



## Message from the Director



The National Institute for Rocket Propulsion Systems (NIRPS) is dedicated to fostering a vibrant U.S. rocket propulsion community that provides reliable and affordable propulsion systems in support of the nation's defense, civil, and commercial needs.

This 2012 NIRPS Annual Report covers the period of May 2011 through December 2012, encompassing the Institute's first full year of operations. All subsequent reports will be annual, covering the months of January through December.

NASA Administrator Charles Bolden directed the creation of NIRPS as a unique national resource capable of serving multiple interests in government, industry, and academia. In these first 20 months of formulation and operations, NIRPS has accomplished numerous milestones and objectives outlined in this report. Significantly, the Institute gained national recognition when the Office of Science and Technology Policy directed NIRPS to develop the response to Section 1095 of the National Defense Authorization Act, requiring a National Rocket Propulsion Strategy.

This report describes the activities involved in the design of NIRPS and its strategic teams, and the initial accomplishments of the Institute, including support of numerous conferences, forums, publications, a comprehensive Red Team Review, and the successful execution of the first annual NIRPS Workshop. NIRPS continues to address the key concerns of the rocket propulsion community, and the report defines the Institute's goals for FY13 as well as a Notional Operational Model.

Outstanding teamwork was demonstrated every step of the way this first full year of operations. The commitment and dedication of the NIRPS team is evident, and I look forward to leading this Institute as it continues to cultivate a critical rocket propulsion community.

L. Dale Thomas, PhD, PE  
Director



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## 2012 Annual Report: A Year of Progress and Challenge

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**Introduction.....4**  
Study Review .....4  
Strategy Development .....5

**NIRPS Operational Model .....6**  
Internal NASA MSFC Organization/NIRPS Core Team.....6  
Strategy Teams .....7  
Planning Team .....8

**CY12 Goals .....9**

**Accomplishments .....10**  
NIRPS Team Accomplishments .....11  
NASA Red Team Review .....14  
National Defense Authorization Act; Section 1095 Summary .....15

**FY13 Goals .....15**

**Five-Year Strategy .....17**

**Conclusion .....18**

**Appendix A – Letter from the Administrator .....19**

**Appendix B – Forums Assessment Summary .....20**

**Appendix C – Glossary of Abbreviations.....21**

## Introduction

The National Institute for Rocket Propulsion Systems (NIRPS) maintains and advances U.S. leadership in all aspects of rocket propulsion for defense, civil, and commercial uses. The Institute's creation is in response to widely acknowledged concerns about the U.S. rocket propulsion base dating back more than a decade. U.S. leadership in rocket and missile propulsion is threatened by long-term industry downsizing, a shortage of new solid and liquid propulsion programs, limited ability to attract and retain fresh talent, and discretionary federal budget pressures. Numerous trade and independent studies cite erosion of this capability as a threat to national security and the U.S. economy resulting in a loss of global competitiveness for the U.S. propulsion industry.

This report covers the period between May 2011 and December 2012, which includes the *creation* and *transition to operations* of NIRPS. All subsequent reports will be annual.

The year 2012 has been an eventful one for NIRPS. In its first full year, the new team overcame many obstacles and explored opportunities to ensure the institute has a firm foundation for the future. NIRPS is now an active organization making contributions to the development, sustainment, and strategy of the rocket propulsion industry in the United States.

This report describes the actions taken by the NIRPS team to determine the strategy, organizational structure, and goals of the Institute. It also highlights key accomplishments, collaborations with other organizations, and the strategic framework for the Institute.

## Creation of NIRPS

NASA Administrator Charles Bolden authorized the creation of NIRPS in a letter dated September 16, 2011 (Appendix A). The letter recommended three focus areas: monitoring and analyzing the state of the rocket propulsion industry; identifying technology needs and recommending technology insertions; and maintaining relationships and awareness across the industry. The letter directed Marshall Space Flight Center (MSFC) to lead the effort to establish NIRPS in cooperation with the Department of the Air Force and the National Reconnaissance Office (NRO).

The initial task for the NIRPS team was to design a strategy that would guide the Institute to a viable organization. This strategy would inform the organization of NIRPS, help the team set short- and long-term goals, and address common problems across all sectors of the U.S. propulsion ecosystem. The NIRPS team collaborated with leaders in three key sectors of the propulsion ecosystem: government (civil and national security space), industry (prime contractor, supplier, and new commercial space entrants), and academia to discuss and refine the strategy in consultation with the larger rocket propulsion community. NIRPS team members also made a significant effort to validate the strategy to ensure that it would address the challenges facing the U.S. rocket propulsion industrial base.

## Study Review

In late 2011 and early 2012, the NIRPS team reviewed more than 40 propulsion industrial base studies and assessments performed by various entities over the past decade and identified numerous recurring themes. These themes encompassed policy related issues, including a lack of integrated space strategies across government agencies and departments, a lack of a multi-agency vision, a lack of defined space missions, as well as a lack of predictable long-term funding.

Programmatic issues were also common theme. The retirement of the Space Shuttle Program and subsequent cancellation of the Constellation Program led to uncertainty in future rocket propulsion needs and contributed to the overall industrial base decline. These developments have led to a further overcapacity of production capability and rising supplier costs. Of particular note was the large solid rocket motor industrial base decline. This led to systems infrastructure, supply chain, and skill base

challenges when coupled with the difficulty in access to government facilities. In addition to these factors, there have been few new large-scale propulsion system development programs. Frequent program starts and cancellations, in both civil and military propulsion, resulted in a general loss of competitiveness for the U.S. rocket propulsion industrial base in the global market.

Common themes in the studies also highlighted workforce-related issues stemming from the aforementioned policy issues. The aging workforce coupled with a lack of sustained technology development resulted in fewer engineers with the necessary technology development experience. The overall decline in aerospace engineering demand has further exacerbated the loss of competitiveness for the propulsion community in the global market. The lack of new engineers and scientists in the rocket propulsion industry has created significant knowledge management problems as experienced personnel retire.

## Strategy Development

After conducting the study reviews, the NIRPS team implemented a two-step process to address these common themes affecting the U.S. rocket propulsion industrial base. First, the team held a strategy meeting with representatives from NASA, DoD, industry, academia, and others to discuss the study reviews and their individual perspectives on the issues facing the rocket propulsion industry. In this session, some common key needs emerged. These needs contributed to the creation of the NIRPS Grand Challenges, the formulation of which is illustrated in Figure 1.



