John F. Kennedy Space Center

LAUNCH SERVICES PROGRAM

NASA
Launch Services Program

Earth Venture AO Pre-Proposal Conference
July 12, 2011

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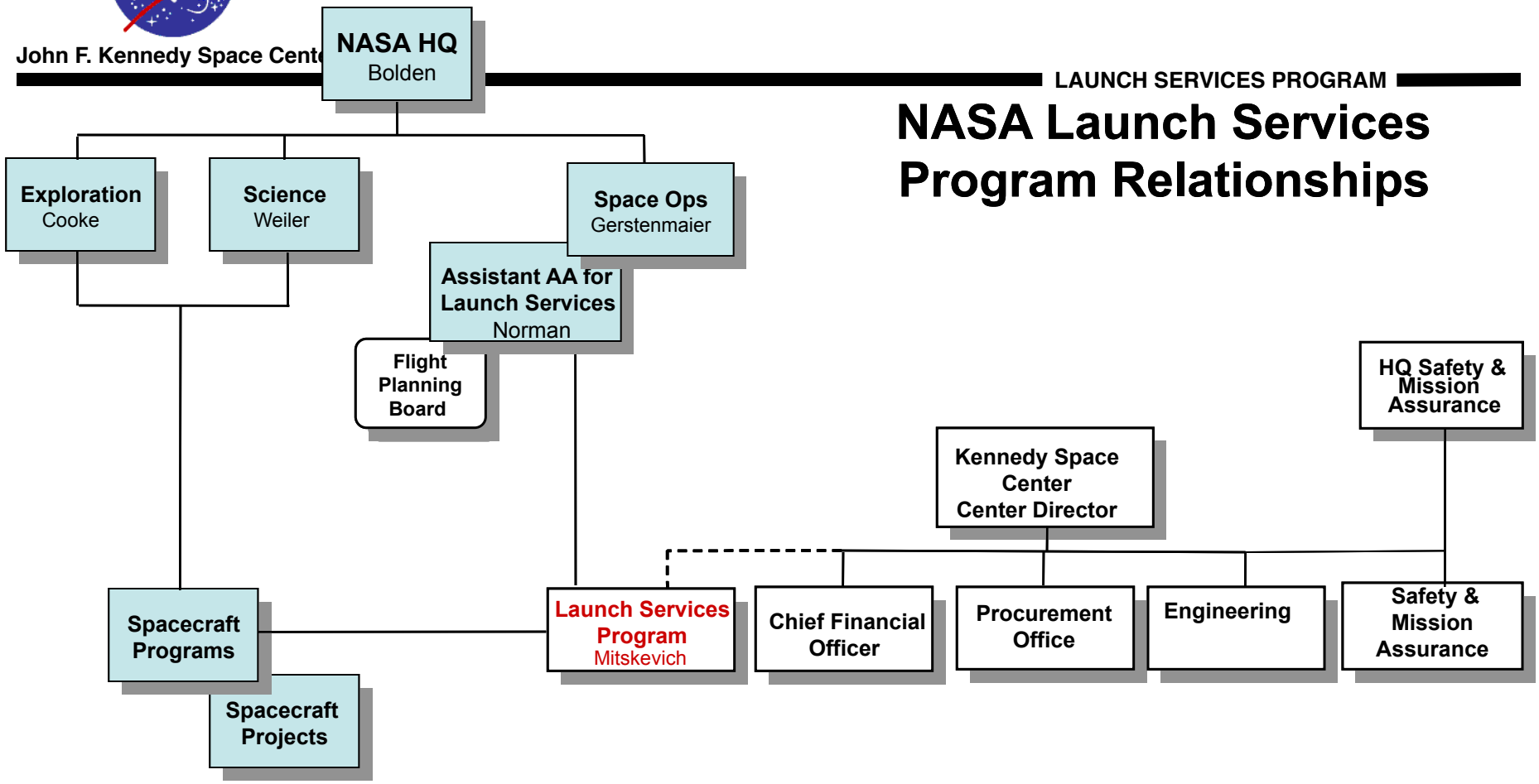
NASA Launch Services Program Relationships



Interfaces to other NASA Centers

GRC Technical Support | SSC Propulsion Support | GSFC Spacecraft Projects | MSFC Technical Support | JPL Spacecraft Projects | ARC Spacecraft Projects

