge Actuated Device (CAD) containing beryllium-copper alloy components. Specifically, NSWC wanted to know the impacts of this item if demiled in the standard U.S. Army Ammunition Peculiar Equipment (APE) 1236M2 Deactivation Furnace.

“The furnace incineration technology is mature and is being used widely by the combustion industries,” said Dr. Solim Kwak, DAC Scientific Advisor, “but the main issue with the proposal was the cartridge contained a terminal stud made of beryllium making demilitarization of the cartridge difficult.”

“During the incineration process in the APE 1236M2, the thermal treatment may cause some of the exposed part of the beryllium-copper alloy to oxidize, causing flaking of the alloy,” explained Kwak.

The American Conference of Governmental Industrial Hygienists and Occupational Safety and Health Administration have determined that beryllium oxides and compounds are suspected human carcinogens. “They are very toxic, especially by inhalation of beryllium dust particles,” expressed Kwak.

As a team effort, DAC provided NSWC with known occupational safety and health problems with beryllium-copper alloys and as a result, NSWC decided to replace the beryllium-copper alloy electric terminals with stainless steel terminals. On a financial note, the beryllium costs $350.00 per pound versus $5.00 per pound for stainless cost, so the solution also saved the American government and taxpayers a substantial amount of money.

“This is the first time, to my knowledge, that a design for demilitarization review has been conducted on a munition item in the active inventory and the results will serve as an example to all munitions design agencies of the importance of design for demilitarization.” said Mr. Terry Trivitt, Chief of the Munitions Operations Division.

Late Registrations Are Being Accepted!

Program Includes

Processing Benefits of Resonance Acoustic Mixing on High Performance Propellants and Explosives by Ms. Tara Cross and Dr. Andrew P. Nelson with Naval Air Warfare Center – Weapons Division, China Lake

ResonantAcoustic® Mixing Principles and Analysis by Peter Lucon, Senior Mechanical Engineer, Resodyn Corporation

Aqueous Based Mixing of Nanothermite Composites using Resodyn LabRAM by Zac Doorenbos, and Jan Puszynski

Resonant Mix Process Development for Castable Propellants and Related Energetics by Mr. Michael McPherson, Director of Energetics Development, Digital Solid State Propulsion, Reno, NV

Mix in Place Energetics Processing by Scott Coguill, Senior Research Engineer, Resodyn Corporation

Solid Propellant and Energetic Powder Processing with the Resonant Acoustic Mixer (LabRAM) by Mr. Michael G. Magnum, Senior Research Chemist at Goodrich Corporation – Interiors

AMRDEC Resonant Mixing Status by Larry K Pledger and Charles Eadon, AMRDEC Redstone Arsenal Huntsville, AL

Contact our Conference Coordinator to Reserve Your Space Now! Jill.Thornton@resodynmixers.com P:(406)497-5228

Visit our website at www.resodynmixers.com

RAM Energetics Conference

July 14-15, 2011—Butte, Montana

Thirty of the Leading Experts in Energetics Mixing from Across the Globe Converge on Butte, Montana to Discuss Mixing through ResonantAcoustic® Technology

Join our national and international distinguished guests and panel experts from the following organizations:

- NSWC – Crane
- EEC, Inc/ AMRDEC
- NAMMO RAUFOSS AS
- US Army - McAlester
- Rutgers University
- USAF AFMC AFRL/RZSP
- Navy Energetics ManTech Center
- Innovative Materials and Processing
- Naval Air Warfare Center China Lake
- SD School of Mines and Technology

Witness Live Demonstrations and Scale Up Mixing on RAM 5 (5 gallon) and RAM 30 (30 Gallon) Systems
Olivia Aberdeen, CPIAC meeting planning intern, recently completed her final project for the Howard County Gifted and Talented (G/T) Intern/Mentor Program. In preparation for her final project, Olivia worked in the CPIAC office twice a week, where she learned about site selection, hotel contracts, food and beverage selection, and the process of fitting all meeting activities into an assigned meeting space. In addition to her work in the office, Olivia attended Destinations Showcase, a hotel and destination trade show, and met with meeting planners and hotel representatives to discuss careers in the hospitality industry.