**Figure 1.** Derivation of the Grand Challenges from the Key Needs Identified

### **Key Identified Needs Competitiveness and resilience of the propulsion industrial base**

- An integrated science and technology plan;
- Better collaboration across agencies for propulsion systems development;
- Better and easier access to government facilities and expertise;
- Revitalized STEM pipeline; *and*
- Reduction of development and sustainment cost for propulsion components and systems.

### **Grand Challenges**

- Reduce development and sustainment costs for missile and rocket systems;
- Support the competitiveness and resilience of the industrial base;
- Foster access to facilities and expertise across government, industry, and academia;
- Develop and implement an integrated science and technology plan for propulsion systems;
- Invigorate the STEM pipeline; *and*
- Collaborate across agencies for missile and rocket propulsion system development.

Although some of the results of the industrial base studies were well known and anticipated, the studies showed that the NIRPS Grand Challenges effectively describe the problems facing the propulsion industry and provide a resolution path. The key finding of all of the studies and the driving factor behind the Grand Challenges is the rapid loss of global competitiveness of the U.S. rocket propulsion industry. Continuation or worsening of this condition will have adverse effects for the United States in numerous areas, including economic performance, scientific discovery, and national security. The overarching goal of NIRPS is to strengthen the global competitiveness of the U.S. rocket propulsion industry.

While the initial derivation of the Grand Challenges identified the key areas of focus, the NIRPS team wanted to ensure that these focus areas complemented and enhanced the work of other rocket propulsion forums, societies, and working groups that were already active. The NIRPS team performed a systematic analysis of these existing forums and the support they provide to the propulsion community. The chart found in Appendix B summarizes the results of this analysis and shows how the existing forums currently address the national needs. This analysis clearly shows the need for a capability to integrate across these existing forums and to serve as a “gap-filler”, addressing open needs. NIRPS will complement these forums and provide value to the national capability to develop, manufacture, and operate propulsion systems.

## **NIRPS Operational Model**

NIRPS is a multi-agency, multi-sector organization that is government-led and includes participation from industry and academia. NIRPS operates as a collaborative organization that leverages the knowledge and capabilities of many agencies including DoD, NRO, and the FAA, industry, and academia. The government agencies require rocket propulsion technology and support research. The industrial base provides the development and manufacturing capabilities. Academia ensures a continuous supply of skilled workers. Operating primarily as a virtual organization, the Institute draws on the resources and capabilities of the nation’s rocket propulsion industrial base.

### **Internal NASA MSFC Organization/NIRPS Core Team**

NASA’s Marshall Space Flight Center (MSFC), as the host organization for NIRPS during formulation and early operations, has formed a core team to:

- Perform the initial strategic planning and organizational formulation of NIRPS;
- Manage the current day-to-day operations;
- Coordinate the strategic teams; *and*
- Manage NIRPS activities for the NASA Program, Planning, and Budget Execution (PPBE) Process.



The organization of the core team is intentionally lean and draws from other MFSC or NASA personnel as needed.

## Strategy Teams

NIRPS formed three strategic teams to address the Grand Challenges facing the U.S. rocket propulsion industrial base as identified by the numerous studies, recognizing that many of these challenges overlap to a degree. Each team is coordinated by a team lead and consists of members from government, industry, and academia. The three strategic teams and their primary mission and areas of focus are:

**Stewardship Team** – to define, create and implement a roadmap to achieve a unified DoD/NASA policy that supports a healthy industrial base. This team monitors and analyzes the state of the rocket propulsion industry and recommends National Policy options and strategies that strengthen the industrial base and ensure value for the American taxpayer.

**Technology Team** – to improve the visibility of propulsion-related STEM opportunities, provide visibility of advance propulsion work and technologies, develop and implement a science and technology plan to facilitate national efforts, and identify methods to transition technology to flight and practical applications. This team identifies technology needs and recommends technology insertions by leading roadmap assessments and participating in program formulation activities.

**Solutions Facilitator Team** – to communicate skills and capabilities, communicate projects and activities, streamline facilitation mechanisms, and provide skills and capabilities assessments. This team maintains relationships and awareness across the government, industry, and academia to align available capacity with emerging demand.

Figure 2 shows the NIRPS organization including the three strategic teams:

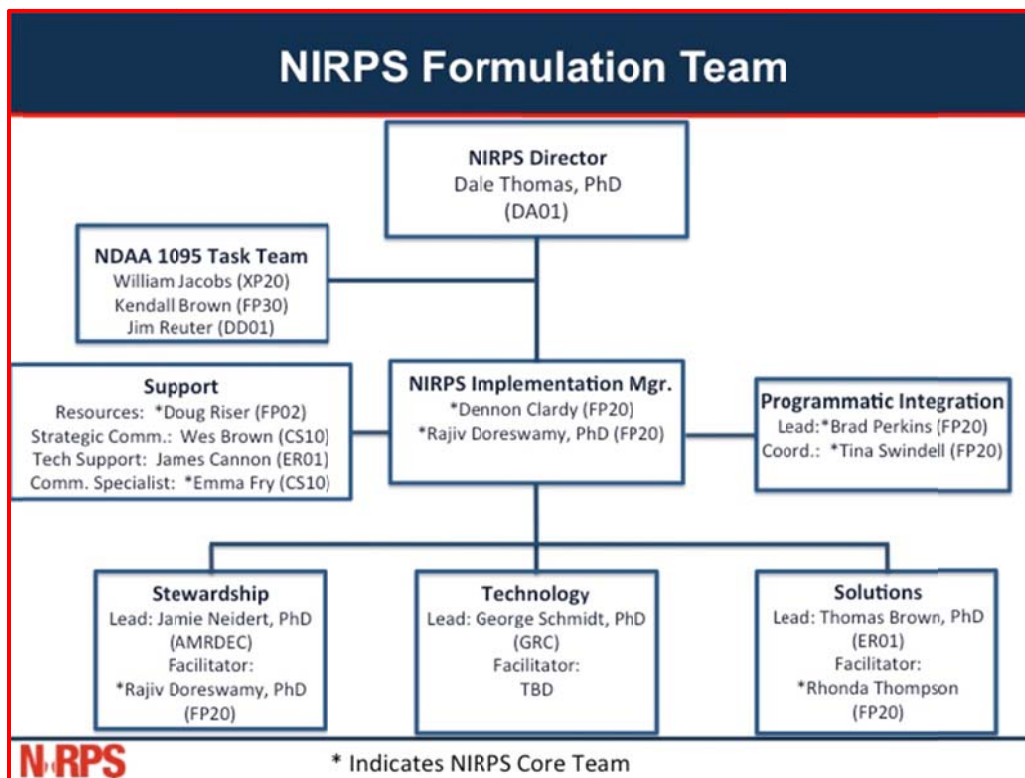


Figure 2. NIRPS Formulation Team

The three strategic teams depicted in Figure 2 perform tasks to address the Grand Challenges facing the U.S. propulsion industrial base and ensure collaboration across the propulsion ecosystem. Each team leader is a recognized expert in his or her area and part of the NIRPS execution team. The facilitators perform day-to-day coordination and integration of team activities as well as budget integration and planning for the NASA budget process, in conjunction with the rest of the NIRPS core team. These team leads also develop action plans, and report status, achievements, and issues to the NIRPS director.

