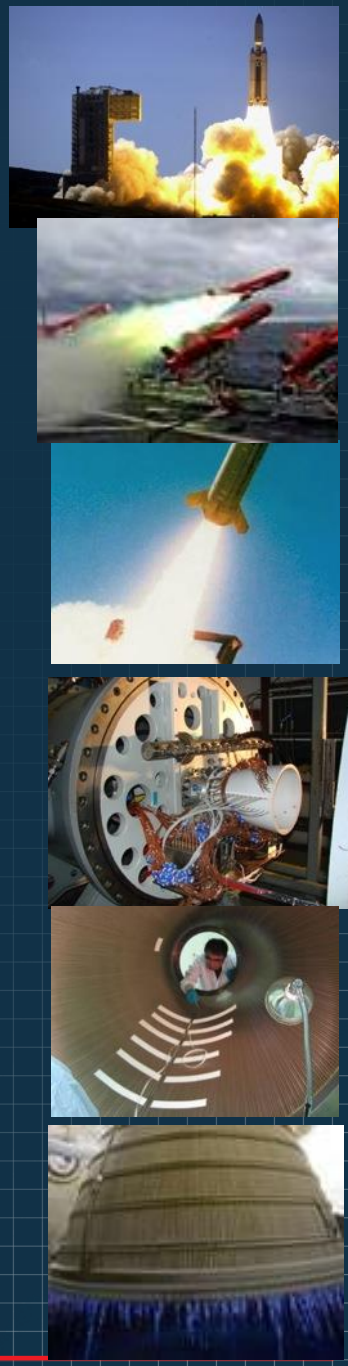
NATIONAL INSTITUTE FOR ROCKET PROPULSION SYSTEMS

NIRPS Planning Team

July 8, 2014

Rajiv Doreswamy Ph. D.



Agenda

- Congressional/Executive Interest in Rocket Propulsion
- COA AoA & JANNAF PIB Recommendation
- JANNAF PIB Implementation
- NIRPS Supply Chain Analyses
- JANNAF/NIRPS Additive Manufacturing TIM
- Upcoming Events

Congressional and Executive Office Concern About Rocket Propulsion Industrial Base

- 2008 NASA Authorization Act 1119
  - OSTP report to Congress on launch propulsion
- 2010 NDAA, Section 1078 & 2011 NDAA Section 916
  - Requested DoD provide report on the Solid Rocket Motor IB.
- 2011 NDAA, Section 917
  - Requested DoD provide report on the liquid engine IB.
- 2012 NDAA, Section 1095
  - Requested the President provide report on liquid engine and solid motor IB after retirement of Shuttle and transition of Constellation.
  - OSTP requested additional study on altitude engine test facilities.

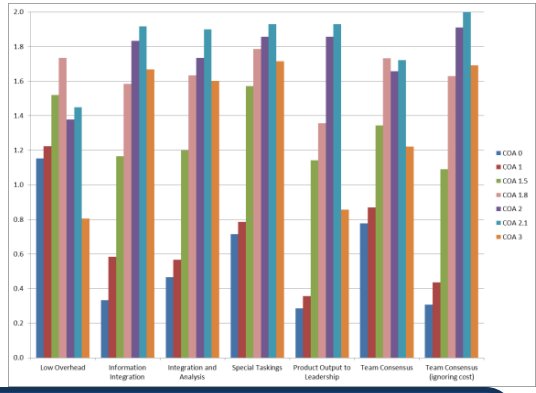
Rocket Propulsion Industry is Very Interconnected with the Agencies and Departments of the U.S. Government

Evaluation and Findings of COA's

- Performed rigorous systems engineering analytical decision process
- Figures of Merit (FOM) identified
- FOM sensitivity analysis performed
- Findings
  - Minimal overhead, structure, and resources highly desired.
  - Status Quo NOT a recommended option under any scenario.
    - Inadequate and unresponsive collaboration.
  - JANNAF-based approach recommended as best value.

