NASA Advisory Council
Space Operations Committee

Kennedy Space Center

July 27-28, 2010

Space Operations Committee

Meeting at Kennedy Space Center, July 27-28, 2010

- Col. Eileen Collins (ret.), Chair
  - Former NASA Astronaut
- Dr. Pat Condon, Vice Chair
  - Aerospace Consultant, former Commander of the Ogden Air Logistics Center, the Arnold Engineering Development Center, and the Air Force Armament Laboratory
- Dr. John Grunsfeld
  - Former NASA Astronaut, Deputy Director, Space Telescope Science Institute
- Ms. JoAnn Morgan
  - Former Kennedy Space Center Associate Director, KSC Safety & Mission Assurance Director
- Mr. Bob Sieck
  - Former Space Shuttle Launch Director

Not attending:

- *Dr. Leroy Chiao*
  - *Former NASA Astronaut and International Space Station Commander*
- *Mr. Tommy Holloway*
  - *Former Space Shuttle and International Space Station Program Manager*
- *Mr. Glynn Lunney*
  - *Former NASA Flight Director*

- Mr. Jacob Keaton, Executive Secretary, NASA

Summary of Activities

- 21st Century Launch Complex
- Commercial Orbital Transportation Service (COTS) Update
- Commercial Resupply Service (CRS) Operational Plan
- Commercial Human Rating Plan (CHRP)
- International Space Station Logistics Plan
- KSC Site Visit
  - Space Life Sciences Lab, Launch Complexes, Technology Development Facilities, Vehicle Assembly Building, Orbiter Processing Facility
- Observations and Recommendations
  - Three observations and one recommendation
- Next meeting September 22-23, 2010, at Johnson Space Center

Space Life Sciences Laboratory

- Built in 2004 by the State of Florida
- 100,000 square feet
- Available for use by commercial launch companies
- Anchor laboratory facility for the new Exploration Park research complex
  - Room for future development
- Visited by the NAC in 2008
  - We have seen growth in the utilization of the building but there is still room for more users

KSC SLSL and Technology Development - Examples

- Electrostatic physics lab
  - Dust mitigation technology
  - Applications to solar panels
  - Hubble spectrometer
- Corrosion Lab
  - Coatings with microcapsules – self healing/detecting
- Bioregenerative Life Support Lab
  - Producing plants with more antioxidants (gene expression)
  - Waste management
  - Bioreactors (engineer functions of bacteria at DNA level)
- Applied Physics Lab
  - Laser measuring device – distance measurement
  - Radiation shielding
  - Remote optical ice detection
  - Ultrasonic leak detection
- Applied Chemistry Lab
  - PCB removal
  - Toxic leak detection
- Cryogenics Test Lab
  - Tank insulation to minimize boil-off
  - Aerogels
  - Wire insulation – detection and healing layer

Collaboration between NASA centers, DoD, academia, industry and international partners was a common theme.

KSC Site Visit

- Space Life Sciences Laboratory
  - Animal Care Facility
  - Small Payload Hardware & Experiment Monitoring Area
  - Orbital Environmental Simulator Chambers
  - Electrostatic and Surface Physics Lab
  - Corrosion Technology
  - Bioregenerative Life Support Systems
  - U. of Florida Astrobiology Department
- Cryogenics Laboratory
- Operations & Checkout Building
  - Applied Physics Lab
  - Applied Chemistry Lab
- Drive-bys of Launch Complex 39A/39B (Shuttle/Ares), 41 (Atlas), 37 (Delta)
- Tour of Launch Complex 40 (SpaceX)
- Orbiter Processing Facility (*Discovery)*