In April, Olivia attended the JPM/CS/APS/EPSS/PSHS meeting in Arlington, Virginia. In preparation for the event, she attended the preconference planning meeting, met with the hotel pastry chef, and toured the hotel kitchen facilities. Olivia then worked at the registration desk during the meeting, helping to register attendees.

Olivia’s final project was to plan the G/T Extravaganza at Wilde Lake High School. Working with a budget of $300, she scheduled the presentations, arranged for space and equipment for poster presentations, planned refreshments, chose thank-you gifts for the mentors, and prepared the event’s invitation and program for the event. On May 9, nearly 80 attendees had an opportunity to hear presentations during two speaker sessions, view poster presentations, and attend a general address by Jeanette Dixon, G/T Resource Teacher and head of the G/T Internship Program.

This fall, Olivia will attend Johnson and Wales University in Miami, where she plans to major in Baking and Pastry Arts with a minor in Business Management. Olivia said her internship was “a great learning experience” and she will use the knowledge and experience she gained during her internship to create business opportunities that will lead her to achieve her goal of one day owning a bakery.
IATAC’s Critical Role in Information Assurance and Cybersecurity

By Gene Tyler, Ron Ritchey, and Karen Mercedes Goertzel, IATAC

The security of Department of Defense (DoD) information systems is of supreme importance in defending our national security. With the increasing amount of concern and Information Warfare (IW) activities requiring rapid responses, it is difficult to ensure that all appropriate organizations are given the knowledge and tools to protect from, react to, and defend against IW attacks. The Information Assurance Technology Analysis Center (IATAC) is a DoD institution that facilitates the sharing of Information Assurance (IA) and cyber security information throughout government, industry, and academia, providing individuals access to knowledge and tools essential for effective computer network defense.

IATAC’s mission is to “provide the DoD a central point of access for information on IA/cyber emerging technologies in system vulnerabilities, research and development, models, and analysis to support the development and implementation of effective defense against IW attacks.” Though IATAC’s mission focuses on DoD’s IA and cybersecurity needs, its scope extends across government, industry, and academia. To meet these needs, IATAC provides several products and services that enable greater information sharing, including in-depth research reports on specific IA topics (State-of-the-Art Reports), a free IA Technical Inquiry research service, a Subject Matter Expert Program, and more, all of which are available at http://iac.dtic.mil/iatac.

Of course, DoD and the federal government have far-reaching IA/cyber needs. To meet these needs, up to May 2010, IATAC provided organization-specific IA research and analysis through specific tasks orders under the IATAC contract. For example, IATAC has had a significant and positive impact on the National Institute of Science and Technology (NIST), which conducts research and develops test methods and standards for emerging and rapidly-changing information technologies. IATAC has provided significant research and analysis to NIST in several key work areas, including Security Content Automation Protocol (SCAP), the National Vulnerability Database (NVD), electronic voting system security, and development of NIST’s Special Publications. To date, IATAC has provided analysis in publication of 69 of the more than 140 special publications, which focused primarily on NIST’s 800-series for the computer security community.

In addition to its work at NIST, the following list illustrates a few DoD organizations for whom IATAC provides IA analysis critical for improved IA and cyber security:

» U.S. Pacific Command: IATAC is providing IA technical analysis to the U.S. Pacific Command J73 All Partners Access Network for Operation Tomodachi, the U.S. disaster relief effort in Fukushima Prefecture, Japan, following the 8.9 magnitude earthquake and subsequent tsunami on 11 March 2011;

» U.S. Cyber Command: IATAC provided IA technical research, analysis, and recommendations to United States Cyber Command (USCYBERCOM) in the stand-up of USCYBERCOM and transition of existing Joint Task Force-Global Network Operations and Joint Functional Component Command-Network Warfare capabilities from their previous locations. IATAC continues to provide IA technical analysis focused on Computer Network Operations to advance USCYBERCOM capabilities to plan, prepare, and execute military cyberspace operations in defense of the Global Information Grid; and

» Defense Cyber Crime Center Enterprise: IATAC provided research, analysis, and recommendations to the Defense Cyber Crime Center Enterprise in the development of an automated network intrusion reporting system. The system reduced analysis time from 44 days to only 6 days and was shared with the Department of Homeland Security and Intelligence Community- Incident Response Center; it is positioned to become the national standard for incident sharing and situational awareness.