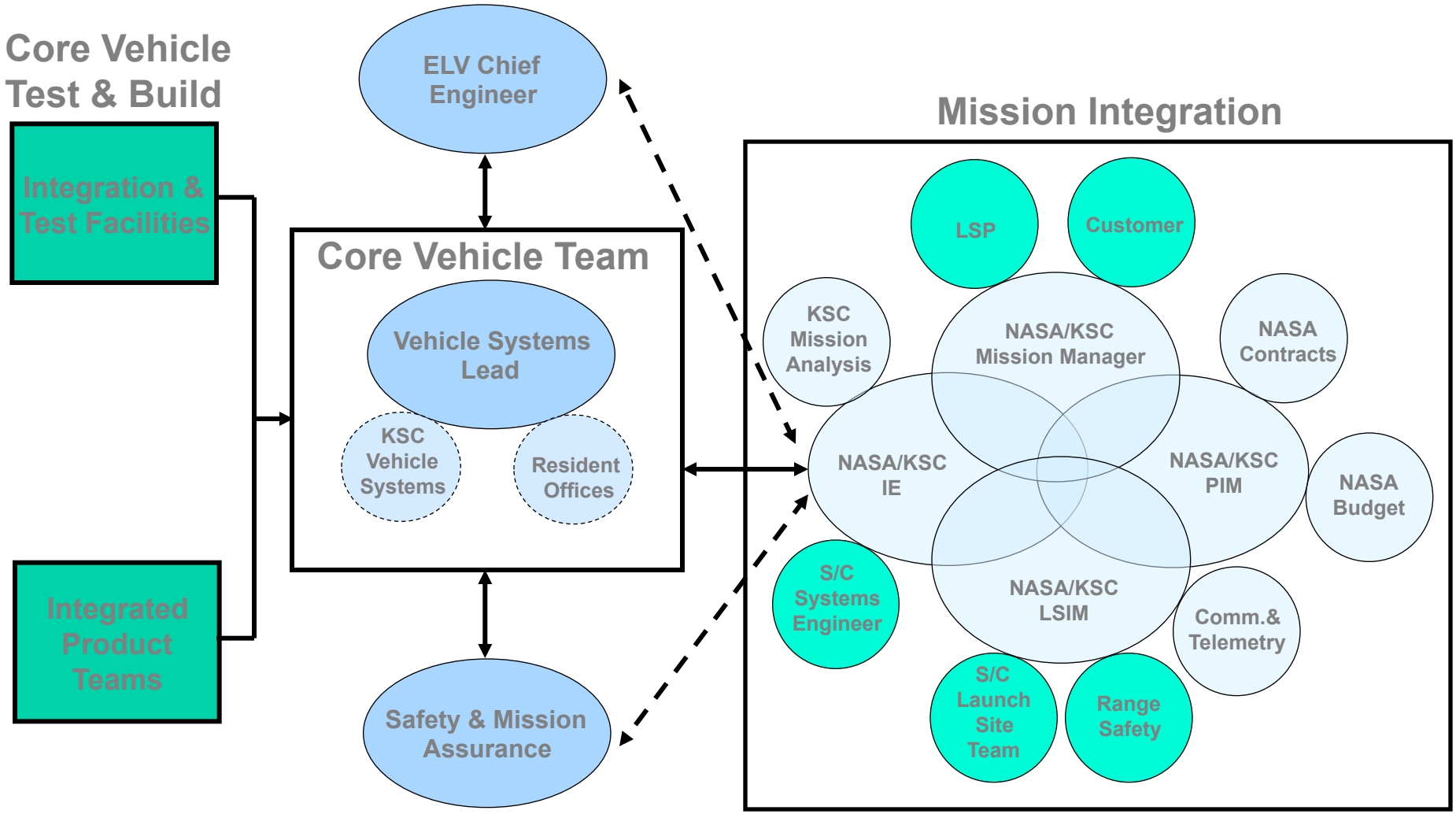
Launch Services Program

The Launch Services Program provides management of the launch service, technical oversight of the launch vehicle production/test, coordinates and approves mission-specific integration activities, provides mission unique launch vehicle hardware/software development, provides payload-processing accommodations, and manages the launch campaign/countdown.

LSP Functional Structure

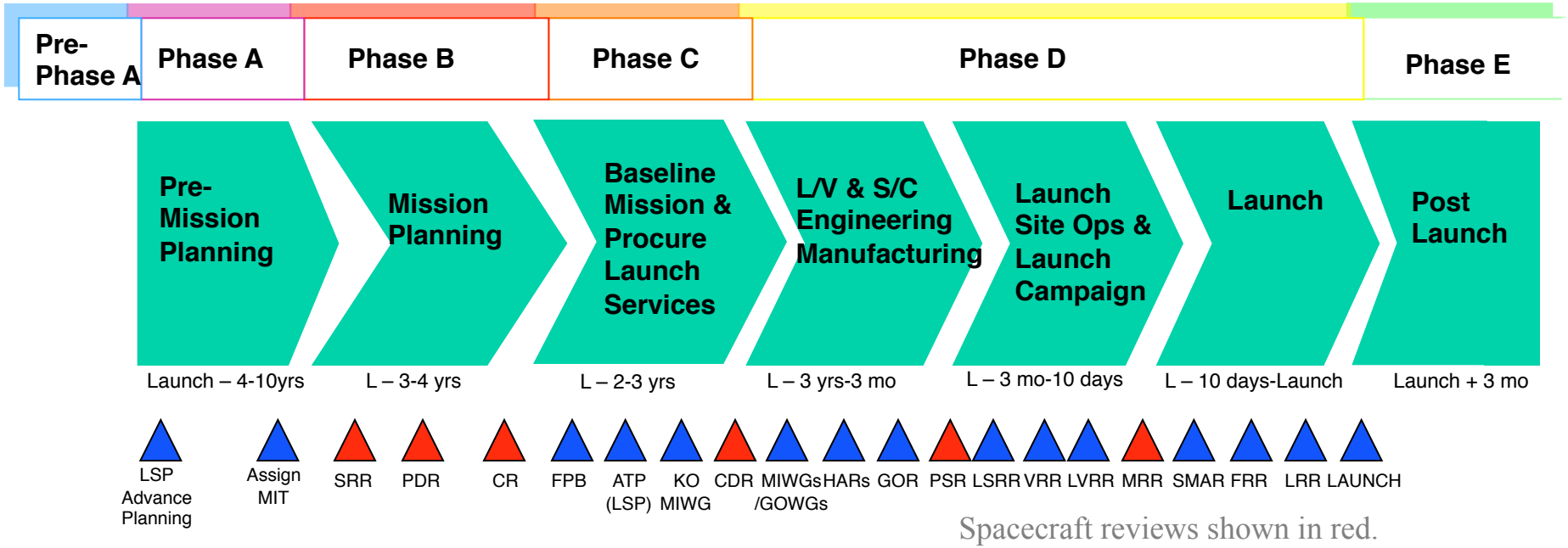
- LSP procures/provides a Launch Service
  - Its more than the basic launch vehicle
  - We don't buy a tail number
  - This is a commercial FFP procurement with additional insight and oversight
- To enable this, LSP has two functional sides
  - Mission integration
    - » Mission Integration team assigned to each mission
    - » Manages mission specific procurement, integration, and analysis
    - » Includes launch site integration and processing
  - Fleet management
    - » Personnel assigned to each contracted rocket
    - » Includes resident offices within the production facilities of all active providers
    - » We watch the production and performance of entire fleet – we certify the manufacture's production line, not just a particular unit (tail number)
    - » We have a say in any change/upgrade/anomaly
    - » Big stick – no-go for launch
- Interface with Safety and Mission Assurance
  - Safety
  - Quality

Technical Information flow into the MIT



Ground Rules

- Acquisition of a NASA-provided domestic expendable launch vehicle proposed for this AO will be procured and managed by the NASA/ Launch Services Program (LSP) via the NASA Launch Services (NLS) contract.
- The LSP will competitively select a launch service provider for these missions based on customer requirements and NASA Flight Planning Board (FPB) approval.



Spacecraft reviews shown in red.