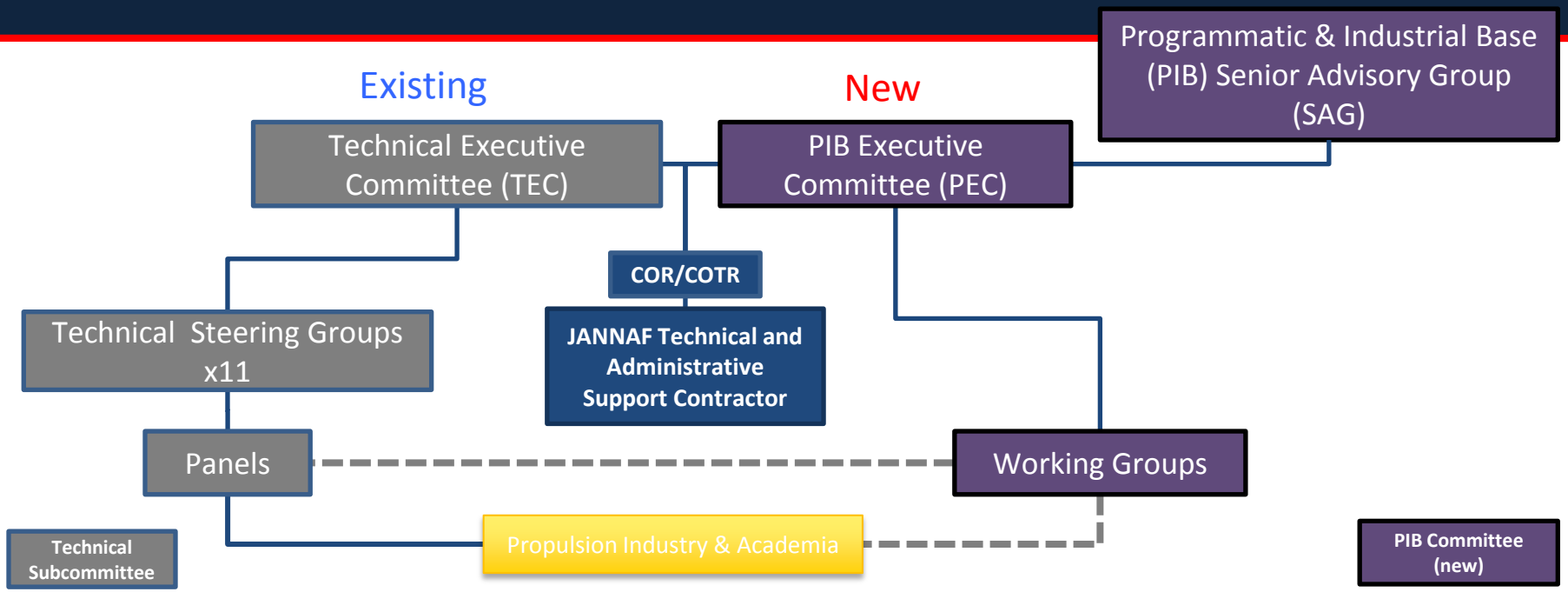
		Weighting										Statistics			Sensitivities					
	Products, Activities, & Key Characteristics	K. Brown	B. Gibson	B. Read	B. Barnes	S. Bluehill	R. Dorcsweny	S. Chaundry	D. Trist	J. Nedder	K. Sharp	D. DeGeorge	average	median	low	high	Sensitivity 1	Sensitivity 2	Sensitivity 3	Sensitivity 4	Sensitivity 5	Sensitivity 6
Integration of Information Processes	a. Integrated program plans and key decision points	20	10	10	20	15	10	10	15	15	80	20	16	15	10	30	7	25	10	7	7	15	15
	b. Industrial base assessments	12	5	5	10	10	10	5	10	10	10	10	9	10	5	12	7	25	10	7	7	10	10
Integration and Analysis	c. Risks and opportunities with respect to skills, knowledge, and experience.	5	10	5	5	10	5	10	10	10	5	15	8	10	5	10	7	8	17	7	7	10	10
	d. Identification of commonality, innovative acquisition, and partnership	12	20	25	10	10	15	15	15	20	80	10	17	15	12	30	7	8	17	7	7	17	17
	e. Integrated assessment to identify RPIB rationalization opportunities	5	5	5	5	10	10	10	10	10	5	5	7	5	5	10	7	8	17	7	7	7	7
Special Taskings	f. Special actions from senior agency, department, or EOP leadership	10	10	5	5	5	10	5	10	10	5	5	7	5	5	10	7	8	10	50	7	7	7
Output	g. Provides decision makers information for either situational awareness or actual decisions in a timely and efficient manner	18	5	10	10	15	15	10	15	10	10	10	12	10	10	18	7	8	10	7	50	12	12
Resources	h. Low Overhead	10	30	30	80	20	20	25	10	10	0	25	19	20	0	30	50	8	10	7	7	20	0
	total	92	95	95	95	95	95	90	95	95	95	100	95	90	52	150	100	100	100	100	100	98	78