The Grand Challenges mapped across the strategic teams are reflected in Figure 3. While all of the Grand Challenges will be addressed by each of the strategic teams, it is important to note that each team will lead efforts in its areas of primary responsibility and contribute in the other areas as illustrated.

<b>Inter-relationships of Grand Challenges</b>			
<b>Grand Challenge</b>	<b>Stewardship</b>	<b>Technology</b>	<b>Solutions Facilitator</b>
Support the competitiveness and resilience of the industrial base	Primary	Secondary	Secondary
Invigorate the STEM pipeline to Grow Propulsion Systems Expertise	Primary	Secondary	Secondary
Develop and implement an integrated science & technology plan for propulsion systems	Secondary	Primary	Secondary
Reduce development and sustainment costs for missile and rocket systems	Secondary	Primary	Secondary
Collaborate across agencies for missile and rocket propulsion system development	Secondary	Secondary	Primary
Foster access to facilities and expertise across Government, industry, and academia	Secondary	Secondary	Primary

**NIRPS** 1

Figure 3. *Inter-relationships of Grand Challenges*

### Planning Team

The NIRPS Planning Team meets monthly and consists of industry, academia, and other government agencies. Its main purpose is to ensure awareness and collaboration of NIRPS planning, strategies, and activities. The Planning Team also provides opportunities for feedback from a broader audience. In 2012, the NIRPS Planning Team membership grew substantially since its formation, and now includes over 185 individuals from over 60 organizations.



## CY12 Goals

In order to track progress and manage the activities of the Institute, the NIRPS team developed a set of goals relating to all aspects of NIRPS operation, including formulation and implementation, outreach and inclusion, and strategic development. The primary goals for calendar year (CY) 2012 were derived from the goals in these three categories, and were the focus for the entire NIRPS team over this time period as shown in Figure 4. The strategic implementation goals were a direct decomposition from the Grand Challenges to the strategies and objectives of each team. The primary strategic implementation goals were based on the importance of the task, available resources, and achievability. NIRPS leadership and the core team determined the other primary goals for the Institute to operate effectively and efficiently.

Category	Goal	EOY
<b>NIRPS Strategic Development</b>	Articulate National Charter <sup>1</sup>	G
	Establish Governing Body <sup>1</sup>	Y
	Develop 5-year plan <sup>1</sup>	G
<b>NIRPS Outreach &amp; Inclusion</b>	Establish reporting mechanisms consistent with governance model <sup>1</sup>	Y
	Formalize partnerships with other government agencies <sup>1</sup>	Y
	Investigate and address FACA requirements <sup>2</sup>	B
	Hold workshop/annual meeting <sup>2</sup>	B
	Sponsor publications <sup>3</sup>	B
	Enhance web presence <sup>3</sup>	B
<b>NIRPS Strategies Implementation</b>	Develop strategies to address the Grand Challenges <sup>2</sup>	B
	Conduct propulsion studies assessment <sup>2</sup>	B
	Develop a series of metrics to measure health of the industrial base <sup>4</sup>	G
	Understand ramifications of declining industrial base on the ability to maintain DoD & NASA propulsion current needs <sup>4</sup>	G
	Ease access to government skills/capabilities <sup>1</sup>	G
	Demonstrate cooperative efforts across multiple agencies <sup>1</sup>	G
	Use existing roadmaps from government agencies to create an integrated propulsion roadmap <sup>1</sup>	G
	Identify demonstrator / workhorse assets that provide infrastructure and accessibility for an affordable technology transition bridge <sup>1</sup>	Y
<b>NDAAs 1095</b>	Support NDAAs 1095: National Rocket Propulsion Strategy <sup>2</sup>	B

### Legend

B	Completed
G	In Progress
Y	Have started; known challenges exist

### Notes:

- 1 – Efforts began to address these goals in 2012 and approaches are being developed to more fully address them in 2013.  
 2 – Goals were completed.  
 3 – Progress in addressing these goals was sufficient to meet expectations at year-end. Additional progress on these will continue in 2013.  
 4 – Data are needed to perform the analyses necessary to effectively address these goals. Data from the Department of Commerce “Deep Dive” Survey and the NIRPS Stewardship Team Industrial Base Health Metrics Survey will feed the analyses associated with these goals but was not available in time to complete in 2012. Effort will continue in 2013.

Figure 4. CY12 Goals

While some of the CY12 goals remain incomplete in 2012, the team made significant progress. Additionally, the team completed major accomplishments that were not anticipated at the beginning of the NIRPS formulation activity. Key among these was the Red Team Review, which was a self-imposed review by an independent NASA panel. The team identified key partnership opportunities with the US Air Force for both upper stage and booster engines and successfully championed this partnership. The team also took advantage of its inter-governmental viewpoint to help develop a coordinated plan to procure ammonium perchlorate, a key ingredient in solid rockets. Finally, NIRPS worked with the Army and NASA to coordinate individual purchases, this enabled the producer to accurately forecast demand and adjust production, resulting in a favorable outcome, for both the contractor and the Government.

Collectively, the goals serve a valuable purpose in communicating to the broader community what the NIRPS team intends to accomplish and keeping the team focused. The process of setting and striving for goals for CY12 helped establish NIRPS as a functioning organization and continues to help the Institute make significant progress in addressing the Grand Challenges. The NIRPS team has learned several valuable lessons from this process that were incorporated into the establishment of goals for 2013.