IATAC recognizes the importance of ensuring organizations maintain high levels of IA and cybersecurity. By providing DoD and the federal government with focused IA research and analysis, IATAC participates in protecting critical information at the national level.

Moving forward, IATAC will remain focused on developing resources that are needed to ensure IA practitioners and cybersecurity professionals have the information necessary to secure cyber infrastructure for government, defense, and our nation’s critical infrastructure. This is now more important than ever given the rapidly rising threats we face combined with the continually evolving nature of cyber technologies.

From the threat viewpoint, our nation has many different types of adversaries who have discovered that cyber attacks are a powerful way of accomplishing their goals. Because of this, attacks are increasing in number, sophistication, and immediacy; this can be expected to continue into the foreseeable future. Attack methods that were once the sole province of well-funded nation-states are now used daily by cyber criminals; this has become widely used by adversaries reaping benefits by taking advantage of the U.S.’s strong reliance on information technology, creating a large asymmetric advantage for them.

The evolution of cyber technologies will also drive future security challenges. Innovation within the information technology world has always occurred at a breakneck speed. This will not change and is a key strength of our country. Our willingness to embrace technology-driven change is a double-edged sword; efforts to secure new technologies and understand what the security challenges are with new technologies can lag behind their implementations by years. IATAC is working with government clients to address this issue by anticipating potential challenges.

IATAC is currently tracking key information technology movements, including cloud computing, social networking, the need to share information versus security/privacy concerns, and mobile computing, each of which offers the potential for great benefits to the government and nation, but also presents unique challenges. These challenges could easily undermine the benefits if left unaddressed because adversaries have become so sophisticated at leveraging new technologies against us.

This duality of information technology, both as beneficial and potentially threatening, is what makes the IATAC mission so important. As a nation, we will continue to embrace change and uphold the importance of innovation. We must also respond to the threat that has emerged to subvert these endeavors. To that end, IATAC will continue to be a preeminent provider of information, guidance, and services that enable the safe use of both existing and emerging information technology.

Readers may contact all IATAC authors via e-mail to iatac@dtic.mil. For more information about IATAC, please visit http://iac.dtic.mil/iatac/. For more information about DTIC, please visit http://www.dtic.mil/dtic/.
Space Cryogenics Workshop Makes Propulsion Connections

By Richard Cartwright, CPIAC

On 8-10 June, the 2011 Space Cryogenics Workshop, sponsored by the Cryogenic Society of America (CSA), was held at the Best Western Inn and Conference Center in Coeur d’Alene, ID. Attendees included NASA and National Institute of Standards and Technology scientists and engineers, aerospace contractors, and academic researchers. International participants were from China, Japan, South Korea and France. While called a workshop, the event was more similar to a symposium, with both oral and poster presentations from attendees.

The workshop focused on the discovery of techniques for achieving cryogenic temperatures. Presenters described developments in various cooling techniques. Although most of the techniques themselves are not particularly novel, many improvements were discussed, such as staging of different cooler types for optimal cooling, improved efficiency, improved sealing and insulation, improved operational stability and reliability, reusability, longer service life, interchangeable system components, compact designs, and tolerance of vibration, contamination, and electromagnetic interference.

A number of topics discussed in the workshop have direct applications to cryogenic propellant technology. For example, increased efficiency of cryogenic coolers, subcooling of propellants (cooling below their normal boiling points), and improvements in insulation reveal that boiloff of liquid hydrogen and oxygen can be reduced or even eliminated, thus enabling significantly longer missions. Subcooling has the additional advantage of increasing propellant density, enabling more propellant to be transported within a given volume. Improved structural materials for cryogenic assemblies have applicability to propellant storage and delivery systems. Bubble breakthrough testing to evaluate the effectiveness of liquid acquisition devices (LADs) was described. LADs are used to ensure that cryogenic propellants delivered to engines are all liquid, with no entrained vapor bubbles. The current status of the Cryogenic Orbital Testbed (CRYOTE) project, which will enable many properties of liquid hydrogen to be determined in microgravity or zero gravity, was also discussed. It will also be possible to evaluate cooling and storage methods with CRYOTE, as well as the use of cold-gas propulsion for attitude control. Cryogenic material property and system performance data developed for space exploration also have direct application to future electric-powered aircraft.