21st Century Launch Complex

- The President's Budget Request invests $1.9B over five years.
- Program objective is to modernize the Florida launch range and transform KSC into a facility that is worthy of this nation's 21st century space programs.
- Primary focus is to make investments in overall launch and processing operations that:
  - Moves KSC from a vehicle-centric infrastructure to **multi-use architecture**
  - Capitalizes on capabilities and infrastructure investments to create efficient, low-cost capability
  - Enhances **payload processing** capabilities to increase throughput and access to all users
  - Accelerates environmental remediation, compliance, and technology activities and addresses climate change adaptation
  - Partners with the **USAF** on their range transformation activities
  - Partners with **state and local government** and commercial entities to identify economic growth potential
  - Partners with existing and emerging **commercial space entities** to identify key investments that would attract them to launch from the Florida Range/Spaceport

21st Century Space Launch Complex
Potential Users & Partners

- Potential Users
  - Heavy Lift Launch Vehicle (HLLV)
  - Commercial Crew Development Program (CCDP)
  - Launch Services Program (LSP)
  - International Space Station (ISS)
  - Flagship Technologies Demonstrations
  - Sub-orbital launch and other government and commercial programs
- Potential Partnerships
  - USAF & other government agencies
  - Space Florida
  - Commercial providers
  - Internationals
- Looking broadly to consider all viable potential customers
- NASA and Air Force need unified strategy and collaboration on development of that strategy is ongoing
- Agency RFIs and commercial advocate teams will be a good source of information
- Able to develop “generic” enabling capabilities early as customer requirements emerge

21st Century Launch Complex Committee Observations

- **KSC Planning Team** formed to focus development on a customer-based architecture that accommodates all feasible users
- Infrastructure will evolve from vehicle-centric, single government-operator to modernized, multi-use, flexible, **multi-operator capabilities**
- We acknowledge that in general there is a need to **upgrade aging facilities** at KSC
- Before these investments can be made, NASA needs to generate specific **requirements**
- NASA does not yet have a **business model** to help determine priorities for investment and the efficient use of funds
- Uncertainty of the **cost** of operations is a major customer concern
- There is an additional risk with multiple users affecting NASA critical capabilities. A **risk model** would help guide decisions.

Recommendation

- Title: **Establishment of a Technology and Development Clearinghouse**

- Recommendation: NASA should establish a technology and development clearinghouse across all NASA disciplines. This could be in the process, format and style of an online wiki where researchers input their own information (such as type of technology, application, license information, key words, and contact info). This information should be organized to be readily available online to other researchers and the public.

- Major Reasons for Recommendation: There is a wealth of world-class research and technology development going on at NASA centers across the enterprise. An effective mechanism for communicating the content and value of that research both within NASA (and beyond the NASA community) would be of substantial utility and value.

Space Shuttle Program (SSP) Manifest

NASA Official: John Coggeshall
USA Project Lead: Barton K. Gibson
Chart updated: 1-July-2010

CY2010 | CY2011
FY2010 (3, 4) | FY2011 (1, 2, 3, 4)

103
Discovery
128 (17A)
8/28/09
MPLM (P)
LMC

131 (19A)
4/5
MPLM(P)
LMC

133 (ULF5)
11/1
(11+1)
2 EVAs
~4:30 pm (Eastern)
SPDU
ELC4
ROEU 751
PMM
ET-137

104
Atlantis
129 (ULF3)
11/16/09
ELC1
ELC2

132 (ULF4)
5/14
ICC-VLD
MRM1

335 (LON for 134)
4/28
CSCS Replenish
ET-122

105
Endeavour
130 (20A)
2/08/10
Cupola
Node3

134 (ULF6)
2/26
(12+1)
3 EVAs
~4:00 pm (Eastern)
ELC3
AMS-2
ET-138

Launch Time is an approximation based on the reference trajectory's planar opening

Flight Rate: FY-4 / CY-4 | FY-2 / CY-1
Launch Beta Angle Cutouts①
① being above +/-60 degrees (for ISSmi Orbit) during Orbiter/ISS combined mated operations (8 days)