## Accomplishments

The initial concept of NIRPS as a multi-sector, multi-agency organization focusing on rocket propulsion systems transitioned to a functional, efficient organization making a meaningful contribution to the overall health, competitiveness, and viability of the U.S. rocket propulsion industry. Figure 5 outlines the NIRPS path from formulation to its current operational model and identifies key milestones throughout the period.

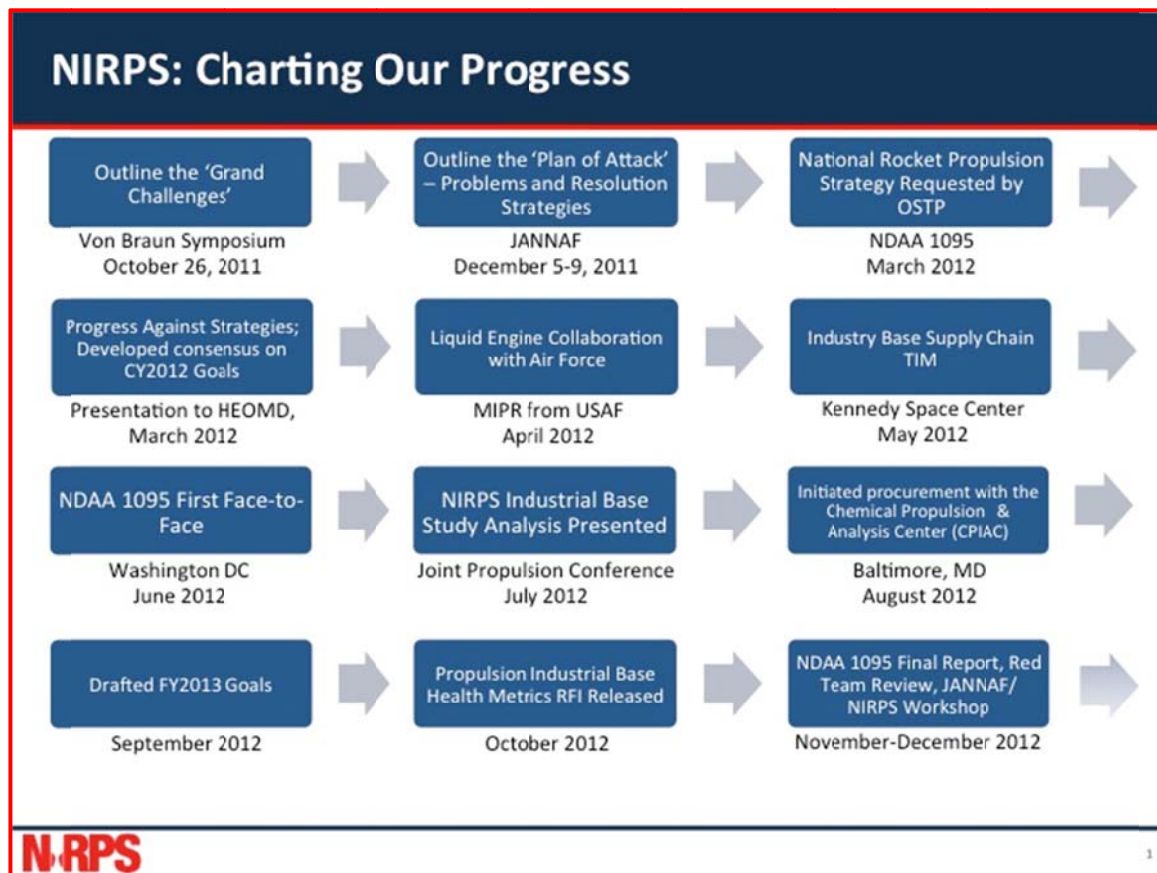


Figure 5. NIRPS: Charting Our Progress

## **NIRPS Team Accomplishments**

The successful initial year is highlighted by the accomplishments of the NIRPS Core, Planning, and Strategy Teams outlined below.

### **Core Team**

NIRPS crossed multiple milestones in CY12 by successfully addressing the Grand Challenges, continuing to increase capabilities, and maturing as a national resource. Key milestones of the Core team included:

- Identification of the propulsion Grand Challenges, including a comprehensive and systematic review of existing studies on the propulsion system industrial base and infrastructure;
- Establishment of three integrated strategy teams, with membership from the U.S. Government, industry, and leading academic institutions;
- Development of integrated strategies and objectives that address all Grand Challenges and encompass the activities of all three strategy teams;
- Establishment of a core team to manage day-to-day activities and coordinate actions across the propulsion industry;
- Completion of the FY13 NASA Program, Planning, and Budget Execution (PPBE) process, developing a capability for future budget cycles;
- Publication of technical papers and an outreach presence at key industry meetings such as the AIAA Joint Propulsion Conference, National Defense Industrial Association, and the Space and Missile Defense Conference (SMDC);
- Development of the National Rocket Propulsion Strategy as the leader of the Interagency Task Team (IATT) developing the response to the 2012 National Defense Authorization Act (NDAA), Section 1095, language;
- Leadership of MSFC efforts in responding to the Department of Commerce (DoC) “Deep Dive” survey of the U.S. Space Industry; *and*
- Planned and executed both the NASA Red Team Review in November 2012 and the NIRPS Annual Workshop at the JANNAF Conference in December 2012.

### **Stewardship Team**

The Stewardship team, which is focused on the health and preservation of the rocket propulsion industrial base, emphasized collecting data and developing metrics to gauge the health of the industrial base, as well as building tools to map and analyze supply chains. In the first year of operations, the Stewardship team accomplished the following:

- Developed and approved metrics for determining the health of the U.S. Rocket Propulsion Industrial Base (RPIB);
- Developed a survey to collect data for Industrial Base Health Metrics (Released: 22 October 2012; input deadline: 22 January 2013);
- Supported the Industrial Base Working Group (IBWG) sponsored by NASA HQ;
- Through USG members of the Team, provided key support to the NDAA 1095 Interagency Task Team (IATT);
- Led MSFC efforts in responding to the DoC “Deep Dive” survey of the U.S. Space Industry; *and*
- Initiated Supply Chain Mapping for Liquid Rocket Engines in cooperation with MSFC Engines Project Office and Pratt and Whitney/Rocketdyne (PWR).