Available Vehicles

- Assumption of a specific launch vehicle configuration as part of this AO proposal will not guarantee that the proposed LV configuration will be selected for award of a launch service competitive procurement
  - Firm technical rationale for sole source justification is required in the proposal, and NASA would have to obtain appropriate approvals.
- The Agency policy, NPD 8610.7, “Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Mission” has been modified so newer launch service providers are eligible earlier to compete for any of NASA’s missions.

Available Vehicles - Continued

- Most likely candidate vehicles for Earth Venture AO that are available on the NLS II contract are
  - Pegasus XL
  - Falcon 1
  - Athena 1

- Bidders must remain compatible with vehicles that provide their performance requirements

- LSP uses the NLS II contract and not the launch vehicle providers users guides when determining LV configurations and performance.

Launch Service Budget

- The launch service includes:
  - The launch vehicle, engineering, analysis, and minimum performance standards and services provided by the contract.
  - Launch Site Processing
  - Range Support
  - Down Range Telemetry support (launch vehicle only)
  - Standard Mission Uniques – these are items typically necessary to customize the basic vehicle hardware to meet spacecraft driven requirements. Already budgeted for are items like Pre-ATP studies such as coupled loads and/or trajectories analysis, a GN2 or pure air purge prior to T-0 and 10,000 Class integration environment.
  - Budget does not include launch delays.

Option Costs

Non-standard services and options that proposers must account for:

Additional Options:	Launch Date NLT	Total ($M)
Mission Unique Adapter	12/16	1.0
Payload Isolation System*	12/16	1.5
Supplemental Propulsion**	12/16	proposer provided
Additional Options	**Launch Date NLT**	**Total ($M)**
Mission Unique Adapter	12/17	1.04
Payload Isolation System*	12/17	1.56
Supplemental Propulsion**	12/17	proposer provided
Additional Options	**Launch Date NLT**	**Total ($M)**
Mission Unique Adapter	12/18	1.08
Payload Isolation System*	12/18	1.63
Supplemental Propulsion**	12/17	proposer provided

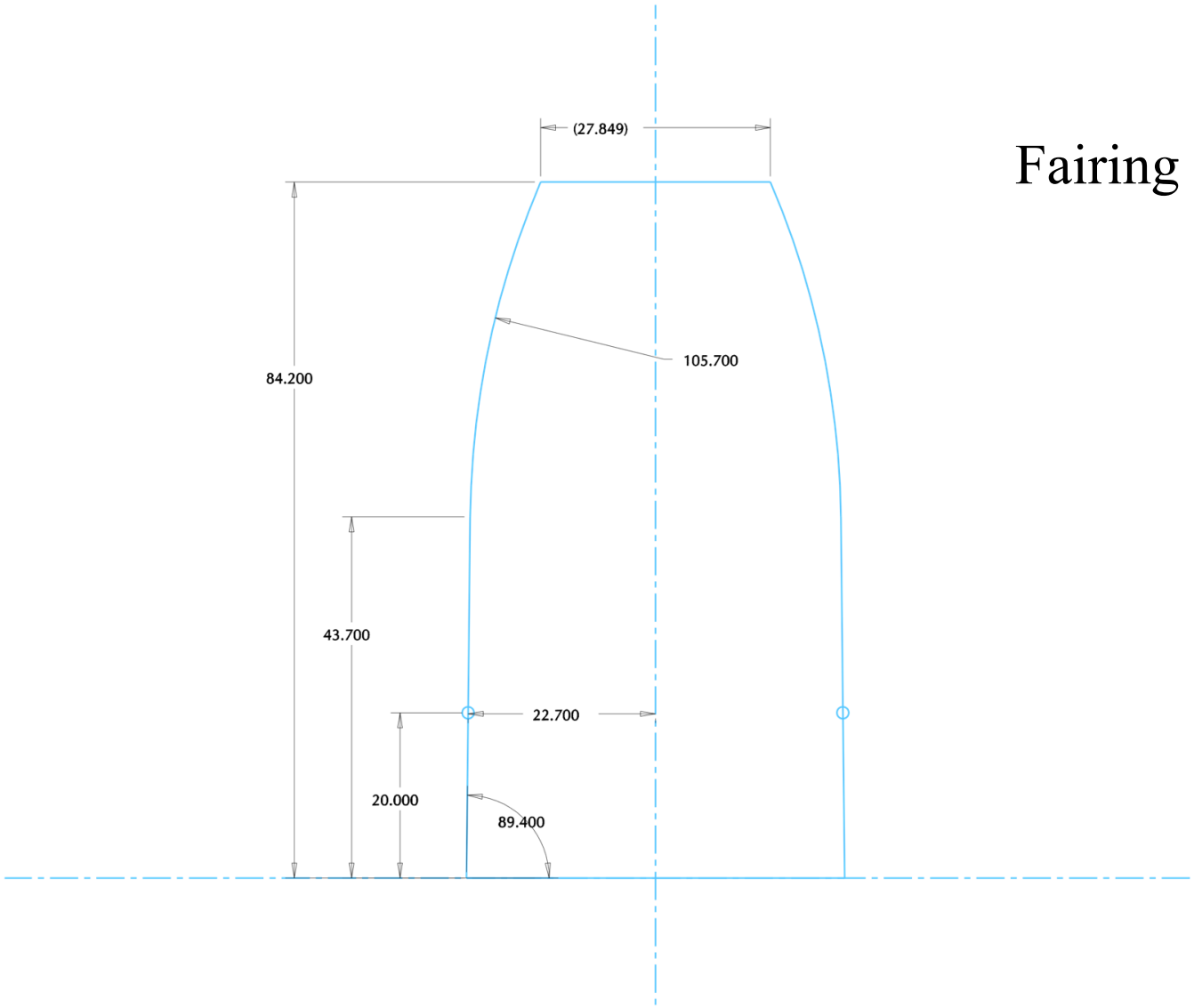
* Bidders may choose to provide their own isolation system.
** Due to the multiple launch vehicle configurations within this launch vehicle class, supplemental propulsion systems must be defined and provided by the proposer to meet mission requirements. The system proposed and the spacecraft shall remain within the fairing envelopes provided.