Product, Actitivity, or Characteristic	COA 0	COA 1	COA 1.5	COA 2	COA 2.1	COA 3	COA 1.8
a. Integrated program plans and key decision points	0	0	1	2	2	2	2
b. Industrial base assessments	0	1	1	2	2	2	1
c. Risks and opportunities with respect to skills, knowledge, and experience.	0	0	1	2	2	2	2
d. Identification of commonality, innovative acquisition, and partnership opportunities	1	1	1	2	2	2	2
e. Integrated assessment to identify RPIB rationalization opportunities	0	0	1	1	2	2	1
f. Special actions from senior agency, department, or EOP leadership	1	1	2	2	2	2	2
g. Provides decision makers information for either situational awareness or actual decisions in a timely and efficient manner	0	0	1	2	2	0	1
h. Low Overhead	2	2	2	1	1	0	2



JANNAF Programmatic and Industrial Base Committee Recommendation Approved by the NDAA 1095 Senior Steering Group on 22 July 2013

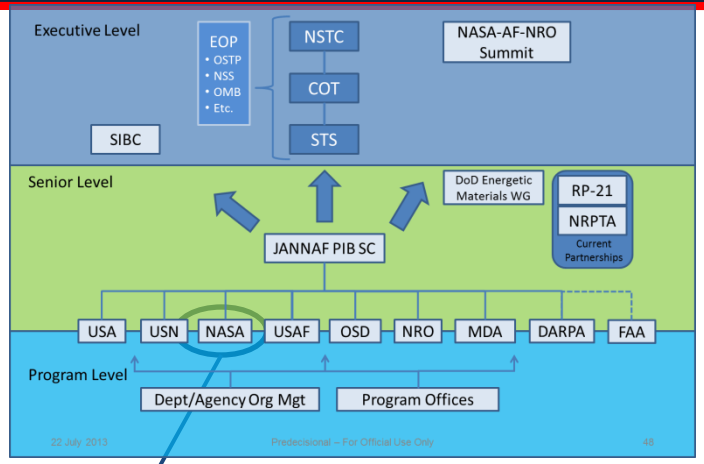
New JANNAF Operational Structure

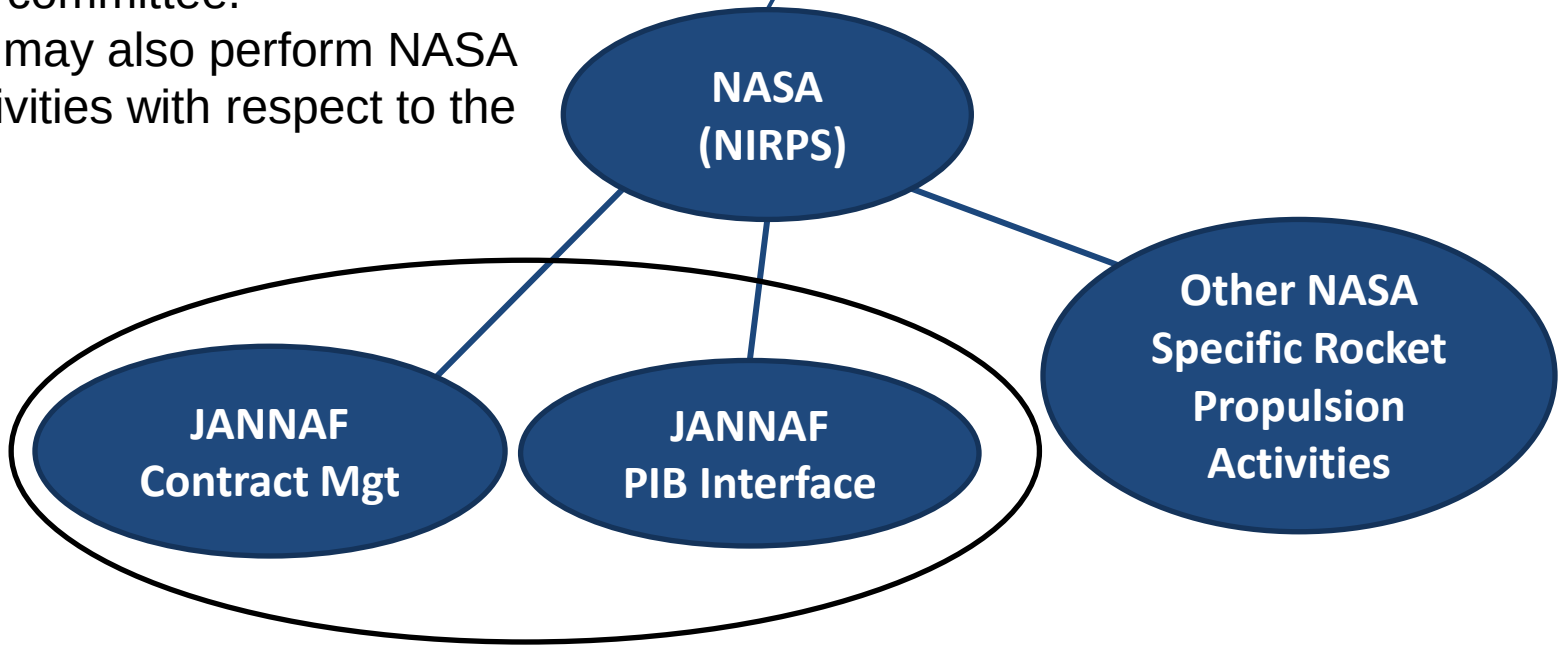


- Preexisting JANNAF 'technical' activities are not affected.
- Inclusion of Programmatic and Industrial Base Committee leverages existing JANNAF framework.
- New PIB functions require PEO/Program Office participation, which is a different group than traditional JANNAF.
- PIB Senior Advisory Group is at the PEO/PO/Command flag officer-level senior leaders/managers.
- PEC members represent key program, project, and IB stakeholders.
- Working Groups formed to address specific areas, permanent and ad hoc.