Investigators in the field of cryogenic propellants would do well to consider attending future workshops of this kind. Further information is available from CSA at www.cryogenicsociety.org.
Spotlight on Small Business Innovation Research (SBIR)

Nanothermites: New Class of Green Initiators

By Dr. Jan A. Puszynski and Dr. Zac Doorenbos
Innovative Materials and Processes, LLC, Rapid City, South Dakota

Innovative Materials and Processes, LLC (IMP) was established in 1999 in Rapid City, South Dakota. This R&D company specializes in development of new nanoenergetic materials for both defense and commercial applications. In addition, IMP’s work focuses on synthesis and processing of advanced ceramic materials, nanomaterials, energetic devices, low energy initiators and pyrotechnic systems. The company also provides analytical and consulting services relevant to physico-chemical characterization of materials, chemical reactivity, electrostatic, impact, and friction sensitivities as well as mathematical modeling of reactive systems. IMP company is well equipped with all necessary attrition milling, mixing, loading, drying, pressing and temperature conditioning equipment as well as energetic materials testing facilities. The company is located in a very secure building allowing for various explosive R&D tests to be conducted. IMP is located in close proximity to the South Dakota School of Mines and Technology, thus providing access to well-equipped analytical facilities at the university based on commercial rates.

Due to environmental regulations, there is a significant need for replacement of many energetic systems, which contain lead-based and other environmentally toxic compounds. For example, small caliber percussion primers, currently used in military and civilian sectors, contain lead styphnate and other compounds, which are not acceptable by the new environmental regulations. Other examples include cartridge actuated devices, low energy initiators, electric primers, electric matches and many others.

During the past decade, advances in synthesis and processing of nanopowders stimulated exploration and development of a new class of nanoenergetic materials. Specific examples of such materials are nanothermites or metastable interstitial composites (MIC). Typically, these materials consist of a mixture of aluminum and metal oxide nanopowders. Conventional thermite mixtures, which consist of micron-sized powders, have been used for many years in both military and civilian sectors because of a high-level of energy release. However, the rate of energy release in such conventional thermite systems is not very fast in comparison with other energetic systems. A typical combustion front propagation velocity in a condensed phase is of the order of several centimeters to a few meters per second but when the size of fuel and oxidizer particles is reduced to tens of nanometers, the propagation velocity might be increased by three or more orders of magnitude. Still photographs from a high speed camera showing the combustion of a nanothermite in a microcavity are shown in Figure 1.

Examples of several thermite systems, together with corresponding heat of reaction, gas generation ability, and adiabatic temperature calculated at 1 atm argon gas pressure are listed in Table 1.

<table>
<thead>
<tr>
<th>Thermite Reaction</th>
<th>Q [cal/g]</th>
<th>Q [cal/cm³]</th>
<th>Gas Generation</th>
<th>T_{ad} [K]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2Al + Fe₂O₃ → 2Fe + Al₂O₃</td>
<td>945.4</td>
<td>3947</td>
<td>0.0784</td>
<td>3135</td>
</tr>
<tr>
<td>2Al + Bi₂O₃ → 2Bi + Al₂O₃</td>
<td>505.1</td>
<td>3638</td>
<td>0.8940</td>
<td>3319*</td>
</tr>
<tr>
<td>2Al + MoO₃ → Mo + Al₂O₃</td>
<td>1124.0</td>
<td>4279</td>
<td>0.2473</td>
<td>3688*</td>
</tr>
<tr>
<td>2Al + WO₃ → W + Al₂O₃</td>
<td>696.4</td>
<td>3801</td>
<td>0.1463</td>
<td>3253</td>
</tr>
<tr>
<td>2Al + 3CuO → 3Cu + Al₂O₃</td>
<td>974.1</td>
<td>4976</td>
<td>0.3431</td>
<td>2843</td>
</tr>
</tbody>
</table>
Since 2002, a nanothermite system, namely Al-Bi₂O₃, has been investigated by IMP. Due to the fact that bismuth oxide is practically insoluble in water, and with proper protection of aluminum nanoparticles, the Al-Bi₂O₃ system can be mixed and safely processed in a water slurry. IMP has developed a process for the formation of inexpensive aluminum nanoflakes and their passivation as well as protection during water-based processing. This process can also be effectively used for size reduction of other fuel and oxidizer materials and may allow for various types of particle surface modification.