May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul

Beta Exceedance: Nov 8 β 23; Jan 1 β 1; Apr 7 β 19

FDRD Launch Date
STS# (ISS#)
Launch Date
Crew Rotation
Mission duration (###)
Number of EVAs
#of times this OV has flown
External Tank ET-###
Soyuz (S)
Progress (P)
Automated Transfer Vehicle (ATV)
H-II Transfer Vehicle (HTV)

39P 24S 40P ATV2 25S 41P HTV2 26S 42P 27S 43P

Observation

- The NAC Space Operations Committee would like to recognize the Space Shuttle Program Manager John Shannon and his team for their outstanding leadership in safely flying the Shuttle manifest and planning for the safe transition of the Shuttle from flight status to retirement.

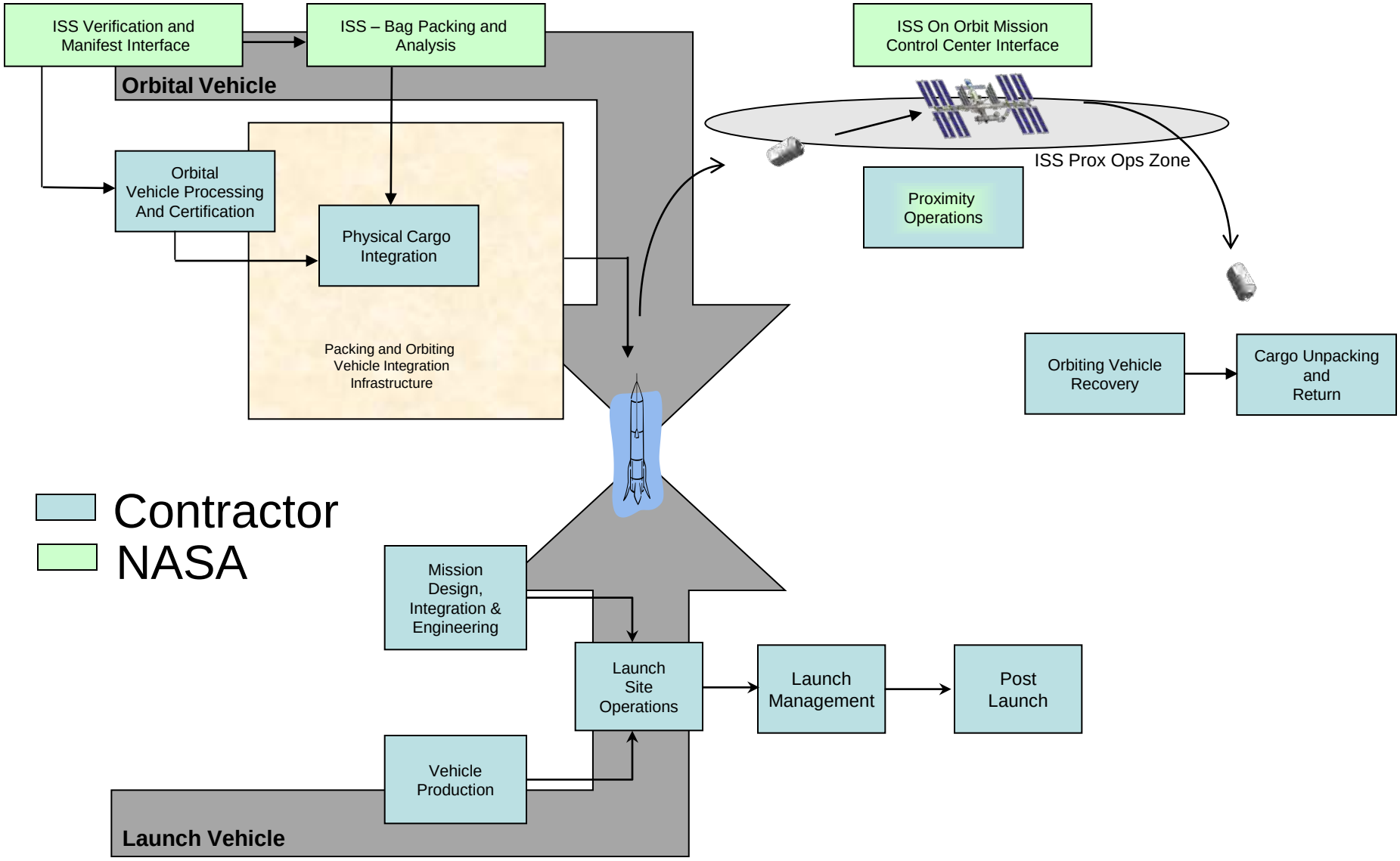
Commercial Orbital Transportation System (COTS)

