Recent Activities of the
MSFC Natural Environments Branch
and
Terrestrial & Planetary Environments Team

Barry C. Roberts/MSFC
NE DOLWG
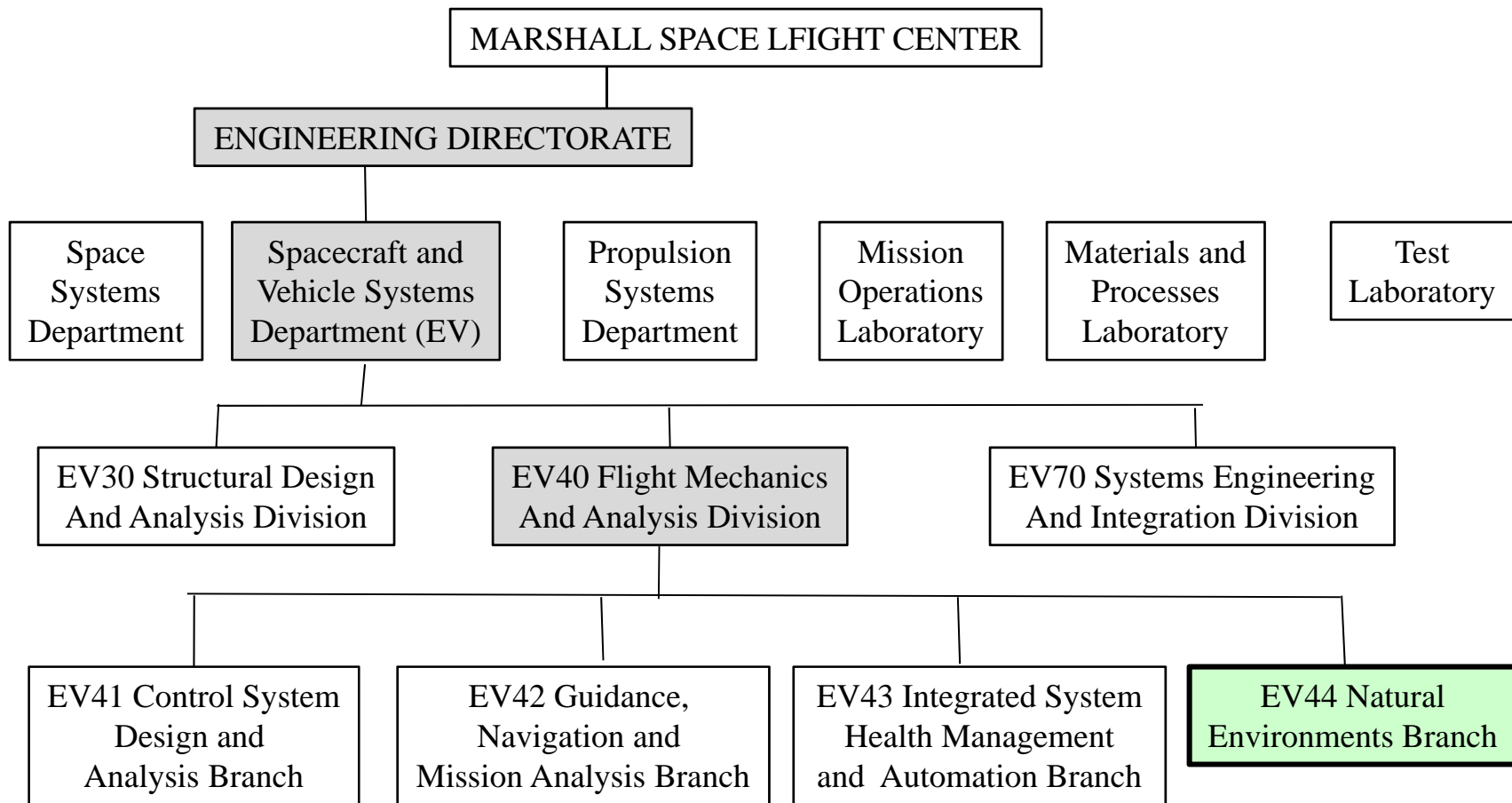**8-9 April 2015**

