Advanced Mirror System Demonstrator (AMSD)

Statement of Work

Summary

AMSD GOALS

The Advanced Mirror System Demonstrator (AMSD) Project has two fundamental goals:

Develop Technical Processes which Dramatically Reduce Cost, Schedule, and Weight for Large-Aperture Optical Systems.

Mitigate Programmatic Cost, Schedule, and Weight Risk.

AMSD Objectives

Primary objective is to advance technology for rapidly and cost effectively producing very low mass mirror systems.

In addition, mirror system performance objectives must be demonstrated at ambient and cryogenic temperatures.

Secondary objective is to provide mirrors in support of NASA/DOD flight demonstration programs.

AMSD Base Ambient Requirements

Item	Requirement	Units
Shape	Hexagonal	
Areal Density **(1)**	< 15	kg/m^2
Petal Size	1.2 to 1.5	m (point to point)
Radius of Curvature	10 **(2)**	m
Prescription **(3)**	Off-Axis Parabola	
Total Surface Error **(4)**		
PV	250 / 100	nm
RMS	50 / 25	nm
RMS Micro-Roughness **(5)**	4 / 2	nm
Survivability		
Quasi-static	10	g
Vibro-acoustic	30 rms	g
Operating Temperature	300 $\pm$ 10	K
Survival Temperature	223 to 335	K
Traceable Design Life	10 / 15	years
Stiffness	**(8)**	
Dynamic Environment	**(9)**	
Traceability	**(10)**	

AMSD Base Cryogenic Requirements

Item	Requirement	Units
Shape	Hexagonal	
Areal Density (1)	< 15	kg/m^2
Petal Size	1.2 to 1.5	m (point to point)
Radius of Curvature	10 (2)	m
Prescription (3)	Off-Axis Parabola	
Total Surface Error (4)		
PV	250 / 100	nm
RMS	50 / 25	nm
RMS Micro-Roughness (5)	4 / 2	nm
Survivability		
Quasi-static	**NA**	g
Vibro-acoustic	**NA**	g
Operating Temperature	**35 +20 / -5**	K
Survival Temperature	**25 to 353**	K
Traceable Design Life	10 / 15	years
Stiffness	(8)	
Dynamic Environment	**NA**	
Traceability	(10)	

Areal Density

Areal density will be calculated from physical dimension and total mass measurements.

If the mirror does not include position actuators, their mass values as supplied by the vendor will be added to the total mass measurement.

Areal density will be calculated over the mirror's entire physical aperture.

Radius of Curvature

Absolute ROC shall be 10 m ± 1mm over operating temperature range.

All residual surface figure errors resulting from active control to achieve desired ROC must be included in the overall wavefront error.

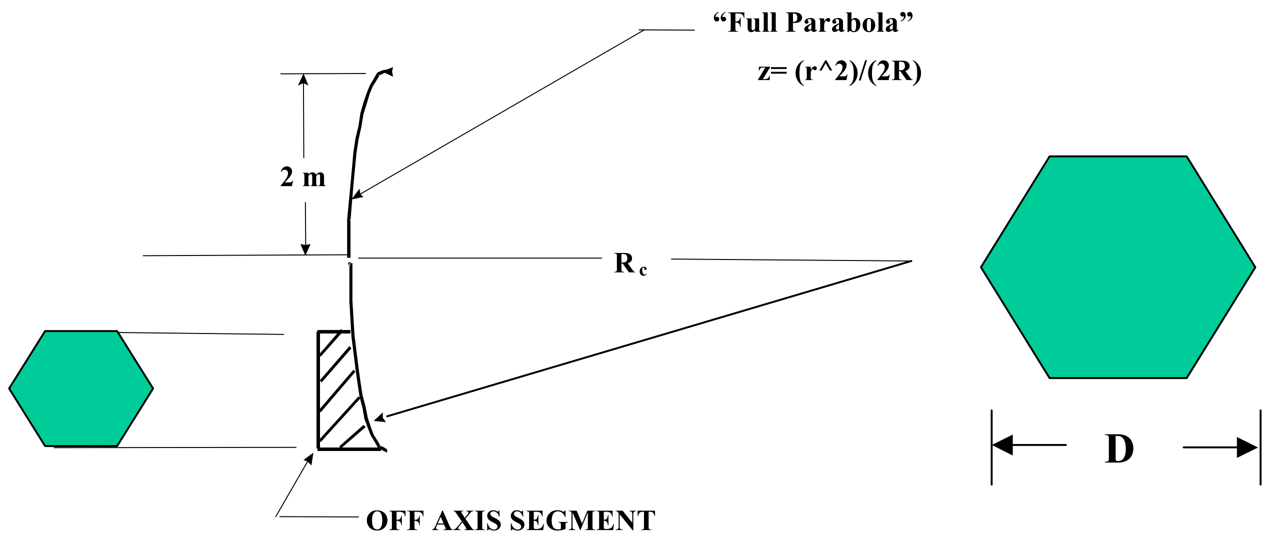
Actuator stroke and resolution must be demonstrated such that when incorporated into the mirror system they achieve a 0.00004m/d^2 ROC matching over the ROC tolerance band.