### **Solutions Facilitator Team**

The Solutions Facilitator team, which is focused on maintaining relationships and facilitating collaboration between agencies, had a successful first year. One CY12 goal for the team was to “Demonstrate cooperative efforts across multiple agencies” with a subtask of “Compile and maintain a complete list of existing and potential collaboration activities using a web-based tool.” Both the CY12 goal and subtask were successfully addressed as follows:

- **USAF/NASA Engine Collaborations** (illustrated in Figure 6)
  - **USAF/NASA Upper Stage Engine:** The team facilitated a partnership between NASA and United States Air Force (USAF) Space and Missile Systems Center's (SMC) Launch Systems Directorate (LR) on SLS Advanced Development NRA. USAF resources were leveraged to increase the total amount of NRA awards and USAF personnel were included in planning, solicitation, and evaluation, and assuring the inclusion of critical AUSEP activities. NASA and USAF continue to collaborate on the execution of awarded efforts.
  - **USAF/NASA Booster Engine:** The team supported a potential collaboration between NASA, SLS, and USAF SMC on SLS Advanced Booster NRA. A potential collaboration between NASA, SLS, and the AFRL Hydrocarbon Boost Program is still in the planning stages.

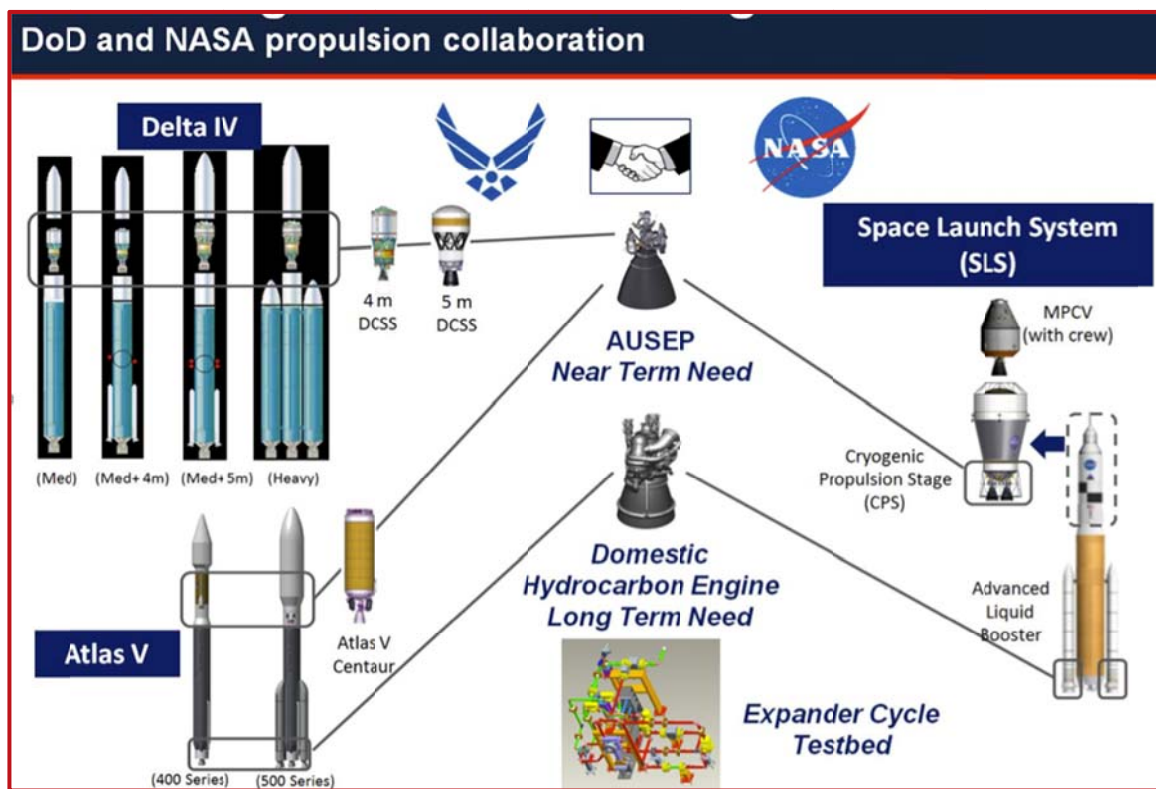


Figure 6. DoD and NASA Propulsion Collaborations

- **MDA/NASA Propulsion System Collaboration:** The team provided a bridge to enable uninterrupted support to MDA through funding transition and supported/augmented NASA/MDA collaboration on MDA thruster system test failure at WSTF. The team also leveraged unique experience with modeling high-frequency response using finite elements.
- **STEM Support:** The team supported continued development and university use of the MSFC Generalized Fluid System Simulation Program (GFSSP) - Student Version, in support of fluid dynamics education and student design projects.
- **Cross-Cutting Collaborative Solutions:** The team formulated tasks that served as a point-of-departure for a cross-cutting collaborative solutions team. Examples included the MDA effort, additive manufacture of propulsion components (of interest to USAF and NASA) and efforts to support propulsion-related studies and projects at universities.

Another CY12 goal of the Solutions Facilitator team was to “Foster access to facilities and expertise across Government, industry, and academia”. One barrier to accessing government skills and capabilities is limited or no knowledge of what is available or how to pursue the access. Therefore, the Solutions Facilitator Team procured the services of the Chemical Propulsion Information Analysis Center (CPIAC) to develop the skills and capabilities database/directory. This directory will be part of a broader online collaborative portal. The team completed milestones in support of this goal including:

- Solicited initial data from government, academia, and industry members of the Solutions Facilitator team to start populating the skills and capabilities database;
- Defined web management requirements; *and*
- Developed a static representation of the skills and capabilities architecture.

The static storyboard for this skills and capabilities database was presented at the 2012 December JANNAF/NIRPS workshop. Comments were solicited from workshop attendees. The storyboard allowed potential users to view how data is categorized, accessed, and the type of information available. The initial steps in developing the online collaboration portal have been completed and address the CY12 Goal – “Ease Access to Government Skills and Capabilities”. The objective of this CY12 Goal will be further addressed in the FY13 Goals.

### **Technology Team**

The Technology team is focused on understanding individual and common propulsion technology needs to formulate an integrated government investment strategy based on synergies and mutual benefit. In its first year of operations the Technology team concentrated on the National Propulsion Science and Technology roadmap processes, products, and requirements. A gap assessment identified areas of need and potential coordination.

The DoD, NASA, and industry are investing in critical technologies that comprise individual roadmaps. Integration has occurred in some technology roadmaps, but more could be achieved by identifying additional opportunities to collaborate for meeting mutual objectives. An integrated technology development roadmap that addresses the needs of the nation would provide:

- A shared understanding of individual technology needs;
- An integrated database of common goals; *and*
- Increased efficiency / maximized individual technology development investments.

