Pathways Beyond Low Earth Orbit
In-Space Chemical Propulsion
Technical Interchange Meeting (TIM)

MEETING BY INVITATION ONLY AS SPACE IS LIMITED

MEETING INVITATION

Jackson Center
Huntsville, AL
4-6 April 2017

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

Last updated 3/13/17
You are invited to attend NASA’s In-Space Propulsion Technical Interchange Meeting (TIM) being held on Tuesday-Thursday, 4-6 April 2017, in Huntsville, Alabama at the Jackson Center.

The Program Co-Chairs for this Meeting are Mary Beth Koelbl, NASA Marshall Space Flight Center, Huntsville, AL and Dr. George Schmidt, NASA Glenn Research Center, Cleveland, OH. A complete list of Program Committee Members can be found on page 6.

NASA has committed significant effort towards understanding future in-space propulsion needs and development of in-space chemical propulsion roadmaps along with starting technology development. This TIM is intended to share the results of these efforts, to encourage organizations with similar interests to share their work/ideas, and provide insight into future development plans.

The journey beyond low earth orbit (LEO) will require the development of highly reliable propulsion systems to fulfill future mission needs. Various in-space propulsion systems are being considered in support of Space Launch System (SLS) Exploration Upper Stage (EUS), Mars Sample Return, Mars architecture studies, Lunar missions, Europa and other deep space missions. The purpose of this workshop is to bring the in-space transportation community together to discuss the in-space chemical propulsion requirements, what has been done, and what needs to be done to support current mission planning, emerging satellite industry and low cost small launch industry. This forum will be conducive to sharing ideas and needs for future in-space chemical propulsion development.

Meeting Site
The overall security classification of this meeting is unclassified. Sessions will be held at the Jackson Center in Huntsville, Alabama. Information about the Jackson Center can be found on its Website at http://www.jacksoncenter.net/.

Hotel Information
Room blocks have not been established for the April 2017 In–Space Propulsion Technical Interchange Meeting. Attendees will be responsible for reserving their own rooms for the meeting.

Click here for a list of hotels located near the Jackson Center.

Transportation and Parking
Free parking is available at the Jackson Center. Please be aware that the hotels near the Jackson Center do not offer an airport shuttle or a shuttle service to nearby businesses such as the Jackson Center. If you will not have your own car, you will most likely need to rent a car or use a taxi service.

Security/Attendance Requirements
The overall security level of the meeting is Unclassified. All sessions will be held at the Jackson Center in Huntsville, Alabama.

Attendance is restricted to invited U.S. Citizens*

Non-government attendees must have their employment confirmed with an organization certified with the Defense Logistics Agency (DLA) to obtain export-controlled technical data AND be certified by a sponsoring government official from one of the participating JANNAF agencies.

*Foreign Nationals and Foreign National Representatives are not permitted. U.S. green card holders (permanent residents) may be considered by NASA for attendance and should contact Tricia Reider, ERG, at treider@erg.jhu.edu for additional information.
ALL non-government attendees (which includes contractors, consultants and universities) attending this meeting must:

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

**DD 2345:** For additional information, contact the Joint Certification Program Office (JCP) at 1-800-352-3572 or visit their Web site at www.dlis.dla.mil/jcp/.

All attendees will be required to register via the JANNAF Secure Portal. Portal accounts are complimentary so if you do not currently have an account, please visit the JANNAF web-site at www.jannaf.org to begin the process. Questions concerning attendance eligibility or establishment of a secure portal account should be directed to the JHU-WSE ERG Assistant Facility Security Officer, Tricia Reider at (410) 992-7300, ext. 222 or treider@erg.jhu.edu.

**Tour of the NASA Marshall Space Flight Center**

Bus tours of the NASA Marshall Space Flight Center will be available for TIM attendees on Monday, 3 April 2017 from 3 p.m to 5 p.m central and Friday, 7 April 2017, from 9 a.m. to 11 a.m.