Organization Chart

```
                    MARSHALL SPACE LFIGHT CENTER

                    ENGINEERING DIRECTORATE
```

| Space Systems Department | Spacecraft and Vehicle Systems Department (EV) | Propulsion Systems Department | Mission Operations Laboratory | Materials and Processes Laboratory | Test Laboratory |

| EV30 Structural Design And Analysis Division | EV40 Flight Mechanics And Analysis Division | EV70 Systems Engineering And Integration Division |

| EV41 Control System Design and Analysis Branch | EV42 Guidance, Navigation and Mission Analysis Branch | EV43 Integrated System Health Management and Automation Branch | EV44 Natural Environments Branch |

MSFC EV44 Organization

MSFC Natural Environments Branch
Glenn Overbey - Chief

Space Environments Team

R. Blaauw	J. Minow
M. Chandler	A. Moorhead
V. Coffey	D. Moser
B. Cooke^	L. Parker
A. Diekmann	I. Small
S. Ehlert	R. M. Suggs*
J. Howard	R. J. Suggs
C. Hozian	E. Willis
A. Kingery	

Terrestrial & Planetary Environments (T&PE) Team

K. Altino
B. J. Barbré
J. Brenton
L. Burns
R. Decker
H. Justh
F. Leahy
J. Orcutt
B. Roberts*
P. White

*Team Lead
^Meteoroid Environment Office Lead
Blue - Civil Servant
Purple - Contractor Support

Space Team Program Support

- Space Launch System (SLS)
  - Provide general natural environment definition and interpretation
  - Provide Ionizing Radiation lead for the SLS Program
  - Supported heavy ion (ionizing radiation) testing of components of main engine controller
  - Support cross-program natural environments function for NASA HQ Exploration Systems Development (ESD)
    - Support the Cross-Program Natural Environments Integration Ad-Hoc Team (NEIAHT)
    - Space environments inputs to SLS-SPEC-159 "Cross-Program Design Specification for Natural Environments

- Orion Multi-Purpose Crewed Vehicle (MPCV)
  - Provide general space environment definition and interpretation including ionizing radiation, spacecraft charging, and meteoroid environment

- International Space Station (ISS)
  - Provide annual meteor shower forecast and updates for EVAs
  - Provide solar activity forecast for orbit decay predictions and reboost planning
  - Operate ground station for Floating Potential Measurement Unit and analyze data to characterize spacecraft charging events
  - Provide plasma/spacecraft charging expertise for EVA plasma hazard evaluations

- Commercial Crew Program (CCP)
  - Provide general natural environment insight, review and Verification and Validation (V&V)

Space Team Program Support (cont.)

- Meteoroid Environment Office (MEO)
  - Program office delegated by HQ Office of Safety and Mission Assurance
  - Developed and maintain NASA standard Meteoroid Engineering Model
  - Provide annual meteor shower forecast for NASA missions
  - Provide situational awareness for fireball meteor events

- Magnetospheric Multiscale Mission (MMS)
  - Provide 2 co-investigators for the plasma instruments
  - Calibrated all 16 Dual Ion Spectrometer (DIS) instruments in EV44's Low Energy Electron and Ion Facility

- Launch Services Program (LSP)
  - Worked with SpaceX on ionizing radiation certification for JASON-3 launch

- Iodine Satellite ion propulsion satellite (ISAT)
  - Provided space environment definition document
  - Performed spacecraft charging and ion plume impingement calculations

- Deep Space Climate Observatory (DSCOVER)
  - Performed spacecraft charging calculations