- Briefed by Alan Lindenmoyer, COTS Program Manager
- COTS
  - Orbital Sciences Corp
  - SpaceX
- Commercial Crew Development (CCDev)
  - Blue Origin
  - Boeing
  - Paragon
  - Sierra Nevada
  - United Launch Alliance

Commercial Resupply Service – Operational Plan

- ISS packed cargo is delivered to the contractor
- Contractor FAA licensed launch
- Rendezvous
  - Both contractors proposing 1-2 day rendezvous planning – depending on propellant margins.
  - Communication required with ISS prior to approach initiation
  - Joint Operations begin with ISS Flight Management
    - Flight ops per previously agreed to procedures and flight rules
    - Holds and vehicle assessments as required
- Berthed Operations
  - Berthing duration is approximately 30 days
  - Contractor supports as required needed on orbit operations (unpacking and packing operations, on orbit anomalies)
  - Contractor supports programmatic meetings (IMMT, Ops reviews) as required.
- Re-entry and disposal/return
  - FAA licensed re-entry
  - Return for SpaceX is currently in the Pacific with cargo return into Los Angeles.
- Between FY11 and FY15 there is an average of four COTS flights per year leading up to the CRS contract flights

Commercial Resupply Service – Operational Plan



Request for Information: Fulfilled

- Title: **Operational Model for Commercial Space Vehicles**

- Committee had requested a briefing on the operational model for commercial space vehicles that will enable NASA flight resources and crews to be committed to commercial space systems. We are satisfied that NASA is developing this model.

Request for Information

- Title: **Using ISS as a Testbed for Future Exploration**

- Request for Briefing: Describe how deep space flight operational concepts are being developed or used on ISS.

- Major Reasons for Request: ISS is a useful spacecraft for developing operational concepts for deep space: Mars time-delayed communication, long-duration crew isolation simulating transit to Mars, nature of crew in-flight schedule, and Mars simulation on Earth return.

ISS Logistics Plan

Four vehicles comprise the USOS resupply fleet following Space Shuttle retirement:
(This assessment assumes Space Shuttle retirement at the end of CY2010)