Transportation will be provided by MSFC with limited seating. There is a limit of 17 guests per day for this event so please register as soon as possible in order to reserve a seat. Seating will be assigned on a first come, first serve basis. Personal vehicles will not be allowed on this tour. Participants will meet at the Redstone Arsenal Gate 9 Visitor’s Center located on South Rideout Rd. Please park your cars in the visitor’s center parking lot where you will be escorted by van for the tour.

In order to access the tour, you must be a U.S. citizen and have a valid state issued ID, passport or Government issued Common Access Card (CAC).

If you register for the tour, please commit to attending as seating is extremely limited. If you do register and cannot attend, please notify the tour coordinator to re-open your seat. Plan to arrive 15 minutes prior to departure times.

If you would like to register for the tour, contact Chris Randall: chris.randall-1@nasa.gov or 256.503.7907

To view tour day agendas, please visit: https://www.jannaf.org/mtgs/April2017_TIM/pages/tour.html

**Posters**

For those attendees who are presenting posters, you may ship your posters to the address below:

Jackson Center/NASA TIM Conference  
c/o Jamie Jones  
600 Genome Way  
Huntsville, AL 35806

**Dining/Boxed Lunches**

Attendees have the option of pre-ordering a box lunch from the Jackson Center for the Tuesday-Thursday sessions. **Orders must be placed by Friday, 31 March 2017.** Unfortunately the Jackson Center will not be able to accept orders after this date. For more information or to place an order, go to the Site Info & Meal Options page of the meeting website.

Coffee, juice, muffins and danish will be offered at Breakfast for $1 each. No pre-order necessary for breakfast.

Snacks will be available for purchase on-site and will include but not necessarily limited to: sodas, coffee, chips, peanuts, granola bars, candy bars, bottled water ($1.00 each).

**(OUTSIDE FOOD AND BEVERAGE IS NOT ALLOWED TO BE BROUGHT INTO THE JACKSON CENTER)**

Attendees are welcome to go beyond the Jackson Center to purchase a lunch. Nearby restaurants include the Hudson Alpha Cafe. In addition, the Jackson Center is located 1.2 miles from the Bridge Street Town Centre which features 70 upscale shops and restaurants.
Luncheon Speaker
Introduction: Mrs. Mary Beth Koelbl
Speaker: Ms. Rebecca Lee – Deputy AA for Office of Legislative and Intergovernmental Affairs (OLIA) NASA HQ

Ms. Lee will discuss what the new administration means to the future of NASA and chemical propulsion from a legislative prospective followed by a short question and answer period.

Attendees must pre-order their lunch to participate.

Networking Night
Come enjoy an evening with fellow meeting attendees on Wednesday, 5 April 2017, at 6:00 p.m. Networking Night will be held at the restaurant Straight to Ale, located at 2610 Clinton Ave W, Huntsville, AL 35805.

Straight to Ale has gained regional and national attention with the craft beer community and they continue to grow their distribution footprint to cover the southeast. In the summer of 2016 they opened their new 55,000 square foot facility at Campus 805, reclaiming a long vacant Middle School campus on the edge of downtown Huntsville and turning it into a thriving community of breweries, bars, restaurants, and local shops. At this new location, they expanded to include cider and mead production along with distilled spirits, a scratch made kitchen (Ale’s Kitchen), a pinball arcade and pool room. Attendees will be on their own for transportation and costs.

Networking Room
The Atrium prefunction area (Jackson Center, 1st floor) will serve as the networking area. This area will be open each meeting day from 7:30 a.m. - 5:00 p.m. Please note that scheduled breaks are included in session agendas where time permits.

Side Meetings
There is one conference room located near the Atrium Lobby in the Jackson Center that is available for side meetings. Please contact Kathleen Rowan at (410) 992-7300, ext. 208 or KRowan@erg.jhu.edu to reserve this room.

Table Top Exhibits Available
If you are interested in reserving a 6 x 24 table for a table top exhibit, please contact Kathleen Rowan at (410) 992-7300, ext. 208 or e-mail: KRowan@erg.jhu.edu. Please note that tables are limited.