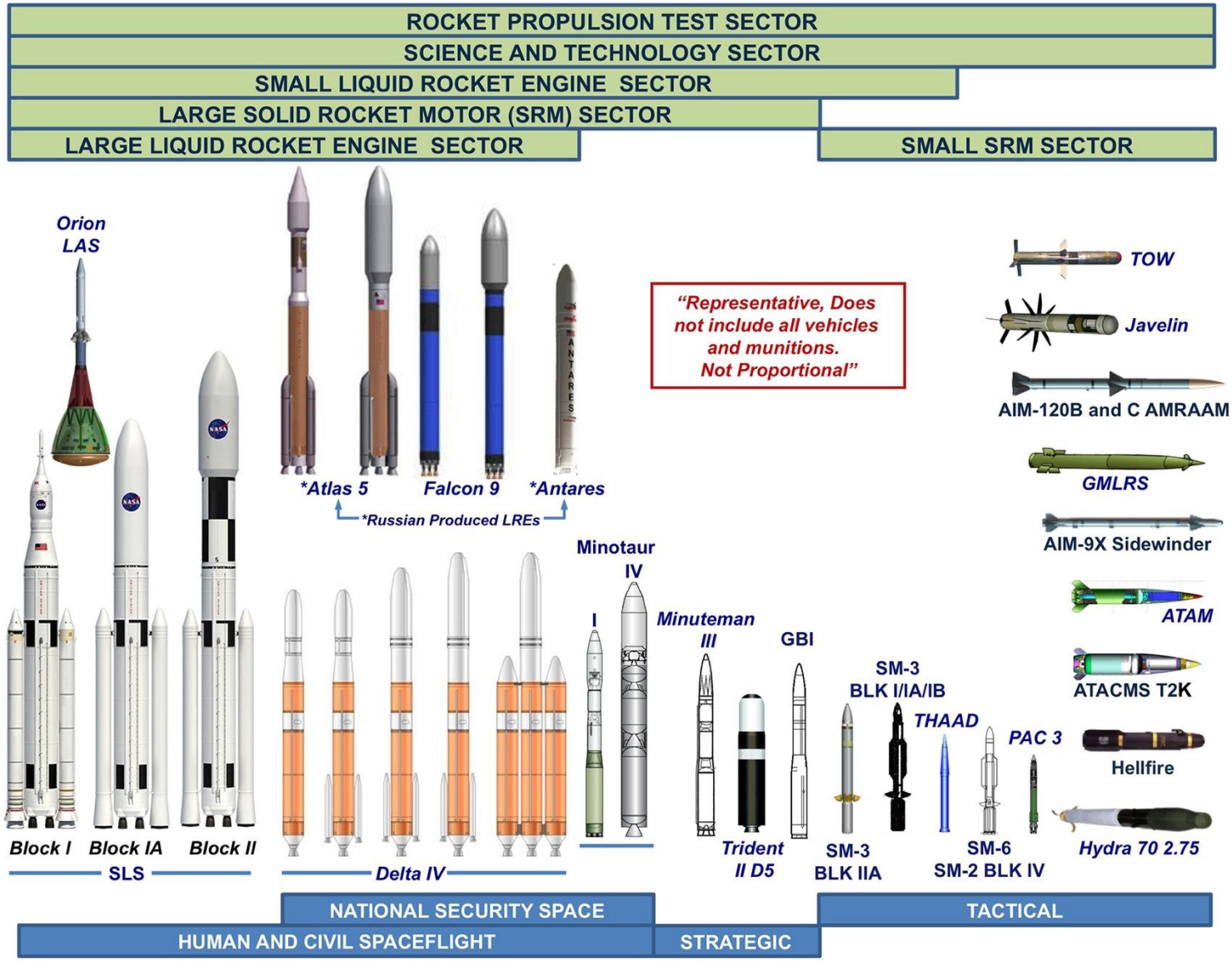
NASA JANNAF Support

- NASA will provide integrated support to Interagency Propulsion Activities.
- An office at NASA MSFC will coordinate NASA's input to the JANNAF PIB.
- NASA providing contract management personnel for new JANNAF contract as institutional support to interagency propulsion committee.
- This office may also perform NASA unique activities with respect to the RPIB.





Rocket Propulsion Applications



Proposed Senior Advisory Group (SAG)

Name	Organization	Title
Dr. Dale Thomas (Co-Chair)	MSFC/DA01	Associate Center Director, Technical, NASA/MSFC
Ms. Elana Broitman (Co-Chair)	DASD (MIBP)	Deputy Assistant Secretary of Defense (Manufacturing and Industrial Base Policy)
Brig Gen Mark Baird	USAF/SMC	Executive Director for Space Launch Enterprise
Dr. Billy Mullins	SAF/A-10	Assistant Chief of Staff, Strategic Deterrence and Nuclear Integration
Maj Gen Whelan	AFSPC	A5 Director of Requirements
Brig Gen Hauck	AFPEO/SS	Program Executive Officer for Strategic Systems
VADM Benedict	Navy SSP	Director, Strategic Systems Programs
Ms. Patricia Gore	MDA/ECM	MDA, Director of Industrial Manufacturing and Technology
Mr. Greg Hulcher	AT&L/S&TS/SW	Director for Strategic Warfare
Mr. Gil Klinger	AT&L/SIO	Deputy Assistant Secretary of Defense for Space and Intelligence
Mr. Barry Pike	Army	Deputy PEO, Missiles and Space