Performance by Launch Site

Range	Assumed Inclination - Degrees	Altitude Range km	Max Performance kg
Cape Canaveral Air Force Station, CCAFS	28.5 □ - 51.6 □	200 - 2000	450
Vandenberg Air Force Base, VAFB	60 □- 90 □, SunSynch	200 - 1200	375
Wallops Flight Facility, WFF	38 □ - 51.6 □	200 - 1300	435
Reagan Test Site, RTS	0 □ - 90 □, SunSynch	200 - 2000	450

- This performance does not include the effects of orbital debris compliance, which must be evaluated on a mission-specific basis. This could result in a significant performance impact for missions in which launch vehicle hardware remains in Earth orbit.
- Guidance reserves account for 3-sigma flight performance.
- Performance is for baseline configuration; non-standard, mission-unique hardware will require additional assessment.
- 38-inch (0.96-meter) separation system.
- Mass of entire separation system is book-kept on the launch vehicle side.
- Listed performance is for separated spacecraft mass.

Static Envelopes



Fairing Envelope

LSP SMART = Supplemental Advisory and Risk Team

- While LSP believes the full LSP launch service provides the best value and highest probability of launch success, we recognize that some customers can not use our full service
  - LSP's job is to enable NASA missions to get to orbit
  - LSP expertise can be used throughout the industry
  - SMART advisory services can benefit full service customers

- Advisory Services are a SMART part of LSP providing mission excellence for all NASA missions
  - Typical customers would be SMD Mission Projects launching on FAA licensed commercial, DoD provided, or Foreign Cooperative vehicles
  - Each type of launch has its own unique considerations for LSP Advisory Services

Supplemental Advisory and Risk Team Tenets

- SMART services integrate LSP Program, Engineering, SMA positions as advice to our customer/partner
  - Offering advisory services, but not inserting ourselves without customer request
  - Overall Advisory Plan Exists, but LSP will document each advisory service separately to define what LSP will do, responsibilities, and resources required

- LSP utilizes existing insight and risk management processes to provide evaluations of mutually agreeable items
  - Subject to constraints and data provided by the partner/customer
  - Reporting of risks by LSP shall be coordinated with the customer project and will include a range of mitigation options and offer a coherent go-forward plan

- LSP won't take overall mission assurance responsibility when in an advisory role because mission assurance is a complex combination of the full complement of LSP services
  - The responsibility for overall mission success of the Mission rests with the Spacecraft Project and SMD
  - Create Memorandum of Understanding (MOU) between LSP and the Project defining the roles and responsibilities associated with a SMART with SMD agreement and Agency Stakeholder knowledge

Examples of LSP advisory services

- NASA delivery on orbit missions
  - CRS: Falcon 9 initiated mid 2009, Taurus 2 initiated mid 2010
  - GOES-O/P on Delta IV completed
- Foreign cooperative missions
  - James Webb Space Telescope (JWST): Ariane V
  - Global Precipitation Measurement (GPM): Japanese H-IIA
- DoD provided launch services
  - NASA LADEE mission: Minotaur V
  - DoD Operationally Responsive Space (ORS) mission approved but not executed due to LV availability
- Launch vehicle centric services
  - Falcon 1 initial DARPA missions completed
  - Taurus 2 ALP and Space Act Agreement initiated early 2008
  - SLV-A/B ALP and Space Act Agreement completed
  - Minotaur IV+ IPT initiated in 2007

Spacecraft Project Responsibilities

- Provided with commercial level of insight into the flight worthiness of the launch vehicle, by the launch provider who has the responsibility to make that determination
- Provide all contractual direction to their contractors
- Determine the adequacy and approval/concurrence for deliverables and reviews described in their launch arrangement
- Identify specific items of concern and contact LSP to determine mutually agreeable tasks and reviews that require LSP support
- Provide the required data or access necessary for technical evaluation(s) requested of LSP
- Resolution of technical differences between LSP, the spacecraft contractor, and/or the launch provider
- Project Manager has the responsibility for giving the NASA spacecraft "Go for launch"

SMART Team Baseline Tasks

- The Launch Services Program will participate in the typical reviews with a Mission Manager or Vehicle Systems Engineer at a minimum.
  - Subsystem Engineers and analysts may attend based on the issues identified by the Project
  - LSP reserves the right to have Program or Engineering Management participation at their discretion.

- The Launch Service Program will evaluate the risks and issues identified by the launch provider and provided to the spacecraft customer
  - Depth of LSP evaluation will be mutually agreeable between the Project and the LSP based on the level of risk, or significance of the issue in question.
  - The evaluation will be subject to the data provided by the launch provider under the agreement to launch the mission
  - In addition mutually agreeable Launch Vehicle related tasks, may be requested of the LSP by the Project.
  - LSP will provide cost and schedule estimates for any assigned task beyond the scope of the risk/issue evaluation.

Additional Options

Capability	Max Mass	Volume	Interface	Status
ESPA	400 lbs per slot	30”x30”38”	15” Clampband	Operational
A-Deck	2000 lbs	60” x 50”	15” and 38 Clampband	ILC 2013
IPC	2000 lbs	60”-in dia	8”, 15”, 37” Clampband	Operational
P-POD 3U	8.8 lbs	3.9”x3.9”x15.45”	P-POD bracket	Operational
6U	26 lbs	7.8’x7.8”x15.45”	6U Bracket	ILC 2012
I CRS flights	Depending on mounting locations and size of SC			
Hosted Payloads Flights	Depending on location on host payload and size of instrument			

- Launch Vehicle and launch opportunities are depended on when the payload (EV-2) will be ready

Summary

- It is the Launch Service Program's goal to ensure the highest practicable probability of mission success while managing the launch service technical capabilities, budget and schedule.
- Questions must be officially submitted to garrett.l.skrobot@nasa.gov; LSP will gladly respond as quickly as possible.