Meeting Proceedings
Proceedings from this meeting will be published by the JHU-WSE Energetics Research Group. Presentations will be available at no charge to Government attendees (DoD, DoE and NASA) via the new JANNAF Digital Online Collection (JDOC) Database, accessible through your account on the JANNAF Secure Portal. Industry and academic attendees will be able to access the presentations from the TIM by subscribing to JDOC. Information about subscriptions or JDOC may be obtained from Tricia Reider at (410) 992-7300, ext. 222 or treider@erg.jhu.edu. Please allow 12 weeks following the conclusion of the TIM for the presentations to be posted on JDOC.

On–Site Electronics Policy
We know how important it is to stay connected. However…as a registered attendee of this ITAR restricted Symposium, you have a personal responsibility to help protect the data exchanged at this event. This includes managing your electronic devices (phones, computers, cameras, pads, etc.), as well as your conversations responsibly. Aside from security concerns, prudence and responsible use of these devices extends basic courtesy to other attendees and speakers.

Please follow these basic guides at this meeting:
• Phones should not be used in any technical session. Preferably turn these devices off. If you must have your phone on, it should be on vibrate mode. Calls should not be accepted during the course of a presentation.
• Confine technical discussions to the meeting space, as an open foyer may be available to the general public.
On Site Registration

The Registration Desk will be located in the lobby of the Jackson Center. Pre-registered attendees must show photo identification before receiving their badge and materials. **Pre-registration is strongly recommended to ensure that all attendance requirements have been met prior to arrival.** Registration will be open Tuesday thru Thursday, 4-6 April, beginning at 7:00 a.m. and closing at the end of sessions each day.

Attire

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

Questions

Questions concerning this program should be directed to Kathleen Rowan at (410) 992-7300, ext. 208 or e-mail: KRowan@erg.jhu.edu.

Upcoming JANNAF Meeting

64th JANNAF Propulsion Meeting (JPM) / Programmatic and Industrial Base Meeting (PIB) / 44th Structures and Mechanical Behavior (SMBS) / 40th Propellant and Explosives Development and Characterization (PEDCS) / 31st Rocket Nozzle Technology (RNTS) / 29th Safety and Environmental Protection (SEPS) Joint Subcommittee Meeting, 22-25 May 2017, Kansas City, Missouri.

For more information visit the meeting website at: https://www.jannaf.org/mtgs/2017May/pages/index.html

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**Registration**

There is no registration fee to attend the April 2017 TIM. However this meeting is by invitation only; all attendance requirements must still be met (see Security/Attendance Requirements, on page 2). **Pre-registration is strongly recommended.**

**STEP #1**

*Create a Portal Account (www.jannaf.org)*

To register for the TIM, **you must first have a JANNAF Secure Portal account.** Please allow sufficient time for completion of the Portal Account application and approval process. For more information and instructions, please visit the FAQ page on the meeting website.

**STEP #2**

*Once you have your JANNAF Secure Portal Account:*

1. Go to the **Registration page** of the meeting website and click on “Register for the In-Space Propulsion TIM.”

2. Log in to your Portal account.

**STEP #3**

*Complete the brief online Registration Questionnaire.*

After your response to the Registration Questionnaire has been entered in the meeting database, you will receive an email confirming your registration for the April 2017 TIM.
NASA Meeting Invitation and Preliminary Program - April 2017

Program Committee Members

PROGRAM CO-CHAIRS
Ms. Mary Beth Koelbl
NASA Marshall Space Flight Center
Huntsville, AL

Dr. George Schmidt
NASA Glenn Research Center
Cleveland, OH

TQM PROGRAM COMMITTEE
Area I: Planned Missions and Future Missions
Mr. John Connolly
NASA Johnson Space Center
Houston, TX

Area II: In-Space Transportation System Concepts
Mr. Gabe Merrill
NASA Langley Research Center
Hampton, VA

Area III: In-Space Liquid Rocket Engines (LRE’s)
Mr. Jason Turpin
NASA Marshall Space Flight Center
Huntsville, AL