Under current SBIR funding from the U.S. Army, IMP is developing a semi-continuous automated process for mixing and metering of nanothermite mixtures into various applications, including small caliber percussion primers and medium size electric primers. At this stage, this IMP’s technology can be transferred to a large scale operation.

Using the same water based mixing process, IMP is currently developing the use of nanothermite materials for impulse generation under SBIR Phase II funding from the U.S. Army. These high gas generating nanothermites have possible uses in space applications or a low-cost course correction technology.

Nanothermite materials have shown a wide range of tunability of combustion parameters by adjusting fuel and oxidizer particles sizes, fuel particle surface property and morphology, fuel to oxidizer ratios and the addition of gasifying agents. Nanothermite materials are sensitive to unwanted ignition from electrostatic discharge (ESD) and friction. Presently, IMP is developing new ways to reduce ESD and friction sensitivities of nanothermites while maintaining their tunable combustion characteristics resulting in the possible utilization of these novel nanothermites in various pyrotechnic applications.

References:
CPIAC Crossword Challenge!

Complete the crossword puzzle below and return your answers to Ashley Hajnos
Fax: 410-730-4969 E-mail: ahajnos@cpiac.jhu.edu

The winner and answers will be published in the next issue of the Bulletin.

References:

Across
2. Difference operator (Greek)
5. Solid fuel and liquid oxidizer
7. Smoky solid propellant fuel
8. Coolant, OXM
9. Anti-Radiation Missile (abbr.)
10. Two points defining an ellipse
14. Angle from perigee to the spacecraft’s position (Greek)
16. Popular propellant choice for electrostatic propulsion
18. Unsymetrical Dimethyl-hydrazine (abbr.)
19. Introduces and meters flow
20. Class of launch vehicle (Taurus II, Delta II)
23. RD-120, vehicles second stage
24. Transfer from one inclination to another, _______ change
31. Ability to control direction of exhaust gas (abbr.)
35. Thickened liquid propellant
36. Right ascension of the ascending node (Greek)
39. Low erosion nozzle material
40. Mechanism used to feed fuel/oxidizer
41. Grain configuration with small C.G. shift
42. Combustion _______

Down
1. Ultimate energy source
3. Between insulation and propellant
4. Monomethyl-hydrazine (abbr.)
5. Cyclotetramethylene tetranitramine
6. Cyclotrimethylene trinitramine
7. Material cooled through charring evaporation
11. Coating applied to grain surface to prevent burning
12. n, burn rate
13. Orbit with 90° inclination
15. Precursor to NASA
17. Formation of hot rocket exhaust gases outside the rocket nozzle
20. Kilogram or pound
21. Valve providing lateral thrust to kill vehicle
22. Progressive, regressive or _______ thrust profile
25. To turn about the vertical axis
27. Rear
28. Burning caused by high velocity flow
30. $P_e = P_a$, expansion ratio
32. Direction and magnitude
33. Q, _________ of reaction
34. Axial or longitudinal instability ______
37. Angle of attack (Greek)
38. Europe’s small launch vehicle, under development
Propulsion News Highlights

Iranian satellite launch (6-20-2011)
Source: UPI.com

Iran’s state television reported that on 16 June, the Rasad-1 satellite, weighing 34 pounds, was launched into orbit 163 miles above the Earth by a Safir-1B launch vehicle. Rasad-1 was built at the Malek Ashtar University, founded and run by the Islamic Revolutionary Guards Corps, the elite military organization that is in charge of Iran’s ballistic missile program and strategic missile command. The Rasad launch presumably took place at the Semnan launch site in the Great Salt Desert, south of Tehran. On 3 February 2009, Iran sent aloft its first indigenously launched satellite, a research and communications craft called Omid-1 atop a Safir rocket. With this feat, the Islamic Republic thus joined the fewer than a dozen other countries capable of launching satellites into space.