NIRPS recommends taking a national perspective with regard to propulsion technology. This would be an integrated propulsion story, which accommodates the long- and near-term views. For example, an Integrated High Payoff Rocket Propulsion Technology (IHRPT)\* organizational plan or roadmap serves as a time-tested approach for long-term technology investments. The NASA perspective serves in the near-term. The two serve as an integrated government propulsion technology story. This will provide easier communications and planning within the government and with industry and academia. The result will be an Integrated National Propulsion Roadmap capturing the synergies available from DoD, NASA, industry, and academia.

The NIRPS team presented possible actions at the JANNAF/NIRPS workshop in Monterey, CA:

- MSFC and AFRL conduct working session to integrate NASA roadmaps with IHRPT roadmaps; *and*
- Evaluate NASA roadmaps using the IHRPT GOTCHA process.

With this continued effort, NIRPS is directly addressing a national need:

Maintaining a technical lead in rocket propulsion with the current budget pressures requires maximizing collaboration and resources across the government.



\* IHRPRT has developed a disciplined approach with a long-term view of propulsion technology. The IHRPRT Steering Committee is co-chaired by OSD and NASA MSFC. Propulsion technology development is coordinated with the Air Force, Army, Navy, NASA, and industry. The IHRPRT purview includes liquids, solids, and in-space propulsion. The numerical, goal-driven prioritization used by IHRPRT is a well-established and sound process. The IHRPRT road mapping approach should be leveraged to achieve these objectives.

## NASA Red Team Review

The NASA Red Team Review (an internal NASA review that served as a self-imposed one-year checkpoint for NIRPS activities) was held on November 6, 2012. The Red Team evaluated the accomplishments, assessed the planned activities, identified weaknesses, and recommended appropriate changes for forward planning.

The 2012 NASA Red Team members were:

- **Chair:** Alex Priskos, Manager, Booster Office, Space Launch System
- Garry Lyles, Chief Engineer, Space Launch System
- Preston Jones, Deputy Director, MSFC Engineering Directorate
- Steve Doering, Director, MSFC Center Operations
- Jih-Fen Lei, Director of Research and Technology, Glenn Research Center.

### *Red Team Objectives*

The NASA Red Team's objectives for the review included:

- Assess the current status and plans for NIRPS in terms of appropriateness, clarity, and the potential for the identified *Grand Challenges facing the Propulsion Community* to impact on a national strategic level;
- Assess the adequacy of NIRPS resources, plans, organizational design, and implementation approach;
- Assess the adequate engagement of stakeholders from MSFC, NASA, other Government agencies, industry, and academia; *and*
- Assess the clarity and appropriateness of the overall vision and end-state for NIRPS.

### *Red Team Recommendations*

The successful one-day Red Team Review resulted in several observations and recommendations. Specifically, the team identified five areas where NIRPS should focus its activities. First, the Red Team recommended that NIRPS simplify and focus objectives in the future. The team suggested that NIRPS prioritize activities in both task sets to ensure the most important and highest leveraging tasks receive the appropriate resources. The team also recommended that NIRPS develop an integral connectivity between NIRPS and the NDAA 1095 Study, and noted that performance on NDAA 1095 is critical. The Red Team emphasized that the NDAA 1095 steering committee could potentially become a strong advocate for NIRPS.

Second, the Red Team recommended that NIRPS define the value proposition of the organization by addressing the following questions: “What organizations or entities can NIRPS most effectively assist?” and “How can NIRPS assist and engage all propulsion-related Government Program Executive Offices?”

The third Red Team recommendation was that NIRPS align the structure of the organization with the desired outcome. The Red Team noted that the current structure and membership of the NIRPS strategy teams appears to be “ad hoc” and suggested that NIRPS consider a tiered membership with defined areas of collaboration and decision authority. Additionally, the Red Team recommended that NIRPS consider evaluating various organizational models and specifically define the end-state of NIRPS in 3-5 years.

Fourth, the Red Team recommended that NIRPS develop a process to leverage the NASA Administrator (NIRPS Chartering Authority) as an advocate for the organization. The frequency of this interaction should



likely be more than annual and NIRPS should consider how its function is related to Multi-Agency Forums that include participation from the NASA Administrator.

The Red Team's final recommendation was that NIRPS consider establishing credibility early through current opportunities, suggesting NIRPS could possibly manage the Academic Contract Management Task within the SLS Advanced Development NRA.

While this review was internal, NIRPS plans to conduct a further external review with input from other government agencies, industry, and academia in 2013. The overarching goal of an external Red Team review is for feedback and course correction from a national perspective. NIRPS will address the following issues prior to the external review: the membership of the Red Team and organizations represented, the Red Team Chair, the role of industry and academia, the scope and terms of reference, the date and location, and the process for action item response and closure.

### **National Defense Authorization Act; Section 1095 Summary**

The Congress recognized the distressed state of the propulsion industrial base and the national need to strengthen and maintain it. Section 1095 of the National Defense Authorization Act (NDAA) of 2012, signed by the President on December 31, 2011, required a National Rocket Propulsion Strategy. In March of 2012, the Office of Science and Technology (OSTP) tasked NIRPS to lead in the development of a strategy. This tasking demonstrates OSTP's confidence in NIRPS' mission to coordinate and address propulsion issues on a national level. The NIRPS formed an interagency task team (IATT) to ensure each government stakeholder to perform the study in the study. The IATT, formed with representatives of NASA, U.S. Army, U.S. Air Force, U.S. Navy, MDA, OSD, the NRO, and the FAA, functioned under the guidance of a Senior Steering Group (SSG), consisting of executive and flag-level leadership. The final draft of the Rocket Propulsion Strategy was provided to the Office of Science and Technology Policy (OSTP) in January 2013.

This unprecedented cooperation aligns with NIRPS' mission to foster a vibrant rocket propulsion community that provides reliable and affordable propulsion systems for the nation's defense, civil, and commercial needs.

## **FY13 Goals**

FY13 will be a year of consolidation and execution for NIRPS. The Institute will pivot from formulation to operations and will continue to add real value to the U.S. rocket propulsion community. The NIRPS team has identified the following strategic needs, execution priorities, and challenges to be addressed in FY13:

### **Strategic Needs**

- Formalize agreements with other U.S. Government agencies;
- Determine interim- and end-states of NIRPS;
- Respond and react to NDAA section 1095 outcomes;
- Develop a STEM strategy and execution plan; *and*
- Effectively communicate the value and accomplishments of NIRPS across NASA, Government, and the propulsion community as a whole.