Area IV: Cryogenic Fluid Management (CFM)
Mr. Jim Martin
NASA Marshall Space Flight Center
Huntsville, AL

Area V: Propulsion for Reaction Control Systems (RCS)
Mr. Chuck Pierce
NASA Marshall Space Flight Center
Huntsville, AL

Area VI: Solid Propulsion and Hybrids
Phillip Franklin
NASA Marshall Space Flight Center
Huntsville, AL

Area VII: Advanced In-Space Propulsion/Nuclear Thermal Propulsion
Dr. Mike Houts
NASA Marshall Space Flight Center
Huntsville, AL

Area VIII: Testing and Ground Operations
Mr. Harold Gerrish
NASA Marshall Space Flight Center
Huntsville, AL

MAFC Office of Strategic Communications
Mr. Chris Randall
NASA Marshall Space Flight Center
Huntsville, AL

ERG Technical Representative
Mr. Kirk V. Sharp
JHU-Whiting School-Energetics Research Group
Columbia, MD

MEETING PLANNER/PROCEEDINGS EDITOR
Ms. Kathleen Rowan
JHU-Whiting School-Energetics Research Group
Columbia, MD

ASSISTANT FACILITY SECURITY OFFICER
Ms. Tricia Reider
JHU-Whiting School-Energetics Research Group
Columbia, MD

Attendee Things to Do Checklist

<table>
<thead>
<tr>
<th>Task</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have you completed your application for a JANNAF Secure Portal account? (Click here to create an Account, Due Date: ASAP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Have you followed up with your FSO or HR contact re: Secure Portal application? (Due Date: ASAP)</td>
<td></td>
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<tr>
<td>3. Did you complete your online Registration Questionnaire? (Due Date: 22 March 2017)</td>
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<tr>
<td>4. Have you submitted your presentation and presentation clearance form? (Due Date: 20 March 2017)</td>
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</tr>
<tr>
<td>5. Have you ordered lunch(s) from the Jackson Center? (Click here to order no later than 31 March 2017)</td>
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</tr>
<tr>
<td>6. Planning to attend the tour of NASA Marshall Space Flight Center? (Please email Chris Randall, <a href="mailto:chris.randall-1@nasa.gov">chris.randall-1@nasa.gov</a> if you are interested in participating)</td>
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<td></td>
</tr>
</tbody>
</table>
## Technical Program

The TIM program currently consists of 8 technical sessions, with 45 presentations. There will also be poster presentations.

### Technical Program Agenda - Tuesday, 4 April

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m. - 8:05 a.m.</td>
<td>Welcome</td>
</tr>
<tr>
<td>8:05 a.m. - 8:15 a.m.</td>
<td>Introductory Remarks; Dr. David Burns, NASA MSFC</td>
</tr>
<tr>
<td>8:15 a.m. - 9:15 a.m.</td>
<td>NASA Mission Directorate Panel Discussion</td>
</tr>
<tr>
<td>9:15 a.m. - 9:45 a.m.</td>
<td>Session 1-Part I: Planned Missions and Future Missions</td>
</tr>
<tr>
<td>9:45 a.m. - 10:00 a.m.</td>
<td>Break; View Posters</td>
</tr>
<tr>
<td>10:00 a.m. - 11:30 a.m.</td>
<td>Session 1-Part II: Planned Missions and Future Missions</td>
</tr>
<tr>
<td>11:30 a.m. - 12:00 p.m.</td>
<td>Session 2-Part I: In-Space Transportation System Concepts</td>
</tr>
<tr>
<td>12:00 p.m. - 1:00 p.m.</td>
<td>Lunch Break</td>
</tr>
<tr>
<td>1:00 p.m. - 2:30 p.m.</td>
<td>Session 2-Part II: In-Space Transportation System Concepts</td>
</tr>
<tr>
<td>2:30 p.m. - 3:00 p.m.</td>
<td>Session 3-Part I: In-Space Liquid Rocket Engines (LRE’s)</td>
</tr>
<tr>
<td>3:00 p.m. - 3:15 p.m.</td>
<td>Break; View Posters</td>
</tr>
<tr>
<td>3:15 p.m. - 5:15 p.m.</td>
<td>Session 3-Part I: In-Space Liquid Rocket Engines (LRE’s)</td>
</tr>
</tbody>
</table>