Mr. Jim Norman	NASA/HQ	Assistant Associate Administrator for Launch Services
Mr. Dan Dumbacher	NASA/HQ	Deputy Associate Administrator for Exploration Systems Development
Mr. Benjy Neumann	NASA/HQ	Division Director for Human Spaceflight Capabilities
Dr. Spiro Lekoudis	AT&L/R&E	Research and Engineering
Ms. Mary Lacey	USN/DASN RDT&E	Deputy ASN for Research, Development, Test and Evaluation
Brig Gen Anthony J. Cotton	NRO	Deputy Director, National Reconnaissance Office
Lt Gen Ellen Pawlikowski	SMC/CC	Commander, Space and Missile Systems Center, Air Force Space Command

Proposed PIB Executive Steering Committee

Name	Office/Org	Organization Title
Rajiv Doreswamy (Chair)	NASA/MSFC/FP	NASA/MSFC Flight Programs and Partnerships/NIRPS
Robert Read (Co-Chair)	OSD/ATL/MIBP	OSD Manufacturing and Industrial Base Policy
TBD	NASA HQ, GRC, JSC	
John Honeycutt	NASA/XP	NASA SLS Program
Andy Culbertson	OSD/ATL/ASD(R&E)	OSD Research and Engineering
Brent Gibson	USAF/PEO/SL	AF PEO Space Launch
TBD	USAF/AFSPC/A5	
Drew DeGeorge	USAF/AFRL/RQR	AFRL, Edwards AFB
Stuart Blashill	USN/NAVAIR	NAWC, China Lake
Frank Tse	USN/NAVSEA	NSWC, Indian Head
Shahab Chaudhry	USN/SSP	NAVY SSP
David Tritt	USA/PEO MS	PEO MS, Office of the Chief Engineer
Jamie Neidert	USA/AMRDEC	Weapons Development & Integration
Megan Meisner	MDA	Industrial Manufacturing and Technology
Tom Williams	NASA/MSFC/ER	Director, Propulsion Systems Department