### **Execution Priorities**

- Use NIRPS metrics and DoC data to develop a "State of the Propulsion Industry" report/dashboard;
- Develop supply chain mapping and analyses capabilities to inform SLS and other major architecture decisions;
- Complete initial Integrated Propulsion Science and Technology Roadmap in conjunction with IHRPT (RP21); *and*

- Build initial collaborative capability across the propulsion ecosystem, easing access to U. S. Government facilities, skills, and personnel.

### Challenges

- Effective integration and coordination with other government agencies;
- Continued active engagement with industry and academia; *and*
- Building an efficient and responsive governance system for a growing national Institute.

Taking the progress and completion of the CY12 goals into account, as well as the previously identified strategic needs, execution priorities, and challenges, the NIRPS team has developed primary goals for FY13. These FY13 goals are shown in Figure 7.

Grand Challenges	FY13 Goals	Team
1. Support the Competitiveness and resilience of the industrial Base	1.1 Develop Supply Chain Analysis for SLS Architecture Decisions.	Stewardship
	1.2 Develop Metrics to Determine Health of Industrial Base.	Stewardship
2. Invigorate the STEM pipeline	2.1 Provide engineering students with practical experience utilizing propulsion design and analysis tools and methodologies.	Solutions Facilitator
3. Develop and integrate a science and technology plan for propulsion systems	3.1 Use existing roadmaps to identify opportunities for collaborations and leveraging of complimentary activities.	Technology
4. Reduce development and sustainment costs for missiles and rocket systems	4.1 Conduct a study/survey of low cost technology test beds and/or other methods for transitioning propulsion component /sub-system technologies through the TRL valley of death (TRL 4-6).	Technology
5. Collaborate across agencies for missile and rocket propulsion system development	5.1 Develop initial community of interest capability.	Solutions Facilitator
	5.2 Establish a Cross-Cutting Collaborative Solutions Team that executes tasks of cross community interest, stimulating potential follow-on collaborations.	Solutions Facilitator
6. Foster access to facilities and expertise across Government, industry, and academia	6.1 Develop initial Propulsion Skills and Capabilities Directory & Web Tool.	Solutions Facilitator
	6.2 Complete study of mechanisms for potential pass through process to ease access to cross government skills and capabilities.	Solutions Facilitator
Integrated Goals		
Integrated Goals	IG.1 Develop operational model defining management concepts, operating principles and framework, and high-level goals including a concept of management oversight for periodic evaluation.	Integrated
	IG.2 Develop a comprehensive Strategic Communications Plan that addresses external and internal stakeholders, interactive websites, and outreach planning for public, STEM, and Agency/Industry engagement.	Integrated
	IG.3 Establish a National Charter	Integrated

Figure 7. FY13 Goals

## Five-Year Strategy

The NIRPS team continues to formulate a strategic operational model and desired end-state for the Institute. The outcome of the NDAA section 1095 report will further guide NIRPS in this direction. Pending the results of the report and any subsequent related tasks, NIRPS has formulated a strategic operational model for the coming five-year period as shown in Figure 8.



Figure 8. NIRPS Notional Strategic Operational Model 2012-2017

## Conclusion

Since the formation of NIRPS in May 2011, the Institute has attracted multiple government, industry, and academic partners across the country. The Institute is establishing itself as a forum and resource for collaboration and integration among all sectors of the U.S. propulsion industrial base, supporting policy development options, identifying technology requirements, and offering solutions that make best use of available national resources to meet future demand. As a multi-agency organization, NIRPS provides comprehensive factual information to policymakers about all issues affecting the propulsion industry.

The Institute is currently building a capability to perform analyses on the industrial base, developing tools to aid collaboration, and interfacing with existing technology development forums throughout the government. These capabilities and tools will enable NIRPS to become a multi-agency organization that will provide comprehensive, unbiased information to policymakers on issues affecting the propulsion industry, as well as identifying and facilitating collaborations between government, industry and academia.

NIRPS is a uniquely responsive solution to the current needs of government, industry, and academia. It leverages the capabilities of the entire industry and makes the most efficient use of taxpayer dollars while keeping the United States in the forefront of space exploration, national defense, and commercial competitiveness. Since Administrator Bolden's letter in September of 2011, NIRPS has gone from an idea on a sheet of paper to a working organization, performing tasks of national scale and priority. NIRPS continues to establish itself and its value among the various members in the rocket propulsion community. The community recognizes the need for a coordination and integration function across the U.S. Government's propulsion activities. As NIRPS evolves, it will act as a trusted collaboration agent -- serving as a catalyst for cooperation and coordination -- and as a multi-agency facilitator.

As a result of this initial and productive formulation period, NIRPS is now performing to an executable plan in accordance with the Grand Challenges and adjusting to Center and Agency priorities. NIRPS's leadership role in the NDAA Section 1095 report, a high-priority Government-wide task to develop a National Rocket Propulsion Strategy, continues to provide the Institute with numerous collaborative relationships.

Although challenges remain for building a sustainable Institute, the NIRPS team is committed to addressing the concerns of the rocket propulsion community. The Institute will continue this work in 2013 and beyond as the operational model and strategic direction become more defined.

## Appendix A – Letter from the Administrator

National Aeronautics and Space Administration  
Office of the Administrator  
Washington, DC 20546-0001

SEP 16 2011



TO: Officials-in-Charge of Headquarters Offices  
Directors, NASA Centers

FROM: Administrator

SUBJECT: Intent to Establish a National Institute for Rocket Propulsion System

Last October, the Secretary of the Air Force, the Director of the National Reconnaissance Office, and I jointly signed a Letter of Intent that signified our commitment to collaborate in multiple areas including the development of a coherent Government strategy aimed at preserving our Nation's rocket propulsion industrial base. Over the past several months, representatives from each of these organizations have had the opportunity to discuss areas of mutual interest as outlined in the Letter of Intent. While still ongoing, these discussions have identified the need for a recognized entity to serve as the Nation's integration point for matters pertaining to rocket propulsion systems.