Back Up

Evaluation

- **Launch Service Technical Evaluation:**
  - **Overall Assessment: - Given the ground rules in the AO, is the proposed launch vehicle (LV) concept feasible for this application? (Yes or No)**
  - **Comments:_____**
    _____
    _____
- **LV Performance: Area of concern (Yes or No)**
  - **Proposed LV configuration: _____**
  - **Proposed Launch Date: _____**
  - **Launch Period (MM/DD/YYYY to MM/DD/YYYY): _____/____/_____ to _____/____/_____**
  - **Launch Window (On any given day of the launch period Minutes:Seconds): _____ : _____ .**

Evaluation

- **LV Performance: Area of concern (cont)**
  - **Orbit requirements: Apogee: _____ km Perigee: _____ km Inclination: _____deg.**
  - **High Energy requirements: C^3: _____ km^2/sec^2 DLA: _____deg RLA: _____deg**
  - **Proposed LV Performance: _____**
  - **Mass (including reserves) Dry Mass: _____ kg Wet Mass: _____ kg**
  - **Dry Mass Margin: _____ kg _____ %**
  - **Wet Mass Margin _____ kg _____ %**
  - **Formulas:**
  - **Mass Margin kg = LV Performance – S/C Mass (including reserves)**
  - **Mass Margin % = [(Mass Margin kg)/ S/C Mass (including reserves) kg] X 100**
  - **LV Performance Comments/issues/concerns:**

Evaluation

- Launch Service Cost Assessment: Area of concern (Yes or No)
  - Is there additional funding for any mission unique modifications/ services? (Yes or No)
- LV Integration: Area of concern (Yes or No)
  - Does the proposer have experience in LV integration? (Yes or No)
- LV to Spacecraft Interface: Area of concern (Yes or No)
  - Proposed Payload Fairing (PLF) _____
  - Spacecraft (S/C) Dimensions: Radial:_____ m Height _____ m
  - Any intrusions outside of the PLF usable Static volume? (Yes or No)
  - Mechanical Interface:
  - Standard Adapter: _____ Custom Adaptor: _____
  - Electrical Interface:
  - Standard _____ Pin(s) Connector(s): (Yes or No)

Evaluation

- **LV to Spacecraft Interface: Area of concern (Yes or No)**
- **Mission Unique requirements:**
  - **Instrument T-0 GN^2 Purge: (Yes or No)**
  - **T-0 S/C Battery Cooling: (Yes or No)**
  - **Planetary Protection Requirements: (Yes or No)**
  - **Contamination Control Requirements: PLF: (Yes or No) LV adapter: (Yes or No)**
  - **Cleanliness Level: _____ other: _____**
  - **Unique Facility Requirements: (Yes or No)**
  - **Pad: _____**
    - » **S/C Processing Facility: _____**
  - **S/C Environmental Test Plans**
  - **Environmental Test Plan/Flow described: (Yes or No)**
  - **Test Levels provided: (Yes or No)**
  - **Test Schedule provided: (Yes or No)**
  - **Comments/issues/concerns:**

Evaluation

- **Spacecraft Schedule: Area of concern (Yes or No)**
  - **Adequate timing of: Launch Service Integration Start Time: (Yes or No)**
  - **S/C Environmental Test Program: (Yes or No)**
  - **Delivery of Verified S/C Model: (Yes or No)**
  - **S/C ship date: (Yes or No)**
  - **S/C to LV integrated Operations: (Yes or No)**
- **Missions with Radiological material Area of concern (Yes or No)**
  - **List the Radiological Sources:**

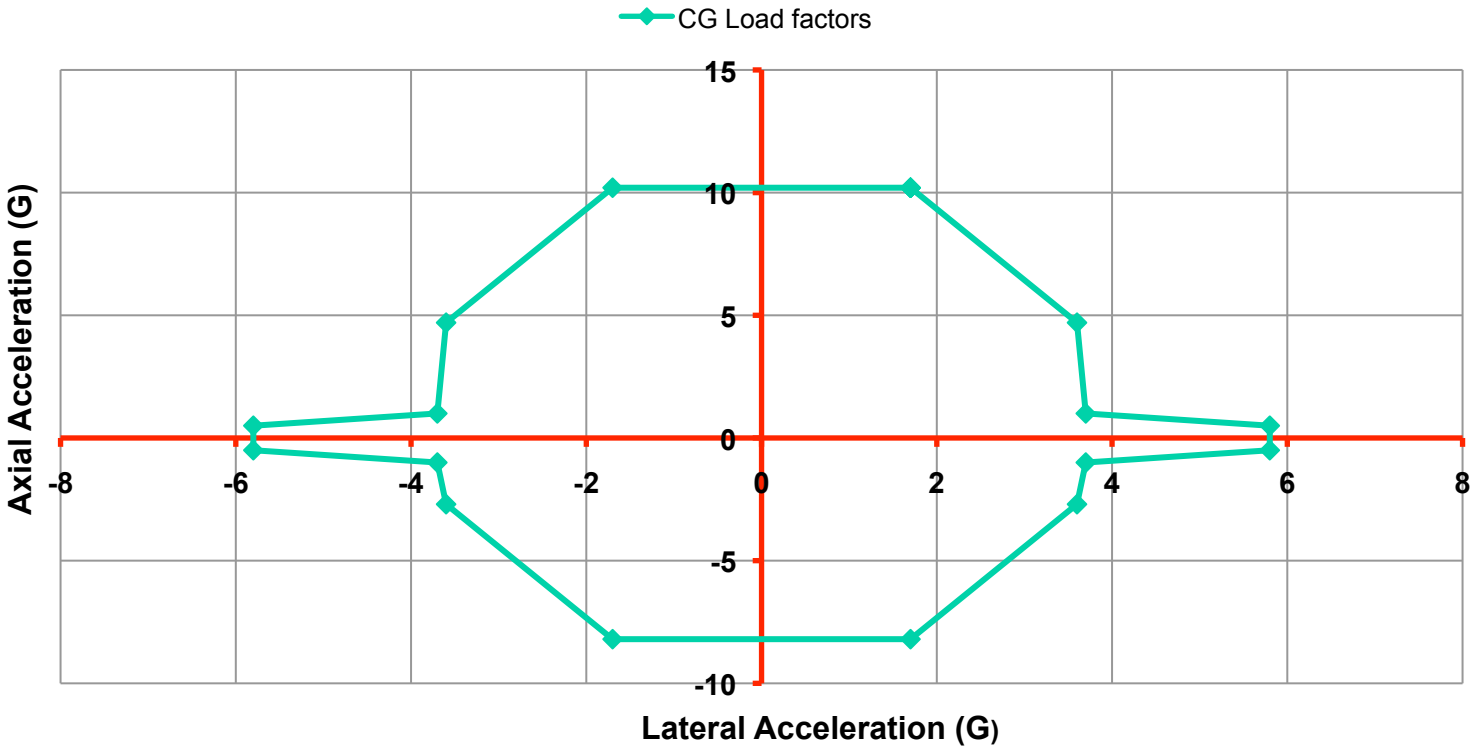
    _____
  - **Are unique facilities required to store/process the Radiological Sources? (Yes or No)**
  - **Any LV modifications required for additional safety or Launch approval? (Yes or No)**

Environments

- Attached are the combined environment of EV-2 for current NLS II launch vehicles:
  - Pegasus-XL, Falcon 1, Athena I
- Whenever possible, one enveloping environment is provided. If the resulting envelope is unrealistically conservative, then the bounding vehicle environments (listed as Vehicle A, Vehicle B, …..).
- Please note the following regarding environments:
  - The NLS II contract does not include the shock environment for Athena I and Athena II for a 38” sep system. These are not defined anywhere yet so no shock data for Athena.
  - All Athena (I and II) and Falcon (1 and 1e) numbers are subject to updates with flight data coming for both vehicles.
- All question regarding environment should be directed to the Launch Services Program.