Highlights of the National Space Transportation Policy

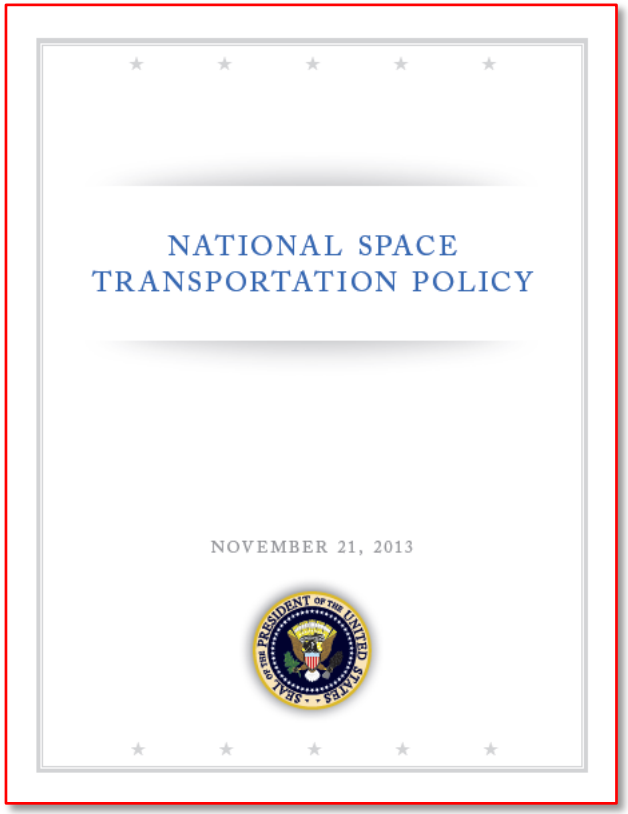
Goals

- *Promote and maintain a dynamic, healthy, and efficient domestic space transportation industrial base;*
- *Encourage and facilitate the U.S. commercial space transportation industry to increase industry robustness and cost effectiveness, foster innovation-driven entrepreneurship and international competitiveness, and benefit the U.S. economy;*
- Conduct and promote technology research and development activities to improve the afford- ability, reliability, performance, safety, and responsiveness of U.S. space transportation capabilities, while increasing collaboration and coordination among departments and agencies;
- Enable the capabilities to support human space transportation activities to and beyond low Earth orbit, including services to and from the International Space Station and the development of a deep-space-capable transportation system; and
- Foster the development of U.S. commercial spaceflight capabilities serving the emerging non- governmental human spaceflight market.

US Space Transportation Industrial Base

To promote a healthy and efficient United States Government and private sector space transportation industrial base, departments and agencies shall:

- *Make space transportation policy and programmatic decisions in a manner that considers the health of the U.S. space transportation industrial base; and*
- *Pursue measures such as public-private partnerships and other innovative acquisition approaches that promote affordability, industry planning, and competitive capabilities, infra- structure, and workforce.*



NIRPS and the JANNAF PIB align with the NSTP

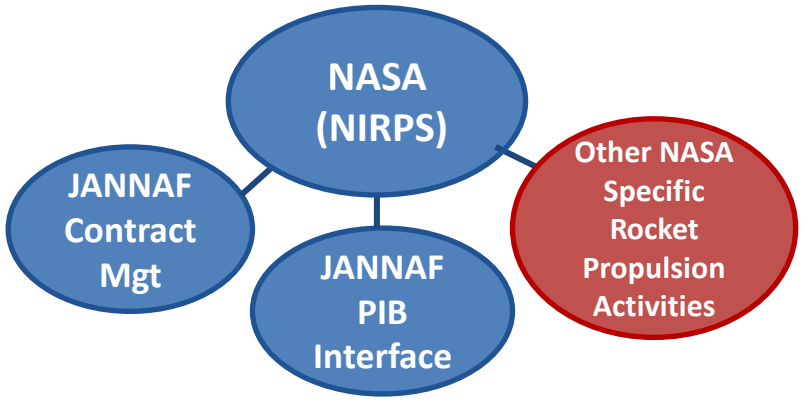
JANNAF PIB Takeaways

- This was the first time that the USG PEOs and Program Offices (with RP Equities) had met to understand each other's program content, budget and schedule
- Industry outbriefs were well received and useful, the PIB executive committee will provide detailed guidance for the next opportunity
- Working groups were formed and 4 tasks assigned
  - Large Liquid Engine Sustainability/SC analysis (LRE WG)
  - Helium Legislation Effects (LRE WG)
  - Ammonium Perchlorate IB (LSM WG)
  - Small Solid Rocket Motor Capability (SSM WG)
- The JANNAF PIB is a work in progress, we will work to improve the meetings, products and value to the community
- Community involvement will be critical to the success of the PIB and JANNAF in general. Please get involved!