T&PE Team Program Support

- Space Launch System (SLS)
  - Provide general natural environment definition and interpretation
  - Provide a natural environments lead to the program
  - SLS-SPEC-044-07 "SLS Environments Vehicle Design Specification Volume 7: Natural"
  - Provide cross-program natural environments function for NASA HQ Exploration Systems Development (ESD)
    - Lead the Cross-Program Natural Environments Integration Ad-Hoc Team (NEIAHT)
    - SLS-SPEC-159 "Cross-Program Design Specification for Natural Environments"
  - Provide support to the Day-of-Launch Initialization Load Update Ad-Hoc Team (DOLIAHT)
  - Lead the monthly Meteorological Systems Integration Control Working Group meetings
- Orion MPCV
  - Provide general natural environment definition and interpretation
- JPL Mars Program
  - Provide Mars Global Reference Atmospheric Model support & updates as requested
- Commercial Crew Program (CCP)
  - Provide general natural environment insight, review and Verification and Validation (V&V)

T&PE Team Project Support (cont.)

- Karen Altino
  - Multi-Purpose Crew Vehicle (MPCV)/Orion - Lead
  - Commercial Crew Program (CCP) - Lead
- BJ Barbré
  - MPCV/Orion
  - SLS
- James Brenton
  - SLS
- Lee Burns
  - SLS
  - MPCV/Orion
- Ryan Decker
  - SLS

- Hilary Justh
  - Mars & Planetary Programs - Lead
  - SLS
- Frank Leahy
  - SLS - Lead
- John Orcutt
  - SLS
- Barry Roberts
  - ESD Cross-Program Integration - Lead
- Patrick White
  - SLS

NASA

T&PE Team Recent Projects

- Kennedy Space Center (KSC) 50 MHz Doppler Radar Wind Profiler (DRWP) Data
  - Developed subsets from merged KSC 50 MHz and 915 MHz DRWP data base
  - Leading the DRWP Operational Acceptance Test

- New Range Reference Atmosphere's (RRA's)
  - Developed 10 new RRA's for Range Commanders Council-Meteorology Group

- Earth Global Reference Atmospheric Model (GRAM)
  - New RRA's to be sent to users
  - Developing next version to be in C++ language

- Planetary GRAM's
  - Mars (most developed model), Venus, Titan, Neptune

- Probabilities of Atmospheric Conditions and Environmental Risk (PACER) Model
  - Includes National Lightning Data Network lightning 2-D data, Interim European Centre for Medium Range Weather Forecasts Re-Analysis (ERA-Interim) ocean data, Surface Observations (including KSC, Edwards Air Force Base, Vandenberg Air Force Base)

T&PE Team Recent Projects

- Ocean Environment Data
    - Updated the ERA-Interim data base

- Continuous Archival of KSC/Cape Canaveral Weather Measurements
    - Began archival and quality control of Launch Pad 39B Lightning Protection System Tower data
    - Continue archival of other Cape area meteorological data sources

- Profile Envision and Splice Tool (PrESTo)
    - Splices and filters data from KSC 50 MHz DRWP, 915 MHz Profiler, balloon data, etc.
    - Intended for use on day-of-launch for Exploration Mission-1

T&PE Team Major Technical Support Areas

- Karen Altino
  - Ocean Data
  - MPCV/Orion environment definition – Lead
  - CCP

- BJ Barbré
  - Atmospheric winds
  - New KSC profiler database-Lead
  - New Range Reference Atmospheres
  - Ocean data

- James Brenton
  - Data archival & management

- Lee Burns
  - New Range Reference Atmospheres-Lead
  - Earth GRAM, Mars GRAM
  - PACER model

- Ryan Decker
  - DOLIAHT Lead
  - NE DOLWG Lead
  - SLS Vehicle Management & NE Deputy Lead

- Hilary Justh
  - JPL Mars Programs -Lead
  - SLS
  - CCP

- Frank Leahy
  - SLS Natural Environment Definition – Lead
  - Atmospheric Winds