Second X-51A flight ends early (6-20-2011)
Source: Military.com

The X-51A Waverider flew its second test flight at the Point Mugu Naval Air Test Range over the Pacific Ocean on 13 June, providing significant hypersonic research data despite a less-than-successful flight. The hypersonic aircraft was successfully boosted to just over Mach 5 and the scramjet engine lit, but failed to transition to full power. Air Force Flight Test Center officials said, after a flawless flight from Edwards Air Force Base, the B-52H Stratofortress aircrew released the experimental vehicle from an altitude of approximately 50,000 feet. The X-51A initially was accelerated by a solid rocket booster to a speed just over Mach 5.

The experimental aircraft’s air breathing scramjet engine lit on ethylene and attempted to transition to JP7 fuel operation when the vehicle experienced an inlet un-start. The hypersonic vehicle attempted to restart and oriented itself to optimize engine start conditions, but was unsuccessful. The vehicle continued in a controlled flight orientation until it flew into the ocean within the test range.


J-2X Engine Ready for Test (6-15-11)
Source: Pratt & Whitney Rocketdyne

Pratt & Whitney Rocketdyne completed assembly of the first J-2X upper-stage engine for NASA’s next era of human spaceflight in preparation for demonstration testing at Stennis Space Center. The J-2X is a highly efficient and versatile rocket engine with characteristics to power the upper stage of a heavy-lift launch vehicle. Pratt & Whitney Rocketdyne is a United Technologies Corp. company. “Pratt & Whitney Rocketdyne is proud to have assembled and brought to test NASA’s first new human rated engine in 31 years,” said Jim Maser, president, Pratt & Whitney Rocketdyne. “Built from a proven engine design, the J-2X is a safe and reliable solution for NASA’s future heavy-lift architecture.” Fueled by liquid hydrogen and liquid oxygen, the J-2X engine will generate 294,000 pounds of thrust to propel a spacecraft into low-Earth orbit. The J-2X can start and restart in space to support a variety of mission requirements.

Calendar of JANNAF Meetings

8th Modeling and Simulation Subcommittee (MSS)/6th Liquid Propulsion Subcommittee (LPS)/5th Spacecraft Propulsion Subcommittee (SPS) Joint Meeting

December 5–9, 2011
Huntsville Marriot, Huntsville, AL

Deadlines:
- Papers/Presentations due to CPIAC: 7 November 2011
- Hotel Reservations: 12 November 2011. Reservations can be made by calling Marriott reservations at 1-888-299-5174. Please refer to JANNAF when making your reservations to ensure the negotiated rate.

Meeting's Web page for additional information and registration: https://www2.cpiac.jhu.edu/meetings/dec2011/pages/index.html

59th JANNAF Propulsion Meeting, (JPM)/41st Structures and Mechanical Behavior Subcommittee (SMBS)/37th Propellant and Explosives Development and Characterization Subcommittee (PEDCS)/28th Rocket Nozzle Technology Subcommittee (RNTS)/26th Safety and Environmental Protection Subcommittee (SEPS) Joint Meeting

April 30–May 4, 2012
Grand Hyatt, San Antonio, TX

Additional details will be available shortly. Visit www.jannaf.org for updates.

45th Combustion Subcommittee (CS)/33rd Airbreathing Propulsion Subcommittee (APS)/33rd Exhaust Plume and Signatures Subcommittee (EPSS)/27th Propulsion Systems Hazards Subcommittee (PSHS) Joint Meeting

December 3–7, 2012
Hyatt Regency, Monterey, CA

Additional details will be available shortly. Visit www.jannaf.org for updates.

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

Visit the JANNAF Web site for meeting updates: www.jannaf.org

Policy on Non-Government Attendees at JANNAF Meetings. Attendance at JANNAF meetings for non-government employees is restricted to U.S. citizens only and whose organizations are 1) registered with the Defense Logistics Information Service (DLIS) AND 2) have a government contract registered with the Defense Technical Information Center (DTIC). If the government contract is not registered with DTIC, the attendee’s registration form can be certified by a sponsoring government official from one of the participating JANNAF agencies. Additional information concerning registrations with DLIS and DTIC can be obtained by contacting DLIS at 1-800-352-3572 (www.dlis.dla.mil/jcp/) or DTIC at 1-800-225-3842 (www.dtic.mil/dtic/registration/index.html).