NIRPS Accomplishments and Activities Underway

Community Solutions

- NASA Interface to the JANNAF Propulsion Industrial Base (PIB) Committee
- Management of the JANNAF Contract
- NASA Propulsion Academy (Graduate and Undergraduate summer program at MSFC)
- NIRPS Web Portal – Skills and Capabilities Directory
- Establish and foster industry and academia relationships in propulsion



Ecosystem Modeling

- Propulsion Supplier Integrated Modeling and Analyses (PropSIMA): Propulsion Supply Chain visualization tool to identify connectivity between suppliers and expose risks, integrated with a probabilistic demand and production rate model, provides scenario analysis capability

Health Metrics

- Monitor and Report Propulsion Industrial Base Health Metrics (most recent survey and study report published in 2013)

Technology Road Mapping

- Leverage Technology Roadmaps for collaborations and complimentary activities
- Sponsor/Coordinate the JANNAF Additive Manufacturing Technical Interchange Meeting, Sept 2014

Propulsion Supplier Integrated Modeling and Analyses (PropSIMA) Environment

Objective: **Inform Agency Decision makers of the impacts to the Propulsion Industrial Base, due to potential SLS (and other) architecture decisions**

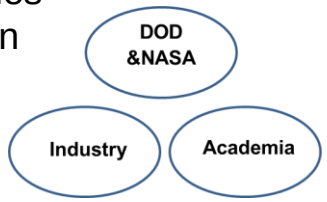
- Approach: Develop a supply chain visualization tool database which interacts with a probabilistic demand and production rate model
  - NIRPS and Aerospace Corporation executing in conjunction with HEOMD, SLS Program Office
  - Phase 1 focused on development of prototype tool/environment
  - Phase 2 focused on Exploration Upper Stage liquid engine options (Test Phase 1)
    - Estimates of supplier financial health, dependency on prime and "importancy" are based on best available information and subject matter experts (SME's) best estimate

$$Importancy = \frac{Percentage\ of\ Hardware\ Cost\ for\ Engine}{Number\ of\ supplier's\ touches\ in\ our\ database}$$

    - Baseline engine demand based on the current launch manifest combined with the National Mission Model (out years)
  - Phase 3 underway, Joint Air Force/NIRPS/Aerospace task will address the PIB impacts of the addition of a new Domestic Hydrocarbon Engine and Commercial Launchers into the market
  - Additional Phases will include tactical/strategic applications, metrics trending with Department of Commerce and possible collaboration with Defense Logistics Agency

Rocket Propulsion Additive Manufacturing TIM

- JANNAF Liquid Propulsion Subcommittee (LPS) Advanced Materials Panel will be hosting an Additive Manufacturing TIM , **September 3-5, 2014**, at the Jackson Center , Huntsville, AL
  - Focus is on AM for Rocket Propulsion
    - Understanding the State of Art AM for fabricating parts for Rocket Propulsion application , where are we today
    - *Understanding what is required to take AM parts to flight*
- The scope of the JANNAF LPS Advanced Materials Panel Additive Manufacturing for Propulsion Applications TIM includes:
  - Technology Roadmaps
  - Additive Manufacturing Techniques and Machines
  - Post Build Processing, Finishing, and Inspection
  - Materials
  - Design for Additive Manufacturing
  - *Component Fabrication and Test*
  - *Process Qualification & Specifications*
  - *Process Analysis, Sensing, and Control, Non-Destructive Evaluation*
  - Economic Considerations, ROI, Schedule
  - Panel Discussion



- Call for presentations was issued on April 7th
- Presentation abstracts will be due June 4th
- CPIAC will manage the administration of the TIM
- This TIM is about building parts: it would advantageous for organizations to bring hardware examples, a limited number of tables will be available to display hardware.
- A bus tour of MFSC's Advanced Manufacturing facility is being considered on the afternoon Tuesday September 2nd, sign-up will be through the JANNAF web site.

NIRPS: Positive Value and Lasting Impact

- **NIRPS is Executing tasks of National Importance**
  - Leading JANNAF PIB implementation
  - Rocket Engine Supply Chain Modeling and Analysis
    - SLS EUS
    - US Domestic Hydrocarbon Engine
- **NIRPS is adding positive value to the Propulsion Ecosystem**
  - Enabling Collaboration across the US Government
  - Engaging with Industry and Academia
  - Building Supply Chain Modeling and Analysis Capability for NASA and the US Government
- **NIRPS is "resource light" but "results heavy"**
  - Small Core Staff, augmented by in-kind contributions of the NIRPS community

Upcoming Engagements/Important Dates

July 28-30, 2014
50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference
http://www.aiaa.org/EventDetail.aspx?id=18582
Cleveland, OH

August 11-14, 2014
Space and Missile Defense (SMD)
http://smdsymposium.org/
Huntsville, AL