- John Orcutt
  - Day-of-Launch definition
  - PrESTo Software

- Barry Roberts
  - Team lead
  - Cross-Program Natural Environment Integration Lead

- Patrick White
  - Earth GRAM Lead

T&PE Team Recent Publications

- Altino, Karen M. and K. L. Burns, R. E. Barbré Jr., and F. B. Leahy. **Analyzing the Impacts of Natural Environments on Launch and Landing Availability for NASA's Exploration Systems Development Programs**. 13th International Conference on Space Operations. American Institute of Aeronautics and Astronautics. Pasadena, California. May, 2014.

- Barbré Jr., R.E. 2015. **Development of a climatology of vertically complete wind profiles from Doppler Radar Wind Profiler Systems**. Paper presented at the 17th Conference on Aviation, Range, and Aerospace Meteorology. American Meteorological Society. Phoenix, Arizona. 7 January 2015.

- Decker, Ryan K. and Robert E. Barbré Jr.. "**Temporal Wind Pairs for Space Launch Vehicle Capability Assessment and Risk Mitigation**", Journal of Spacecraft and Rockets, Vol. 52, Special Section on Numerical Simulation of Hypersonic Flows (2015), pp. 209-216.

- Decker, Ryan K. and R. E. Barbre Jr., R. Leach, J. R. Walker, and J. Brenton. **Assimilation of wind profiles from multiple Doppler Radar Wind Profilers for space launch vehicle applications**.19th Conference on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface (IOAS-AOLS). American Meteorological Society. Phoenix, Arizona. January, 2015.

- Huddleston, L., W. Roeder, R.E. Barbré, Jr., R. Decker, B. Geldzahler, M. Seibert, M. Miller, J. Morgan, D. Morabito, L. D'Addario, 2014: **Remote Sensing at the NASA Kennedy Space Center: A Perspective from the Ground Up**. Paper presented at the 2014 Remote Sensing Europe Conference. International Society for Optical Engineering. Amsterdam, Netherlands. 23 Sep 2014.

- Justh, H. L. and K. L. Burns. "**Independent Verification of Mars-GRAM 2010 with Mars Climate Sounder Data**," Abstract No. 1319, Eighth International Conference on Mars, Pasadena, CA, July, 2014.

- Staton, Eric and G. Cates, R. Finn, K. M. Altino, K. L. Burns, and M. D. Watson. **Use of DES Modeling for Determining Launch Availability for SLS**. 13th International Conference on Space Operations. American Institute of Aeronautics and Astronautics. Pasadena, California. May, 2014.