The contractor is also required to test for ROC change over the operating temperature range of the AMSD.

Active Control, if required, can be implemented to correct the ROC at each temperature range extreme after change in ROC data is acquired.

AMSD Prescription

Off-axis parabola is defined by the outer edge of a 4 meter segment whose width D is point to point.



Total Surface Error Requirement

Total surface error requirement is measured over a clear aperture 15 mm from the physical edge. Goal is entire physical aperture. Active control is allowed to obtain required surface figure.

Total Surface Error is defined to include:

low-spatial frequency (figure) (after removing Z0 to Z3)	Full Aperture to 0.26 meter (Z4 to Z36)
mid-spatial frequency (ripple),	260 to 1 millimeter
high-spatial frequency (micro-roughness)	1000 to 1 micrometer

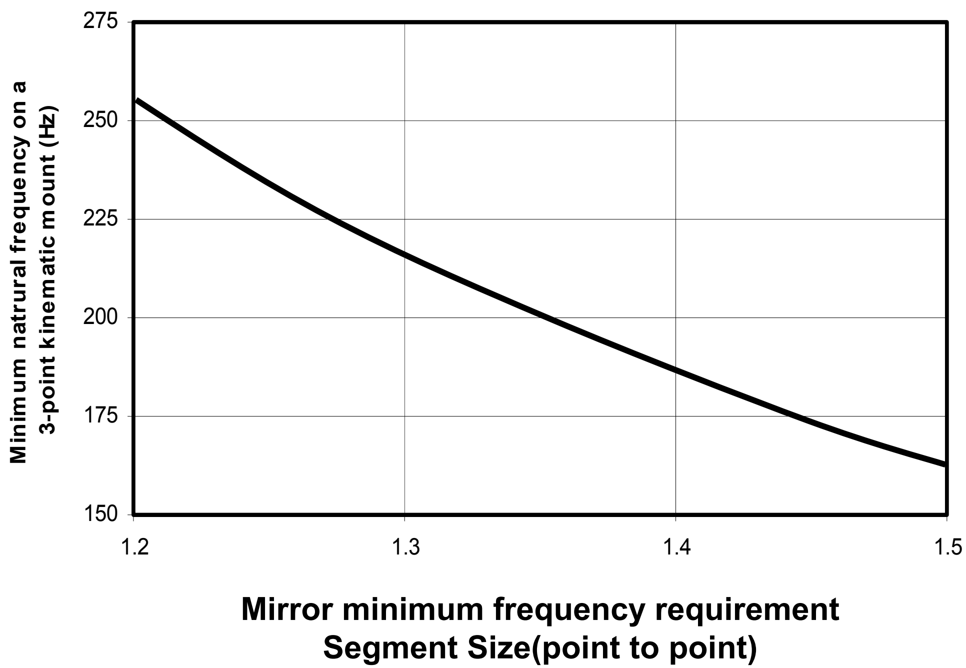
Total surface error shall be expressed as a composite 2-D PSD from full aperture to 1 micrometer. No PSD value shall deviate from its local, nominal average by more than 10X.