CG Load Factor

Design Load Factors (to be applied to CG of Spacecraft)

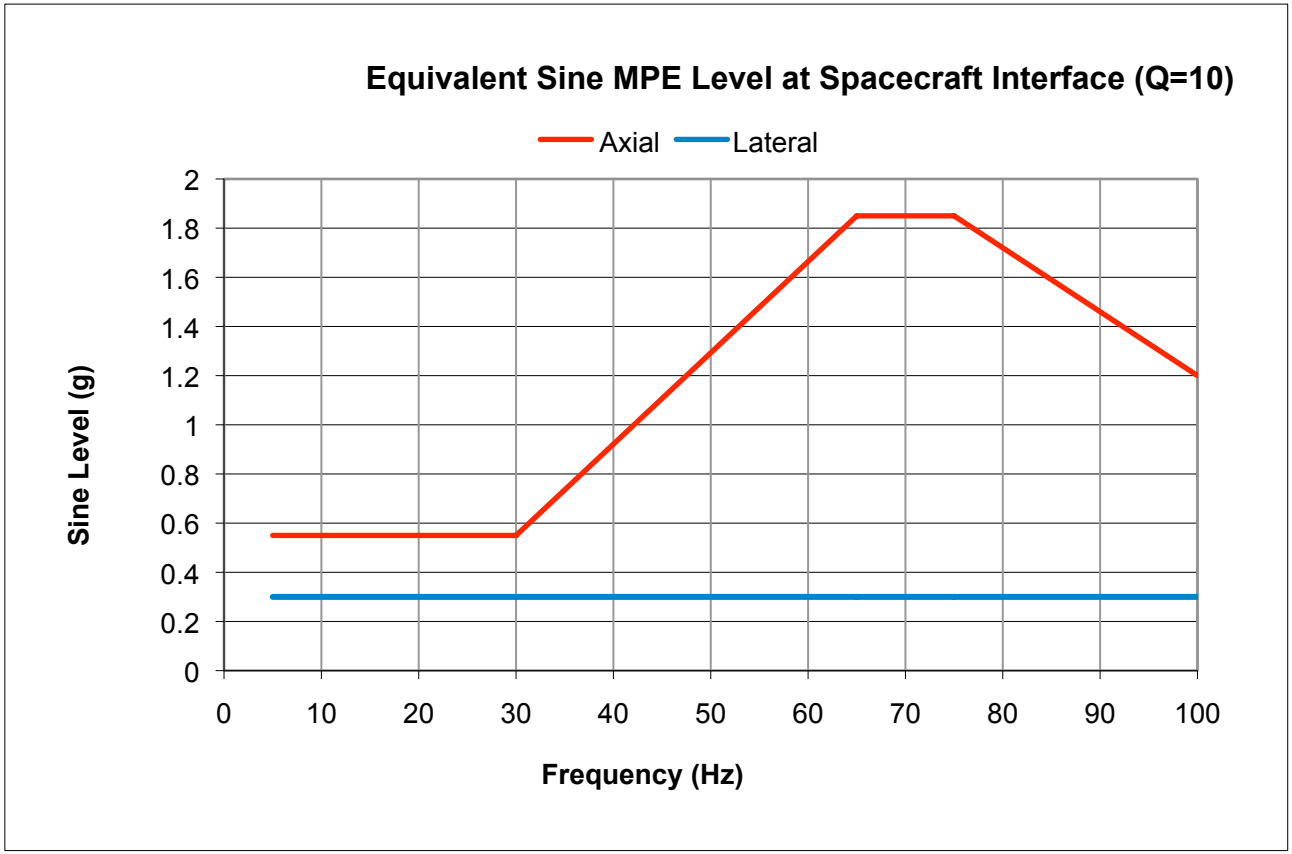


CG Load factors

Lateral (g's)	Axial (g's) *
1.7	10.2
3.6	4.7
3.7	1
5.8	0.5
5.8	-0.5
3.7	-1
3.6	-2.7
1.7	-8.2
-1.7	-8.2
-3.6	-2.7
-3.7	-1
-5.8	-0.5
-5.8	0.5
-3.7	1
-3.6	4.7
-1.7	10.2
1.7	10.2