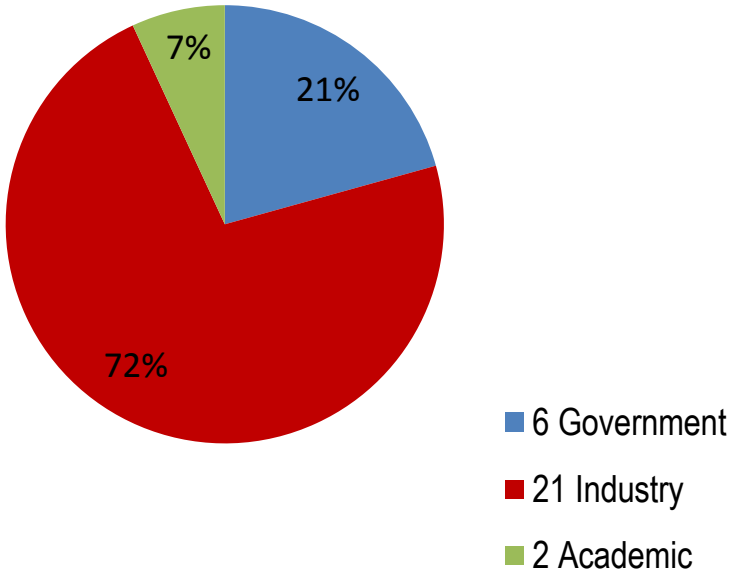
September 2-5, 2014
JANNAF Rocket Propulsion Additive Manufacturing Technical Interchange Meeting
https://www2.cpiac.jhu.edu/meetings/Sep2014/pages/index.html
Huntsville, AL

December 1-4, 2014
Defense Manufacturing Conference
http://dmcmeeting.com/
San Antonio, CA

December 8-11, 2014
Joint Army-Navy-NASA-Air Force (JANNAF) 46th Combustion / 34th Airbreathing Propulsion / 34th Exhaust Plume and Signatures / 28th Propulsion Systems Hazards Joint Subcommittee Meeting
https://www2.cpiac.jhu.edu/meetings/Dec2014/pages/index.html
Albuquerque, New Mexico

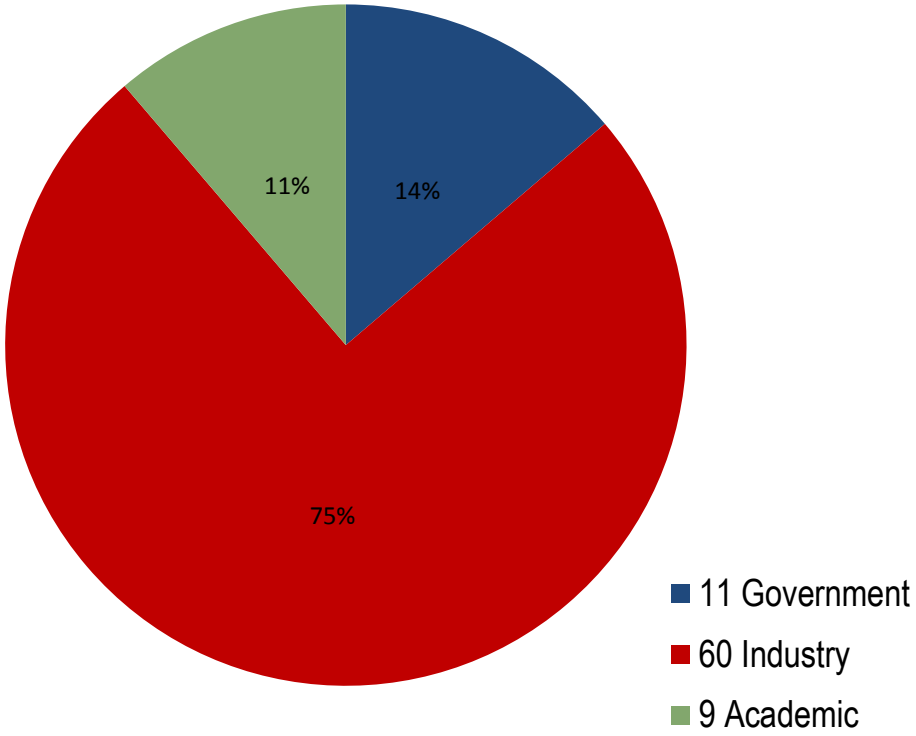
Growing Participation

November 2011



80 Individuals
29 Organizations Represented

July 02, 2014



222 Individuals Representing
80 Organizations

NIRPS

National Institute for
Rocket Propulsion Systems

http://nirps.msfc.nasa.gov/home