RMS micro-roughness from to 1 millimeter to 1 micrometer shall not exceed 4 nm rms. A goal of 2 nm rms is desired.

Stiffness Requirement

AMSD shall be designed to a minimum fundamental frequency traceable to a full flight mirror system.

Modal analysis and testing is required to define the first 5 structural modes that impact the optical surface.



Dynamic Environment

Model the mirror TSE in presence of three dynamic loads:

- Translational Base Disturbance Acceleration
- Rotational Base Disturbance Acceleration
- Filtered Laser Disturbance Acceleration

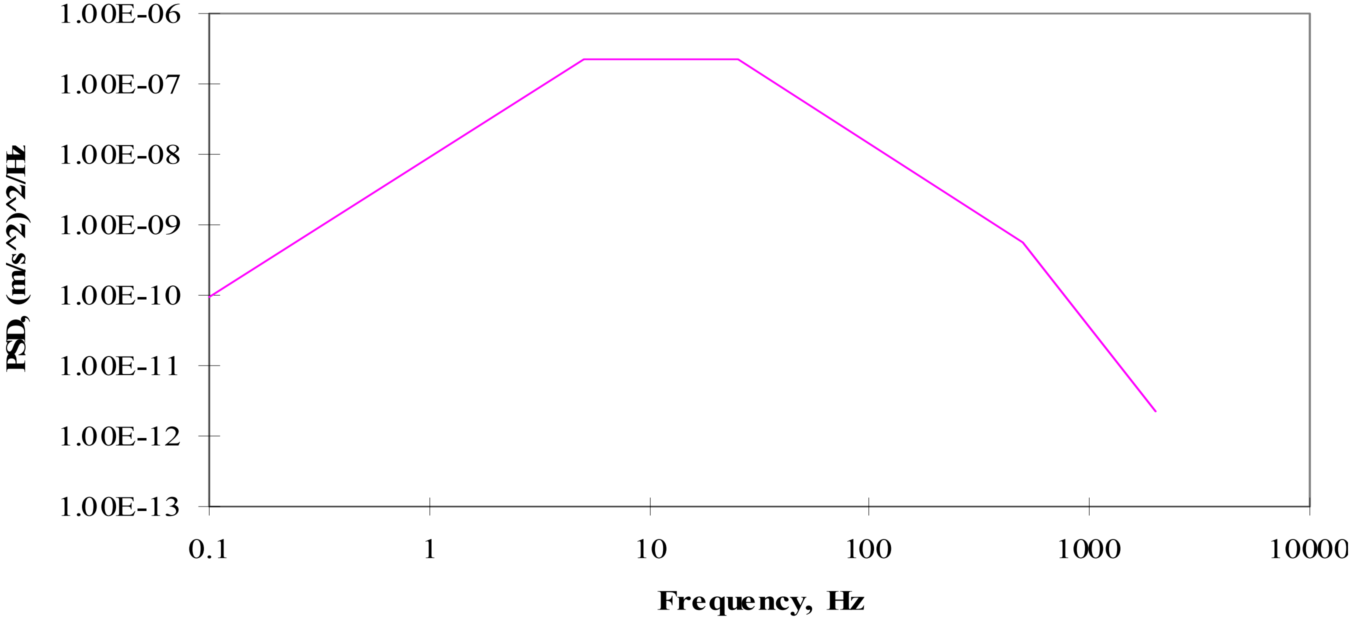
applied to mirror system at an ideal 3-point base interface.

Generate 2D PSD from full aperture to 100 mm

Model mirror survivability for vibroacoustic and acoustic pressure distribution loading during launch on EELV.