International Partner Vehicles

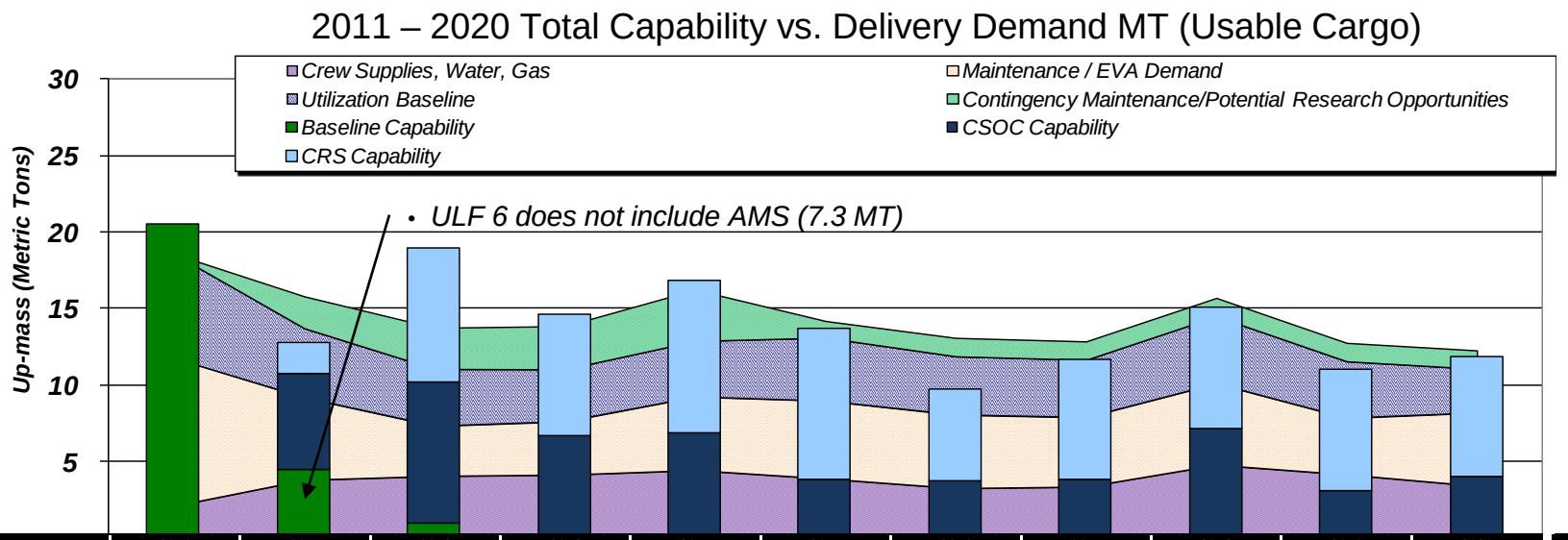
- ATV - supplied by ESA
  - Pressurized cargo delivery
  - Capable of supplying water and atmospheric gas
  - Capable of providing ISS reboost and transfer propellant
  - Non-recoverable downmass
- HTV - supplied by JAXA
  - Pressurized and unpressurized cargo delivery
  - Capable of supplying water
  - Non-recoverable downmass

NASA Commercial Resupply Service Vehicles

- ***Orbital Cygnus***
  - *Pressurized cargo delivery*
  - *Capable of supplying conditioned upmass*
  - *Non-recoverable downmass*
- ***SpaceX Dragon***
  - *Pressurized and unpressurized cargo delivery*
  - *Capable of supplying conditioned upmass*
  - *Recoverable pressurized downmass*
  - *Capable of returning conditioned downmass*
  - *Non-recoverable unpressurized downmass*

		Dry Cargo Upmass - Customer		Dry Cargo Upmass - Usable	
Vehicles		Internal	External	Internal	External
CSOC	ATV	2.8 MT	-	2.4 MT	-
	HTV	3.2 MT	1.5 MT	2.7 MT	0.7-1.0 MT
CRS	SpaceX	1.6 MT	1.5 MT	1.4 MT	0.6 MT
	Orbital	2.3 MT	-	1.9 MT	-