A Few
Space Launch System
Updates

SLS Program Management Matrix

SLS SE&I MANAGEMENT STRUCTURE

September 5, 2014 version

Updates in Red

( ) = OPR   [ ] = ORGANIZATIONS MAPPED TO DISCIPLINE

SLS PROGRAM OFFICE ORGANIZATION	PROGRAM OFFICE Assignments	CHIEF ENGINEERS OFFICE ORGANIZATION	Chief Engineer Assignments	Systems Engineering (EV01) [EV70, EE12]	Vehicle Management (EV40) [EV40]	Structures & Environments (StE) (EV30) [EV30, ER40, ES21, ES22]	Propulsion (ER01) [ALL ER EXCEPT ER40]	Production (EM01) [ALL EM]	Integrated Avionics and Software (ES01) [ALL ES EXCEPT ES21,ES22]	Operations (EO01) [ALL EO, ES10]	Test (ET01) [ALL ET]	S&MA (QD01) [ALL QD]
SLS Program Manager **SLS Program Deputy Manager** **SLS Associate Program Manager** **Assistant PM** **Procurement**	**Todd May** **John Honeycutt** **Keith Hefner** **Sharon Cobb** **Earl Pendley**	**Program Chief Engineer** **Program Deputy Chief Engineer** **SE&I Technical Manager** **Assistant CE for Affordability** **Tech. Assist. Cross Program Integ.** **Tech. Assist.**	**Garry Lyles** **Jay Onken** **Dawn Stanley** **Tyler Nester** **Gary Langford** **Jeff Spencer**	LSE: John Hutt EV01 Alt: John Hanson EV70 Alt:Regina Reaves EV73	DLE: Mark West EV40 Alt: Heather Koehler EV40	DLE: Jeff Bland EV30 Alt: Don Ford EV30	DLE: Mike Ise ER01 Alt: Yvonne Villegas-Aguilera ER51 Alt: Amy Sivak ER24	DLE: Sandeep Shah EM03 (temporarily detailed to ED01) DLE: David McGaha EM03 (Acting) Alt: Matt Lansing EM03	DLE: Kurt Jackson ES01 Alt: Bob Hawkins ES01	DLE: Chris Bramon EO04 Alt: Vacant EO04	DLE: Mike Mims ET10 Alt: Vacant	Program CSO: Rick Burt Deputy CSO: Dan Mullane SE&I S&MA Lead: Linder Metts
Stages Element Manager **Stages Deputy Element Manager** **Associate Element Manager** **- Avionics Design Lead** **- Core Stage Design Lead** **- Integration Lead** **- EUS Lead**	**Tony Lavoie** **Julie Bassler** **D.K. Hall** **Lisa Blue** **Joan Funk** **Tim Flores** **Kent Chojnacki**	**Stages Chief Engineer** **Stages Deputy Chief Engineer** **Stages Deputy CE - Avionics** **Stages Deputy Chief Engineer - Test**	**Neil Otte** **Ken Welzyn** **Jeff Ratley** **Zena Hester**	Wendy Cruit EV70 Alt: Deborah Bagdigian EV71	Brent Hipp EV41	Terry Prickett EV34 Alt: Davy Haynes EV33	Pete Mazurkivich ER22	Keith Albyn EM03 Alt: Shane Brooke EM32	Mark Wallace ES13 (Acting)	Scotty Stewart EO40	Pat Fulda EV73	Rich Gladwin Jim Stott
Booster Element Manager **Booster Deputy Element Manager** **- Control Systems Manager** **- Assem & Struct Systems Manager** **- Motor/BSM ASM** **- Booster CEI/Interface Mgr**	**Alex Priskos** **Bruce Tiller** **Kendall Junen** **Brian Pung** **Tim Lawrence** **Kate Matus**	**Booster Chief Engineer** **Booster Deputy Chief Engineer** **Asst. Chief Engineer (detail)**	**David Wood** **Mat Bevill** **Deborah Crane**	Hank Miller ER50 (Represents SE at ERB)	Willie Robinson EV72 (detailed to ER35)	Mike Murphy EV40	Karen Bishop ER51	Scott Tillery EM03	Nathan Brown ES12	Ralph Arnold EO40		Tim Hemken
Engines Element Manager **Engines Deputy Element Manager**	**Steve Wofford** **Johnny Heflin**	**Engines Chief Engineer** **Engines Deputy Chief Engineer**	**Eric Tepool (Acting)** **Randy Thornton (Acting Detailed from ER31)**	Philip Benefield ER20 (Represents SE at ERB)	Anita Cooper EV43	Don Harris ER41	Jay Dennis ER21 (Acting)	Rob Lambdin EM03	Ralph Heusinger ES12	Kate Estes ER21 (matrixed)		Dan Thompson Rose Lindsey
Spacecraft/Payload Integration and Evolution (SPIE) Office Manager **SPIE Deputy Manager** **Assistant Manager** **Technical Assistant** **SLS Chief Technologist**	**Chris Crumbly** **Steve Creech** **Lori Mullins** **Joe Gentry** **Fred Bickley**	**SPIE CE** **SPIE Deputy CE**	**Rene Ortega** **Jeff Brown**	Tony Lyons EV70 Alt: Steve Battle EV70	Susan Elrod EV41	Mark Hill EV30	Rachel Garces ER22	Andy Hodge EM03	Terry Roberts ES10	Jimmy Wrape Acting EO40	Mike Roberts ET30	Chris Cowart Warren Woods
		SPIE CE for Evolvability **SPIE Deputy CE for Evolvability**	**Keith Dill** **George Young**				Pat Lampton ER01 R.H. Coates ER21	Sherrie Millwood EM03				POC:Chris Cowart