***** AMBIENT ONLY REQUIREMENT *****

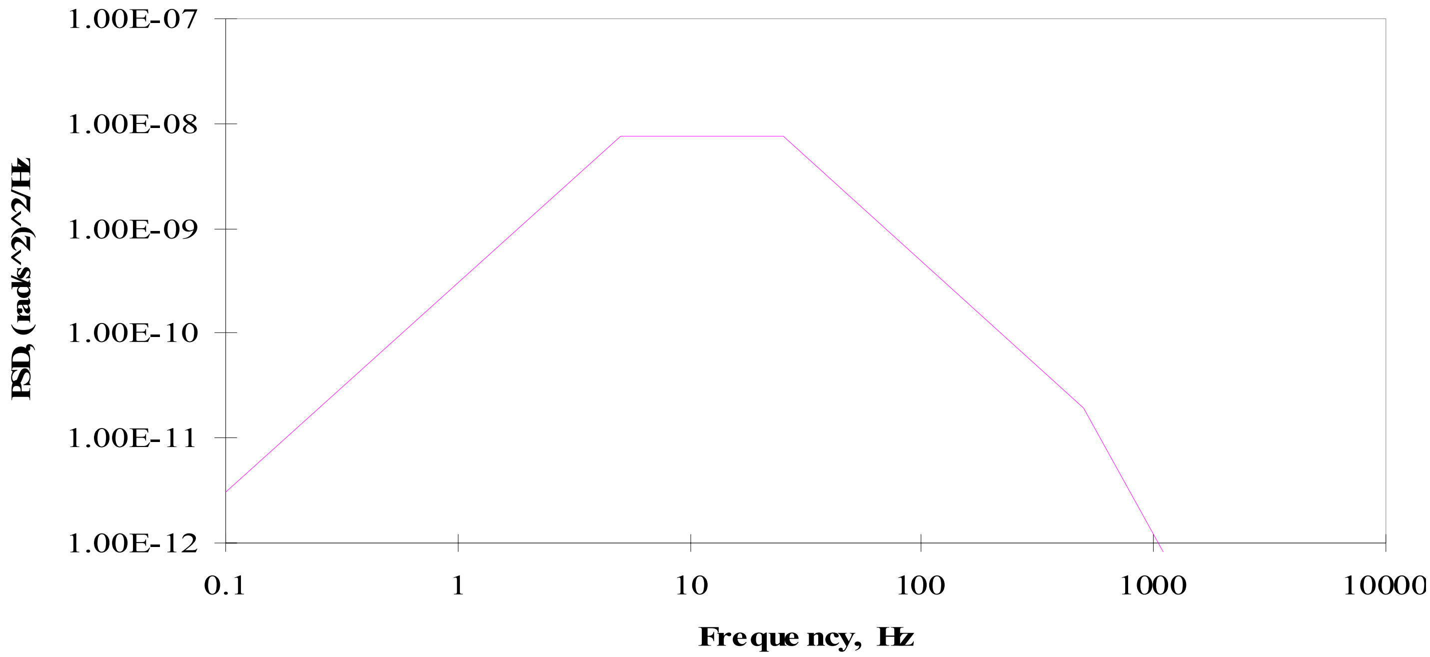
Translational Base Acceleration PSD



Frequency Range	PSD Value
0.1-5 Hz	+12 dB/Octave
5-25 Hz	2.5e-7 $(m/s^2)^2/Hz$
25-500 Hz	-12 dB/Octave
500-2000 Hz	-24 dB/Octave

Translational base acceleration PSD, Must be applied to all axes simultaneously.