Fundamentally, it is envisioned that the mission of this organization will be to help preserve and align Government and private rocket propulsion capabilities to meet present and future U.S. commercial, civil, and defense space needs, while providing authoritative insight and recommendations to national decisional authorities. To accomplish this mission, specific efforts of the proposed organization may include the following:

1. Monitoring and analyzing the state of the industry in order to inform policy leaders on options and strategies that promote a healthy industrial base and ensure best-value for the American taxpayer.
2. Identifying technology needs and recommending technology insertions by leading roadmap assessments and actively participating in program formulation activities.
3. Maintaining relationships and awareness across the industry to match requirement holders with the most relevant solution approach.

In order to support this need, I have asked the Marshall Space Flight Center Director, Mr. Robert Lightfoot, to lead this Agency's efforts in the joint definition and establishment of a National Institute for Rocket Propulsion Systems in cooperation with the Department of the Air Force and the National Reconnaissance Office.

It is my belief that this institute will be a strategic asset that better prepares NASA and other Government agencies to plan and nurture future national propulsion needs and ensures that commercial industry is ready to fulfill those needs. Your support and cooperation with Mr. Lightfoot and his staff regarding this matter are greatly appreciated.

  
Charles F. Bolden, Jr.



## Appendix B – Forums Assessment Summary

Forums Assessment								
National Needs Forums	Forum for Collaboration (Technical Exchange/ Teaming/ Partnership)	STEM	Technology Roadmap Assessments	Recurring Industrial Base Assessments (Corporations, Facilities, Infrastructure, Obsolescence)	Access to Engineering Resources to Address Problems	Coordination and Synchronization of Government Investments	Scenario Analysis (in Support of Acquisition Strategy)	Policy Analysis and Recommendation
<b>Associations/Councils</b>								
JANNAF	Primary	Contributing	Contributing	Not Addressed	Not Addressed	Not Addressed	Not Addressed	Not Addressed
AIAA	Primary	Contributing	Not Addressed	Not Addressed	Not Addressed	Not Addressed	Not Addressed	Contributing
AIA	Contributing	Not Addressed	Not Addressed	Contributing	Not Addressed	Not Addressed	Not Addressed	Primary
NDIA	Contributing	Contributing	Not Addressed	Not Addressed	Not Addressed	Not Addressed	Not Addressed	Contributing
SIBC	Not Addressed	Not Addressed	Not Addressed	Primary	Not Addressed	Not Addressed	Not Addressed	Primary
<b>Sponsored Programs</b>								
RP21 (IHPRPT)	Contributing	Contributing	Primary	Not Addressed	Not Addressed	Primary	Not Addressed	Not Addressed
NRPTA	Primary	Not Addressed	Not Addressed	Not Addressed	Primary	Primary	Contributing	Not Addressed
XUIP (CUIP)	Not Addressed	Primary	Not Addressed	Not Addressed	Contributing	Not Addressed	Not Addressed	Not Addressed
<b>Needs Assessment</b>								
	Forum for Collaboration (Technical Exchange/ Teaming/ Partnership)	STEM	Technology Roadmap Assessments	Recurring Industrial Base Assessments (Corporations, Facilities, Infrastructure, Obsolescence)	Access to Engineering Resources to Address Problems	Coordination and Synchronization of Government Investments	Scenario Analysis (in Support of Acquisition Strategy)	Policy Analysis and Recommendation
<b>Aggregate Assessment</b>	<b>Well Addressed</b>	<b>Slightly Addressed</b>	<b>Moderately Addressed</b>	<b>Slightly Addressed</b>	<b>Slightly Addressed</b>	<b>Slightly Addressed</b>	<b>Slightly Addressed</b>	<b>Moderately Addressed</b>
<p>NIRPS will address open needs and coordinate across the domains.</p>								
<b>Legend</b>								
<b>Primary</b>		A key activity or organization that supports the national need in this area.						
<b>Contributing</b>		An activity or organization that offers opportunities to help support the national need in this area.						
		<b>Addresses Entire Sector</b>						
		<b>Addresses Multiple Sectors</b>						
		<b>Addresses Small Sector</b>						



## Appendix C – Glossary of Abbreviations

<b>ABET</b>	Accreditation Board for Engineering and Technology
<b>AFRL</b>	U.S. Air Force Research Laboratory
<b>AIA</b>	Aerospace Industries Association
<b>AIAA</b>	American Institute of Aeronautics and Astronautics
<b>AMRDEC</b>	Aviation & Missile Research, Development, & Engineering Center
<b>AUSEP</b>	Affordable Upper Stage Engine Program
<b>CPAIC</b>	Chemical Propulsion
<b>CY12</b>	Calendar Year 2012
<b>DoC</b>	Department of Commerce
<b>DoD</b>	Department of Defense
<b>FAA</b>	Federal Aviation Administration
<b>FY13</b>	Fiscal Year 2013
<b>GFSSP</b>	Generalized Fluid System Simulation Program
<b>HEOMD</b>	NASA's Human Exploration Operations Mission Directorate
<b>IATT</b>	Interagency Task Team
<b>IBWG</b>	Industrial Base Working Group
<b>IHPRPT</b>	Integrated High Payoff Rocket Propulsion Technology
<b>JANNAF</b>	Joint Army, Navy, NASA, Air Force, Interagency Propulsion Committee
<b>LOA</b>	Letter of Agreement
<b>LRSC</b>	LOX Rich Staged Combustion
<b>MDA</b>	Missile Defense Agency
<b>MIPR</b>	Military Interdepartmental Purchase Request
<b>MOU</b>	Memorandum of Understanding
<b>MSFC</b>	Marshall Space Flight Center
<b>NDAA 1095</b>	National Defense Authorization Act, Section 1095
<b>NDIA</b>	National Defense Industries Association
<b>NIRPS</b>	National Institute for Rocket Propulsion Systems
<b>NRA</b>	NASA Research Announcement
<b>NRO</b>	National Reconnaissance Office
<b>NRPTA</b>	National Rocket Propulsion Test Alliance
<b>PPBE</b>	Program, Planning, and Budget Execution
<b>PWR</b>	Pratt & Whitney Rocketdyne
<b>RPIB</b>	Rocket Propulsion Industrial Base
<b>SIBC</b>	Space Industrial Base Council
<b>SLS</b>	Space Launch System
<b>SMC</b>	Space & Missile Center
<b>SMDC</b>	Space and Missile Defense Conference
<b>STEM</b>	Science, Technology, Engineering, and Mathematics
<b>TRL</b>	Technology Readiness Level
<b>USG</b>	U.S. Government
<b>XUIP (CUIP)</b>	Constellation University Institutes Project