Exploration Systems Development (ESD) Natural Environment Specification Documents Maintained by MSFC Natural Environments

- SLS-SPEC-159, Cross-Program Design Specification for Natural Environments (DSNE)
  - Contains natural environment specifications to be used by all ESD programs
  - Not a requirements document
  - Each program selects environments that they will be exposed to and address them in terms of design to withstand, operationally mitigate, or accept as risk

- SLS-SPEC-044-07, SLS Program Vehicle Design Environments Volume 7: Natural Environments
  - Selects DSNE environments that are applicable to each SLS element, and describes how they are addressed (in terms of design, operational mitigation, or acceptance of risk)
  - Is a requirements document and is pointed to by the SLS Systems Requirements Document

SLS-SPEC-159 DSNE Update to Revision C – April 2015

- Update the sand & dust environment in Section 3.1.8 'Aerosol Environment for Ground Operations at KSC'
  - Method 510.6 of MIL-STD-810G Change 01 describes process for sand/dust testing
  - However, particle concentrations in Method 510.6 (10.7 g/m^3) are intended for severe sand/dust condition in dessert areas
  - Particle concentrations in MIL-STD-810G Part3, Section 5.7 (0.177 g/m^3) represent naturally occurring concentrations
  - Section 3.1.8 now states the test procedure for sand/dust is Method 510.6, but the concentration to use with the test is 0.177 g/m^3

- Include adjustment factor for conversion between heights above ground level and heights above Cross Program reference datum in Section 3.1.3 'Ground Winds for Transport and Launch Pad Environments' and 3.2.1 'Ground Winds Environments During Launch'
  - Ground wind data heights are with respect to ground level. Engineering assessment are relative to vehicle and Mobile Launcher (ML) coordinate systems
  - SLS-SPEC-048 Rev C, Cross Program Integrated Coordinate Systems provides vehicle and ML coordinate systems relative to the North American Vertical Datum of 1988 (NAVD-88), but does not include ground level height
  - Surveyor data from KSC shows ground level in the Pad 39B area is approximately 16 feet (4.9 m) above the NAVD 88 reference datum

SLS-SPEC-159 DSNE Update to Revision C – April 2015

- Update wording regarding uncertainties associated with Meteoroids and Orbital Debris environment models in Section 3.3.6
  - Adds verbiage stating uncertainty is included in ORDEM 3.0, and is to be included in future version of the Meteoroid Engineering Model
  - No environment definition change

- Correct the unit in label for Aluminum Shield Depth in Table 3.3.1.10.2-3, located in Section 3.3.1.10.2 'Geomagnetic Unshielded'
  - Should be specified in mm, not cm

- Correct the unit in label for Solar Spectral Irradiance in Table 3.3.10-1, located in Section 3.3.10 'Solar Illumination'
  - Should be specified in W m-2 micron-1, not W m-2 m-1

- Updated SAE ARP5412 & SAE ARP5414 to SAE ARP5412 Rev. B & SAE ARP5014 Rev. A in the Applicable Documents Table in Section 2.1.1
  - These documents are used to describe the lightning strike environment

SLS-SPEC-044-07 SLS NE Environments
Update to Revision C – Expected Late April 2015

- Updated to become a Cross-Program document
  - The document is being expanded to include tailored natural environment descriptions for Orion MPCV & Ground Systems Development Office