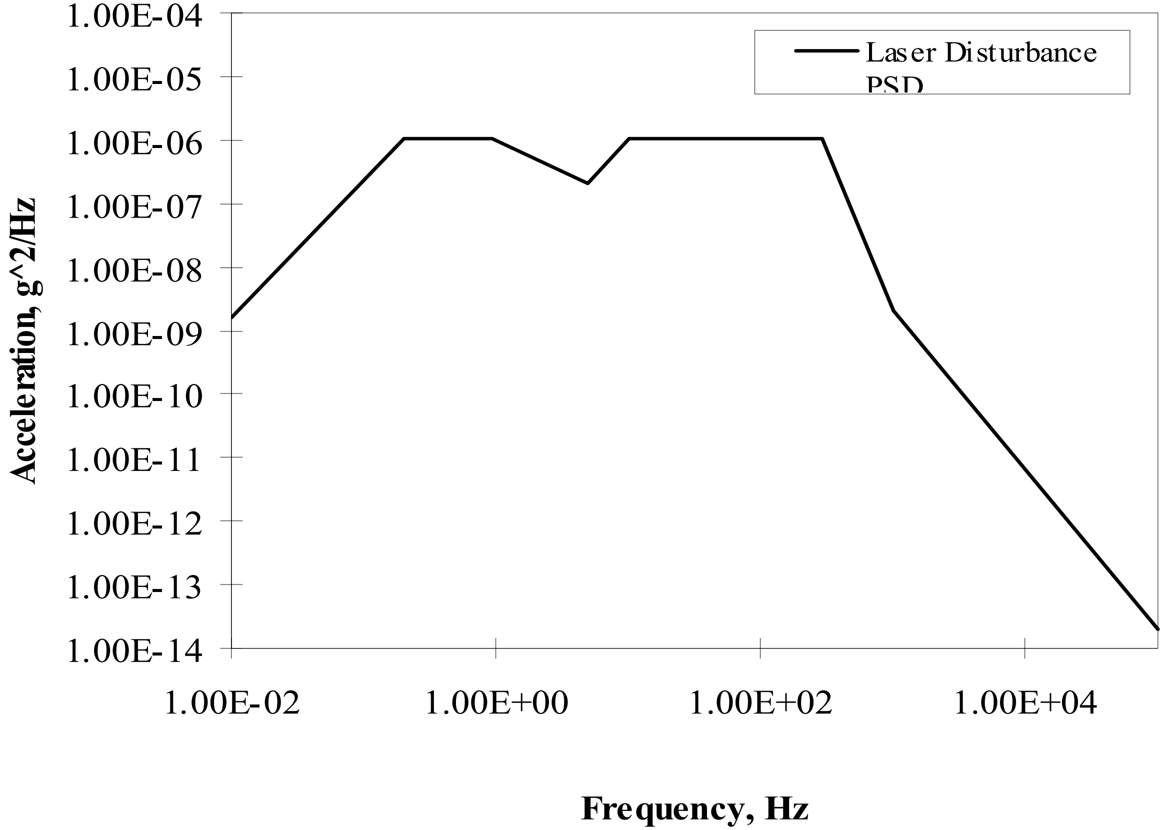
Rotational Base Acceleration PSD
Filtered Reaction Wheel Disturbance



Frequency Range	PSD Value
0.1-5 Hz	+12 dB/Octave
5-25 Hz	7.5e-9 $(rad/s^2)^2/Hz$
25-500	-12 dB/Octave
500-2000	-24 dB/Octave

Rotational base acceleration PSD due to filtered reaction wheel disturbance

Filtered Laser Disturbance Composite Acceleration Spectra (g^2/Hz)



Traceability

Contractors must show traceability to NGST and SBL

- Areal Density
- Radius of Curvature Matching
- Total Surface Error
- Dynamic Performance
- Survival Environment
- Operating Temperature
- Slew Response
- Line of Sight Stability
- Coating
- Thermal Loading
- Manufacturability
- Cost

AMSD Implementation Approaches

AMSD is exploring multiple design solutions to achieve SOW Requirements.

Design	Ball	Kodak	Goodrich
Facesheet	Beryllium	ULE Glass	Fused Silica
Diameter	1.38 meter	1.4 meter	1.3 meter
Reaction Structure	Composite	Composite	Composite
Actuators	4 Displacement	16 Force	37 Displacement
Control Authority	Low	Medium	High
Mounting	Spreader Bar and Flexures	3 Hard Points & 16 Force	3 Biaxial & 34 Axial Flexure