* positive sign in axial load factor denotes compression

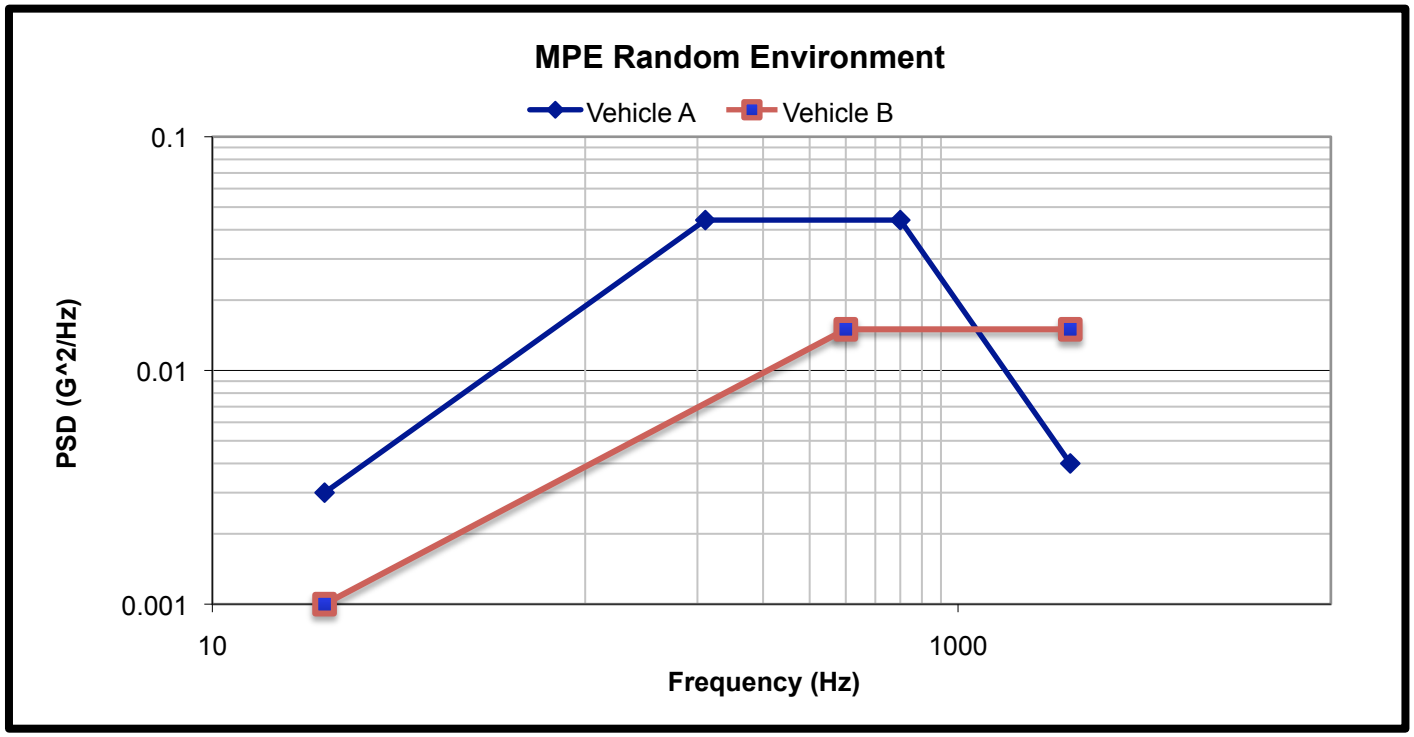
Sine



Equivalent Sine MPE Level at Spacecraft Interface (Q=10)

Frequency (Hz)	Axial	Lateral
5	0.55	0.3
30	0.55	0.3
65	1.85	0.3
75	1.85	0.3
100	1.2	0.3

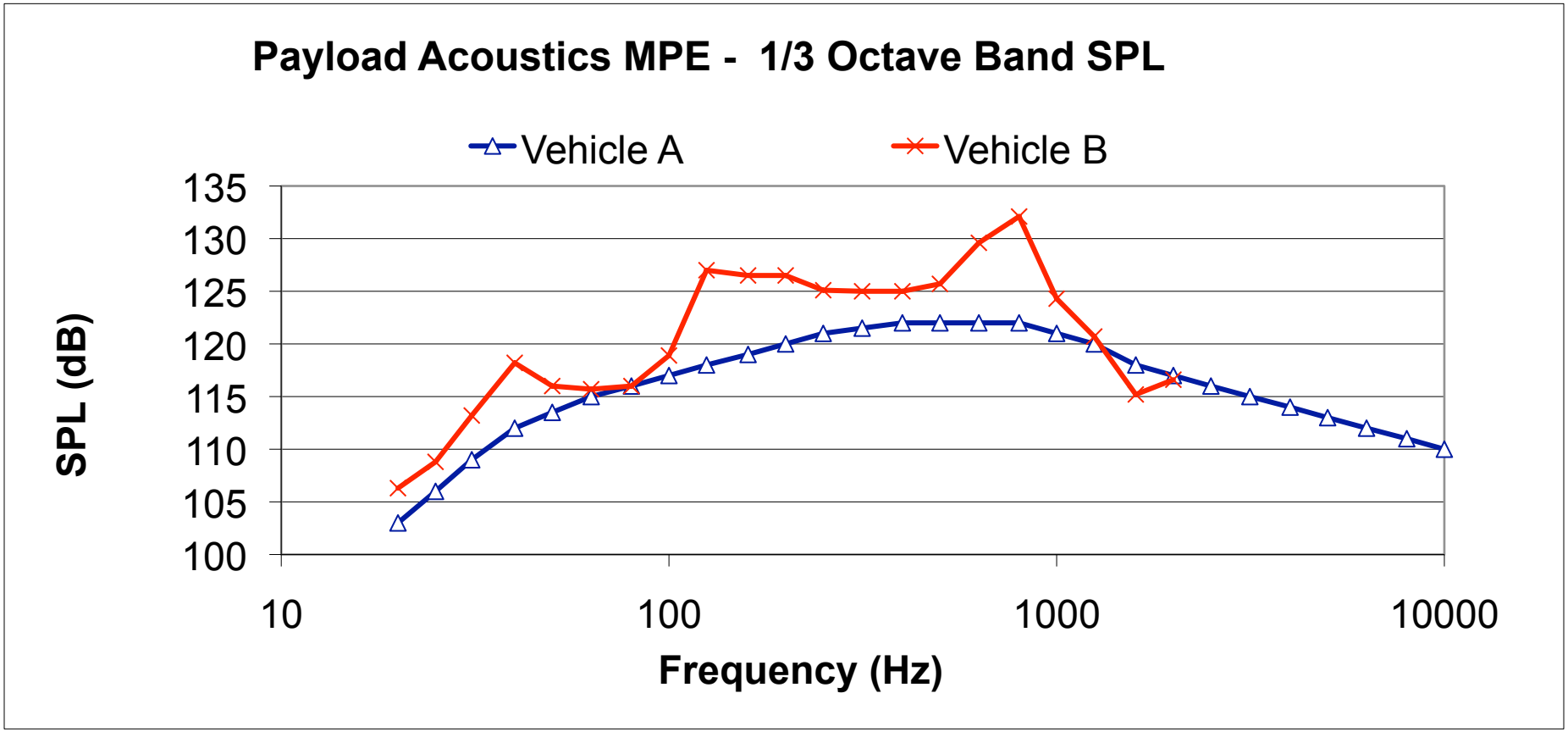
Random Vibration



Vehicle A		Vehicle B	
Frequency (Hz)	PSD (G^2/Hz)	Frequency (Hz)	PSD (G^2/Hz)
20	0.003	20	0.001
210	0.044	500	0.015
700	0.044	2000	0.015
2000	0.004		
Overall Grms	6.50		5.15