### Technical Program Agenda - Wednesday, 5 April

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m. - 8:05 a.m.</td>
<td>Welcome</td>
</tr>
<tr>
<td>8:05 a.m. - 9:35 a.m.</td>
<td>Session 3-Part II: In-Space Liquid Rocket Engines (LRE’s)</td>
</tr>
<tr>
<td>9:35 a.m. - 10:05 a.m.</td>
<td>Session 4-Part I: Cryogenic Fluid Management (CFM)</td>
</tr>
<tr>
<td>10:05 a.m. - 10:20 a.m.</td>
<td>Break; View Posters</td>
</tr>
<tr>
<td>10:20 a.m. - 11:50 a.m.</td>
<td>Session 4-Part II: Cryogenic Fluid Management (CFM)</td>
</tr>
<tr>
<td>11:50 a.m. - 12:50 p.m.</td>
<td>Luncheon/Speaker; Ms. Rebecca Lee NASA HQ</td>
</tr>
<tr>
<td>12:50 p.m. - 1:20 p.m.</td>
<td>Session 4-Part II: Cryogenic Fluid Management (CFM)</td>
</tr>
<tr>
<td>1:20 p.m. - 2:50 p.m.</td>
<td>Session 5-Part I: Propulsion for Reaction Control Systems (RCS)</td>
</tr>
<tr>
<td>2:50 p.m. - 3:05 p.m.</td>
<td>Break; View Posters</td>
</tr>
<tr>
<td>3:05 p.m. - 5:05 p.m.</td>
<td>Session 5-Part II: Propulsion for Reaction Control Systems (RCS)</td>
</tr>
</tbody>
</table>

### Technical Program Agenda - Thursday, 6 April

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m. - 8:05 a.m.</td>
<td>Welcome</td>
</tr>
<tr>
<td>8:05 a.m. - 8:35 a.m.</td>
<td>Session 5-Part III: Propulsion for Reaction Control Systems (RCS)</td>
</tr>
<tr>
<td>8:35 a.m. - 10:05 a.m.</td>
<td>Session 6-Part I: Solid Propulsion and Hybrids</td>
</tr>
<tr>
<td>10:05 a.m. - 10:20 a.m.</td>
<td>Break; View Posters</td>
</tr>
<tr>
<td>10:20 a.m. - 11:50 a.m.</td>
<td>Session 6-Part II: Solid Propulsion and Hybrids</td>
</tr>
<tr>
<td>11:50 a.m. - 12:50 p.m.</td>
<td>Lunch</td>
</tr>
<tr>
<td>12:50 p.m. - 2:50 p.m.</td>
<td>Session 7: Advanced In-Space Propulsion/Nuclear Thermal Propulsion</td>
</tr>
<tr>
<td>2:50 p.m. - 3:05 p.m.</td>
<td>Break; View Posters</td>
</tr>
<tr>
<td>3:05 p.m. - 5:05 p.m.</td>
<td>Session 8: Testing and Ground Operations</td>
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</tbody>
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<thead>
<tr>
<th>Jackson Center</th>
<th>Discovery Hall</th>
<th>Discovery Hall B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday 4/4/17</td>
<td>NASA Mission Directorate Panel</td>
<td>Session 1: Planned Missions and Future Missions</td>
</tr>
<tr>
<td>Wednesday 4/5/17</td>
<td>Session 3-Part II: In-Space Liquid Rocket Engines (LRE’s)</td>
<td>Session 4: Cryogenic Fluid Management (CFM)</td>
</tr>
<tr>
<td></td>
<td>Session 7: Advanced In-Space Propulsion/Nuclear Thermal Propulsion</td>
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