ISS Logistics Plan



Vehicles (FY)		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Baseline	Shuttle	5	1										5
	CCS							2	2	2	2	2	10
	USOS Progress	2 MT	2.1 MT	1.0 MT									5.1 MT
	USOS Soyuz	2	2	2	2	2	2						12
CSOC	ATV		1	1	1	1				1	1		6
	HTV		1	2	1	1	1	1	1	1		1	10
CRS	SpaceX		1	3	2	3	3						12
	Orbital			2	2	2	2						8
	Life Ext. - Vehicle A							2	2	2	2	2	10
	Life Ext. - Vehicle B							1	2	2	2	2	9
Total Margin - Usable*		2.0 MT	0.0 MT	5.3 MT	0.8 MT	0.6 MT	0.0 MT	0.0 MT	0.0 MT	0.0 MT	0.0 MT	0.0 MT	8.7 MT
Total Margin - Customer**		3.1 MT	0.0 MT	8.5 MT	1.4 MT	1.2 MT	0.0 MT	0.0 MT	0.0 MT	0.0 MT	0.0 MT	0.0 MT	14.1 MT
Crew Supplies, Water, Gas - **Customer**		2.5 MT	4.5 MT	4.8 MT	4.9 MT	5.2 MT	4.6 MT	3.8 MT	3.9 MT	5.6 MT	4.9 MT	4.0 MT	46.2 MT
Maintenance / EVA Demand - **Customer**		17.8 MT	9.2 MT	4.1 MT	4.3 MT	6.8 MT	7.6 MT	7.2 MT	7.2 MT	8.1 MT	5.0 MT	7.5 MT	66.9 MT
Utilization Baseline - **Customer**		8.4 MT	6.1 MT	5.2 MT	5.3 MT	5.2 MT	6.7 MT	4.9 MT	5.4 MT	5.6 MT	5.4 MT	3.8 MT	53.6 MT
Contingency Maintenance - **Customer**		0.0 MT	3.0 MT	3.9 MT	3.9 MT	4.6 MT	1.6 MT	1.7 MT	1.7 MT	1.7 MT	1.7 MT	1.7 MT	25.6 MT
Shortfall with no CRS - **Customer**		0.0 MT	7.3 MT	4.0 MT	9.4 MT	12.8 MT	14.7 MT	12.3 MT	12.0 MT	10.8 MT	12.7 MT	10.4 MT	106.4 MT

*Value shown in usable cargo (does not include packing, FSE, or accommodations)
** Value shown in customer cargo (includes packing, FSE, or accommodations)

Impacts of delayed CRS operational capabilities:

- ***Utilization may be impacted in late-2012***
- ***System functionality may be impacted if CRS is not available in 2013***

Commercial Human Rating Plan (CHRP)

- Briefing by Mark Erminger, Chief Safety and Mission Assurance Officer
- Plan for how they will certify a launch vehicle and spacecraft for human use
- NASA sought industry feedback through a Request For Information (RFI)
  - The RFI was released on May 21, 2010 and inputs were due on June 18, 2010
  - Top-level breakdown of the 32 responders:
    - 24 - For-profit Companies
    - 3 – NASA Engineering and Safety Center
    - 2 - Internationals
    - 2 - Non-profit Organizations
    - 1 - Academic Laboratory
- NASA will make changes to the CHRP as a result of industry feedback and work through the process to get Agency approval of the CHRP before any competition.
- Three types of standards:
  - Type 1: must be abided by
  - Type 2: must be abided by or must propose an alternative
  - Type 3: recommendations and/or best practices
- The committee looked at the CHRP and believes that it is an ongoing activity
  - The committee believes we should take a closer look at NASA insight vs NASA oversight

Observation

- Due to recent announcements in proposed national policy resulting in a changing environment, there is a need for the deliberate and careful integrated planning of the transition to the new direction, including careful phasing of the Shuttle manifest, transition of the Constellation program, and development of the 21st Century Launch Complex and Technology Development programs.

(Repeat observation from April 2010 meeting)

Observation

- The Space Operations committee understands that NASA is developing a strategic plan. We are following this process as we believe is it important for NASA's employees to have specific direction as to carrying out the national policy.

Future Activities

- Next meeting: September 22-23, 2010 at Johnson Space Center
- Request briefings on:
  - Crew involvement in commercial space launches
  - NASA crew collaboration on commercial vehicle design
  - Micrometeroid orbital debris and radiation protection for human spaceflight
  - Shuttle and ISS utilization update
  - Space Communication and Navigation (SCaN) update in February
- JSC site visit:
  - Advanced suit lab
  - Advanced simulator facilities
  - Crew displays and controls
  - Low Impact Docking System (LIDS)
- The committee will have reviewed all items on the 2010 work plan with the exception of SCaN.

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