Random MPE Levels at Spacecraft Interface

Acoustics

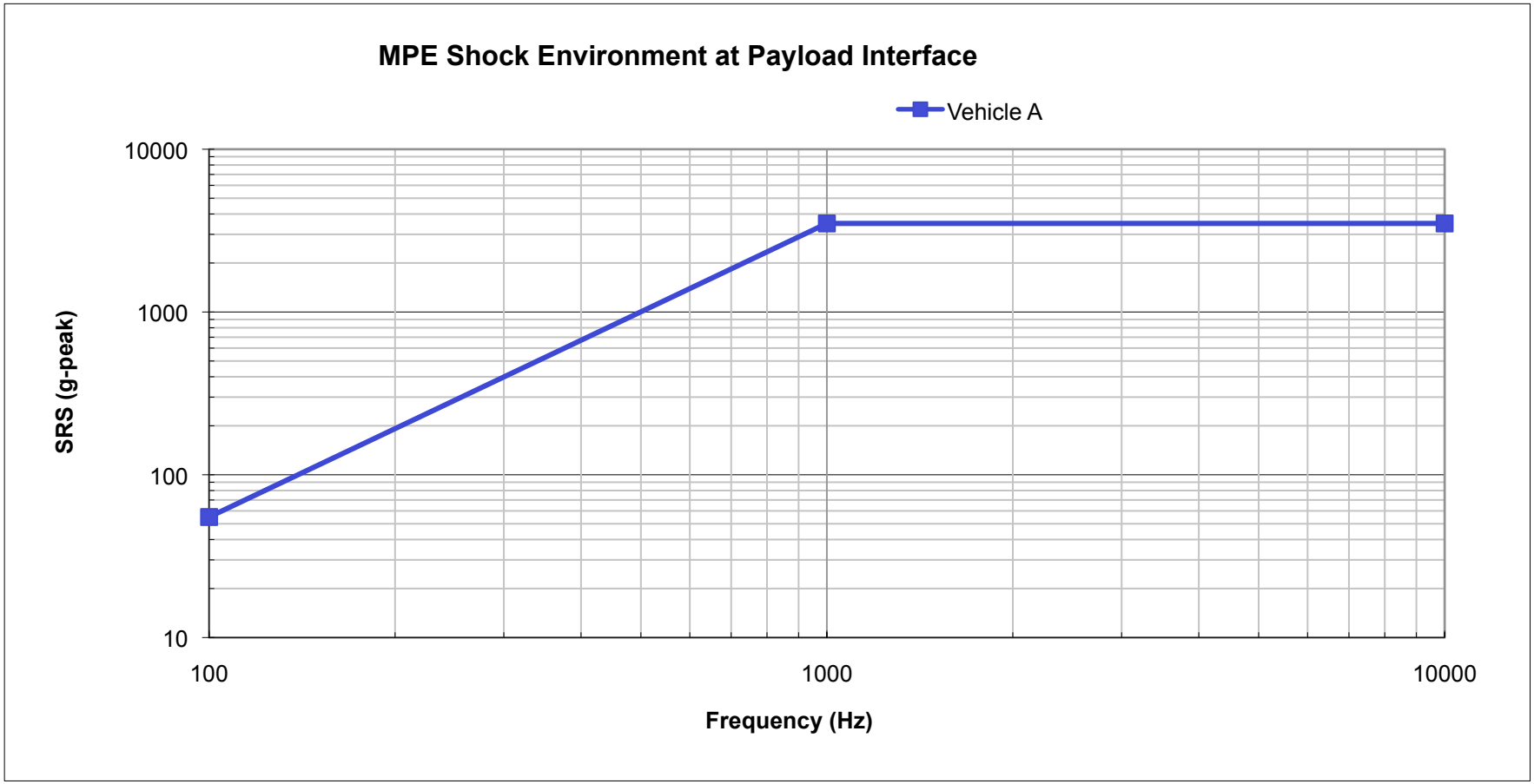

Payload Acoustics MPE - 1/3 Octave Band SPL
Vehicle A
Vehicle B
SPL (dB)
135
130
125
120
115
110
105
100
10
100
1000
10000
Frequency (Hz)

Acoustics

Acoustics MPE Level (1/3 Octave Band SPL)

Vehicle A			Vehicle B		
Frequency (Hz)	SPL (dB)	to compute OASPL	Frequency (Hz)	SPL (dB)	to compute OASPL
20	103	19952623150	20	106.3	42657951880
25	106	39810717055	25	108.8	75857757503
31	109	79432823472	31	113.2	2.0893E+11
40	112	1.58489E+11	40	118.2	6.60693E+11
50	113.5	2.23872E+11	50	116	3.98107E+11
63	115	3.16228E+11	63	115.7	3.71535E+11
80	116	3.98107E+11	80	116	3.98107E+11
100	117	5.01187E+11	100	118.9	7.76247E+11
125	118	6.30957E+11	125	127	5.01187E+12
160	119	7.94328E+11	160	126.5	4.46684E+12
200	120	1E+12	200	126.5	4.46684E+12
250	121	1.25893E+12	250	125.1	3.23594E+12
315	121.5	1.41254E+12	315	125	3.16228E+12
400	122	1.58489E+12	400	125	3.16228E+12
500	122	1.58489E+12	500	125.7	3.71535E+12
630	122	1.58489E+12	630	129.6	9.12011E+12
800	122	1.58489E+12	800	132.1	1.62181E+13
1000	121	1.25893E+12	1000	124.3	2.69153E+12
1250	120	1E+12	1250	120.7	1.1749E+12
1600	118	6.30957E+11	1600	115.2	3.31131E+11
2000	117	5.01187E+11	2000	116.6	4.57088E+11
2500	116	3.98107E+11	2500		
3150	115	3.16228E+11	3150		
4000	114	2.51189E+11	4000		
5000	113	1.99526E+11	5000		
6300	112	1.58489E+11	6300		
8000	111	1.25893E+11	8000		
10000	110	1E+11	10000		
		132.0583433			137.7920953

Shock



Shock MPE Levels at Spacecraft Interface

Vehicle A	
Hz	**SRS (g-peak)**
100	55
1000	3500
10000	3500